Recommendations by Experts on the Required Parameters for Microplastics Monitoring in the Ocean

As of 12 June 2018

The following table shows recommendations on procedures for monitoring microplastics in the ocean as a result of discussions among the international experts who attended the meetings organized by the Ministry of Environment, Japan (MOEJ).

The Japanese Government has been working towards standardization and harmonization of monitoring procedures for microplastics in the ocean in accordance with discussions about the importance of marine litter at the G7 Elmau Summit and other international meetings.

The recommendations are made for the purpose of compiling a 2-dimensional worldwide distribution map (2-D map) of microplastics, and to be updated as necessary.

The first draft of the recommendations was made based the discussion in the first experts meeting in 2016. This version was revised based on the discussion of inter-laboratory calibration exercise results at the second experts meeting in February 2018.

Item	Recommendations for microplastics monitoring in the ocean	Background/reason for recommendation
Sampling		
Sampling equipment	Neuston/ manta net (single net)	
	[for specific purposes] Sampling by bottle or vessel's underway pump[*1]	[*1]:A bottle or the vessel's underway pump can be selected instead of the net or for specific purposes to focus on particles smaller than the net aperture. (Note: While a grab sampler is used to collect sediment samples for studying the accumulation or fate of microplastics, the procedure is not covered here.)
	[for specific purposes] Neuston/manta net (multiple connection)	
(Mesh size)	Less than 0.4 mm[*2]	[*2]:The smaller the better, but it should be considered that mainstream mesh sizes are 0.330 or 0.355 mm.
	[for specific purposes] No lower limit (decide in accordance with research needs)	

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Towing procedure	The towing procedure should be decided by each researcher according to the purpose, necessary number of particles, conditions in the target area, and so on. The important considerations are as follows.*1 1) Tow time, speed and area: about 20 minutes (based on literature) at 2-3 knots, which converts to about 1000 m^2 sampling area/tow, but this would depend on plankton abundance. 2) Tow length: consider the rough particle volume of the target sea area (to estimate minimum particle abundance), and existence of biota 3) Tow number: needs further consideration, but depends on tow time, length, and area considerations.	*1: It is suggested that a tow direction against the wind is important for reducing the sampling variability. If every tow is perpendicular to the wind direction, data variability (standard deviation) is minimized and the necessary number of tows is decreased. *(Reference: Based on Dr. Cozar's study in the North Pacific, an optimal tow number and sampling area to obtain an average value would be 120 tows and 174,000 m^2, respectively.* *Goldstein et al.(2012) also shows 50 tows and 33,000m^2, and also suggests 250 tows as an optimal sampling effort, corresponding to 165,000m^2.* *Area figures from two analyses show the sampling area to be better than tow number as a sampling effort unit.)*
Metadata	(Major items)*1 - Sampling level (depths) - Wind speed - Beaufort scale - Current speed and direction - Filtered volume - Log -	*1: Metadata are critical to introducing inter-comparability and helping harmonize. *(Reference: EU has a table on metadata.)*

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	[for specific purposes] - Significant wave height - T/S record (locations of oceanic fronts) - Photos or videos of net towing*2	*2: It is useful to assess sea states, use automatic detection for larger plastics and understand wind row issues.
Primary analysis		
Sample processing	Record how each sample was stored and processed, including description of chemical treatment. *1	*1: Number of microplastics in organisms could be counted when chemical treatment is implemented.
	Special care should be taken to distinguish plastics from natural particles. *2	*2: Even in other laboratories that did not use equipment such as FTIR or Raman spectrometers for ILC, by carefully confirming plastic particles, the accuracy reported was similar to those that used equipment such as FTIR or Raman spectrometers.
	To enhance reliability, it is required to provide or report QA/QC data. *3 Any use of procedural blanks and blank corrections should be noted.	*3: Examples of QA/QC data can be procedural blanks, recovery rate, repeatability, etc. Subset of sample analysis should be confirmed with further analytical methods such as FTIR or Raman spectrometers. FTIR or Raman spectrometer should be used when visual identification can be/should be supported by FTIR or Raman, if the particles are less than 1mm.

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Sample processing	When taking out particles from samples, care should be taken not to overlook smaller particles less than 1 mm.*2 It is recommended to use stereo microscope to take out particles. Particles should be dried thoroughly before weighing them.	*2: When filtering particles from the samples, particles with minor diameters smaller than the sieve openings passed through the sieve, even though the major diameter was larger than the sieve openings. Also, when picking up particles from sieves and filters, it became difficult to visually spot transparent particles mixed among contaminants, so small particles were overlooked. Regarding the method of filtering particles from samples, using sieves and then filtering the particles that passed through the first sieves again with sieves or filters with smaller openings, improves the accuracy of filtration and is effective in operation.
	[for specific purposes] Density separation or chemical processing (e.g., H_2O_2 treatment)	The type of processing is important with regard to harmonization.
Size of particle	Length (longest length (maximum Feret's diameter) *1)	*1: Aperture length is the size of the smallest opening through which the particle can pass. This means that even if the mesh size is 0.3 mm, it doesn't mean that any particle less than 0.3 mm is not captured. It depends on the shape.
	It is recommended to use image processing software to acquire additional size dimensions, for example minimum aperture length.*2	*2: Provide comment on the reason for the additional experiment. If particles are classified according to type, it will be possible to convert area to weight with equations of volume and weight.
Concentration (particle counts/weight) by size	5 mm*1>d	*1: While 'micro' means from 1 micron to 1,000 microns in SI, the definition of microplastics in policy (NOAA, EC Directive) is particles of less than 5 mm.

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categories	[for specific purposes] d≥5 mm d< 1 mm (The result of d < 1 mm should be reported separately from the result of d ≥ 1 mm. *2)	*2: In the result of the ILC, while the accuracy for the measured number of particles ≥ 1mm was high, for particles less than 1mm the result tended to be smaller than the actual number. Data should be accumulated to determine the factor to convert the measured number of particles less than 1mm to a more authentic number. Analysis of microplastics in marine organisms (plankton, fish, etc.) is necessary when investigating biological effects, etc.
	Measuring weight is optional, especially for particles less than 1mm. Sufficient drying is required and chemical processing is recommended before weighing *3.	*3: Converting numbers to weight is possible assuming particle size, shape and density. Data from actual sea areas need to be accumulated to compare the results of numbers and weight. Moisture and electro-static changes the results.
Units (metrics)	- Particle count per unit area or weight per unit area*1 Area is calculated by the width of the net and towed length	*1: If the dimensions of net aperture are recorded, the per unit area could be converted to per unit volume with certain assumptions. *1: Use of unit area is better for talking about floating plastics, while concentration per volume depends on the sea state and sampling depth.
	- Particle count per unit volume or weight per unit volume*2 For calculating the volume, it is important to record flowmeter data, speed thorough the water, tow distance and tow time.	*2: Unit volume would be used in talking about contaminants or environmental modelling for calculations. *1,*2: A convincing explanation on why two-dimensional units should be used is that the nature of the sample is mostly at the surface, where it affects organisms, such as surface feeding fish and birds

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Colour	Record the colour of each particle [for specific purposes] Photos of microplastics samples to categorize the color.	
Particle type categories	(Five broad categories) 1) Fragments (irregular shapes particles, crystals, powder, granules, shavings, fluff, films) 2) Beads (grains, spherical microbeads, microspheres) 3) Foams (expanded polystyrene) 4) Pellets (nibs, nurdles, reproduction resin pellets) 5) Fibers (filaments, lines, microfibers, strands, threads, strings, etc.)	(A specific discussion) *In the "fibers" category, separation between lints and fishing lines should be considered; lints can originate from ropes, fishing lines or other products but they are likely mainly of textile origin. Moreover, lints can be transported by air currents, becoming very abundant, and are the main candidates for contaminating samples. "Potential textile fibers" can be identified according to shape and rigidness, although they can be difficult to classify in some cases. Lints typically ranged from hundreds of microns to centimeters in length and from one to a few tens of microns in width, being easily folded; whilst pieces of fishing lines are wider and generally straight in shape.*
Polymer types (for specific purposes)	[for specific purposes] If you need additional information on polymer composition, spectroscopy or similar methods should be used.	PE, PP, PS, others
Sample preservation	Maintain visual representation (pictures, etc.) of all individual particles Store and record samples	
Contamination	Record possible risks (quantify) and take steps to prevent contamination	

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Automation	[for specific purposes] FTIR can be semi-automated Automation of measurement parameters[*1] (e.g., size, colour, polymer type)	[*1]:Depending on progress of automating technologies, monitoring method categories may change from 'recommended' to 'minimum' in the future.