



EFH-EG-3

Assessment of marine litter in the Egyptian Mediterranean coastline and proposed management options

Overview of best practice marine litter monitoring methodologies and management measures (EFH-EG-3, Task 2)

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THE SWIM AND H2020 SUPPORT MECHANISM PROJECT (2016-2019)

The SWIM and H2020 SM is a Regional Technical Support Program, funded by the European Commission, Directorate General (DG) NEAR (Neighborhood and Enlargement Negotiations), that includes the following Partner Countries (PCs): Algeria, Egypt, Israel, Jordan, Lebanon, Libya, Morocco, Palestine, [Syria] and Tunisia. However, in order to ensure the coherence and effectiveness of Union financing or to foster regional co-operation, eligibility of specific actions will be extended to the Western Balkan countries (Albania, Bosnia Herzegovina and Montenegro), Turkey and Mauritania. The Program is funded by the European Neighbourhood Instrument (ENI) South/Environment. It ensures the continuation of EU's regional support to ENP South countries in the fields of water management, marine pollution prevention and adds value to other important EU-funded regional programs in related fields, in particular the SWITCH-Med program, and the Clima South program, as well as to projects under the EU bilateral programming, where environment and water are identified as priority sectors for the EU co-operation. It complements and provides operational partnerships and links with the projects labelled by the Union for the Mediterranean, project preparation facilities in particular MESHIP phase II and with the next phase of the ENPI-SEIS project on environmental information systems, whereas its work plan will be coherent with, and supportive of, the Barcelona Convention and its Mediterranean Action Plan.

The overall objective of the Program is to contribute to reduced marine pollution and a more sustainable use of scarce water resources. The Technical Assistance services are grouped in 6 work packages: WP1. Expert facility, WP2. Peer-to-peer experience sharing and dialogue, WP3. Training activities, WP4. Communication and visibility, WP5. Capitalizing the lessons learnt, good practices and success stories and WP6. Support activities.



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ABBREVIATIONS

ATR	Attenuated Total Reflectance
COP	Conference of the Parties
D10	Descriptor 10
EC	European Commission
EO	Ecological Objective
EU	European Union
FTIR	Fourier-Transform Infrared Spectroscopy
GES	Good Environmental Status
GPS	Global Positioning System
H2020	Horizon 2020
ICZM	Integrated Coastal Zone Management
IMAP	Integrated Monitoring and Assessment Programme
LBS	Land-Based Sources
MSFD	Marine Strategy Framework Directive
NaCl	Sodium chloride
NAP	National Action Plan
NGO	Non-Governmental Organization
NKE	Non-Key Expert
ROVs	Remotely Operated Vehicles
SCUBA	Self-contained underwater breathing apparatus
TG	Technical Group
UNEP/MAP	United Nations Environment Programme/Mediterranean Action Plan



1 GENERAL INTRODUCTION

Marine litter -any persistent, manufactured or processed solid material discarded, disposed of or abandoned in the marine and coastal environment- is globally acknowledged as a major societal challenge of our times due to its significant environmental, economic, social, political and cultural implications. Marine litter negatively impacts coastal and marine ecosystems and the services they provide, ultimately affecting people's livelihoods and well-being.

Marine litter related information in the Mediterranean, remains limited, inconsistent and fragmented, however it is widely accepted that it is one of the most affected seas by marine litter worldwide. Effective measures to tackle marine litter in the region are seriously hampered by the lack of reliable scientific data. Within this context the need for accurate, coherent and comparable scientific data on marine litter in the Mediterranean countries is evident in order to set priorities for action and address marine litter effectively, thus ensuring the sustainable management and use of the marine and coastal environment of the region.

Within the framework of the SWIM-H2020 SM Egypt has asked for an Expert Facility Activity (EFH-EG-3) in order to assess marine litter in the Egyptian Mediterranean coastline and come up with targeted management options. This activity will support the implementation in Egypt of the obligations and measures relevant to the Regional Plan for Marine Litter Management in the Mediterranean of the Barcelona Convention and will contribute to Integrated Coastal Zone Management (ICZM) within the framework of the implementation of the regional ICZM Protocol of the Barcelona Convention. More specifically, the action will support Egypt in: integrating marine litter measures into the LBS National Action Plan in line with Article 7 of the Regional Plan; assessing marine litter in the Egyptian Mediterranean coastline in line with Article 11 of the Regional Plan; designing a marine litter monitoring programme in line with Article 12 of the Regional Plan; supporting the implementation of Regional Plan through technical assistance and capacity building in line with Article 15 of the Regional Plan.

The assessment of marine litter in the Egyptian Mediterranean coastline and the proposed management options based on the results would trigger positive changes in the design and implementation of the relevant national institutional, policy and regulatory frameworks, which should incorporate marine litter prevention and reduction measures. Furthermore, it will strengthen the regional coherence and cooperation in approaches to marine pollution prevention and control, and sustainable waste management. The areas addressed/covered by the proposed activity include a study/assessment, technical assistance and capacity building.

The overall Activity entails the following tasks:

- Task 1: Carry out marine litter pilot surveys (including a workshop) on the Med Coast of Egypt along with a literature review focusing on strengthening the evidence base concerning marine litter and in particular plastics.
- Task 2: Compile a document with 'best' available techniques and methodologies for monitoring marine litter in the coastal and marine environment and short listing of best environmental practices for management of marine litter.



- Task 3: Carry out a literature review on the degradation process for plastics.
- Task 4: Review the socioeconomic implications of marine litter.

2 AIM AND SCOPE OF THIS DELIVERABLE

The overarching aim of this document is to present a summary review of the state-of-the-art methods to monitor marine litter (macro-litter and micro-litter) in all marine compartments (beach, sea surface, seafloor, biota). This document takes stock of key documents on marine litter monitoring that have been developed to support the implementation of the Barcelona Convention Integrated Monitoring and Assessment Programme of the Mediterranean Sea and Coast (IMAP) (UNEP/MAP-MEDPOL, 2017) and the EU Marine Strategy Framework Directive with regards to marine litter (Galgani et al., 2013). In addition, this document provides an overview of best practice marine litter measures to prevent, reduce and mitigate marine litter. The compiled summary review aims to establish a common understanding within the project partnership on the recent advances made with regards to marine litter monitoring and management in order to define appropriate marine litter monitoring schemes and strategies and programmes of measures.

3 DEFINITIONS AND POLICY CONTEXT

Within this document marine litter is defined as any persistent, manufactured or processed solid material discarded, disposed of or abandoned in the marine and coastal environment. Marine litter can be classified in size classes as follows: macrolitter referring to items above 25mm in the longest dimension; mesolitter from 5mm to 25 mm; and microlitter from 1µm to 5mm. Sometimes the later size class is further broken down to large microplastics from 1mm to 5 mm and small microplastics from 1µm to 1mm.

The main legislative frameworks related to marine litter in the Mediterranean are: the Barcelona Convention Regional Plan for Marine Litter Management in the Mediterranean (UNEP/MAP IG.21/9) and the Ecosystem Approach (COP19 IMAP Decision IG.22/7); the EU Marine Strategy Framework Directive (2008/56/EC, 2010/477/EC, 2017/848/EC) and the EU Plastics Strategy (COM(2018)).



Figure 1. The Marine Litter Ecological Objective and the respective Indicators within the framework of the Barcelona Convention Ecosystem Approach and the Integrated Monitoring and Assessment Programme.

Marine Litter and the Barcelona Convention Ecosystem Approach

Ecological Objective 10 (EO10): Marine and coastal litter do not adversely affect the coastal and marine environment.

IMAP Common Indicator 22:

Trends in the amount of litter washed ashore and/or deposited on coastlines (including analysis of its composition, spatial distribution and, where possible, source).

IMAP Common Indicator 23:

Trends in the amount of litter in the water column including micro plastics and on the seafloor.

IMAP Candidate Indicator 24:

Trends in the amount of litter ingested by or entangling marine organisms focusing on selected mammals, marine birds, and marine turtles.

Figure 2. The Marine Litter Descriptor, Criteria, and respective Indicators within the framework of the EU MSFD.

Marine Litter within the EU MSFD

Properties and quantities of marine litter do not cause harm to the coastal and marine environment (Descriptor 10)

Criteria D10C1 - Primary:

The composition, amount and spatial distribution of litter on the coastline, in the surface layer of the water column, and on the seabed, are at levels that do not cause harm to the coastal and marine environment.

- ✓ amount of litter washed ashore and/or deposited on coastlines, including analysis of its composition, spatial distribution and, where possible, source (10.1.1)
- ✓ amount of litter in the water column (including floating at the surface) and deposited on the seafloor, including analysis of its composition, spatial distribution and, where possible, source (10.1.2)

Criteria D10C2 - Primary:

The composition, amount and spatial distribution of micro-litter on the coastline, in the surface layer of the water column, and in seabed sediment, are at levels that do not cause harm to the coastal and marine environment.

- ✓ amount, distribution and, where possible, composition of microparticles (in particular microplastics) (10.1.3)

Criteria D10C3 - Secondary:

The amount of litter and micro-litter ingested by marine animals is at a level that does not adversely affect the health of the species concerned.

- ✓ amount and composition of litter ingested by marine animals (10.2.1)

Criteria D10C4 - Secondary:

The number of individuals of each species which are adversely affected due to litter, such as by entanglement, other types of injury or mortality, or health effects.



4 OVERVIEW OF BEST PRACTICE MARINE LITTER MONITORING METHODOLOGIES

4.1 MONITORING MARINE LITTER ON BEACHES

Macrolitter

Beach surveys for macrolitter (items > 2.5 cm) assessment are the most common mode of marine litter monitoring in the Mediterranean. Beach litter surveys focus on the collection and visual identification and classification of litter items found at a shoreline site. The protocols applied may differ in terms of sampling units (size and positioning), frequency and timing of the surveys, size limits and classes of litter items to be surveyed, classification list and quantification units.

The guidance documents that have been produced within the IMAP and the MSFD recommend the following methodological approach:

Site selection. The survey sites are selected taking into consideration the following criteria: they have a minimum length of 100 m; they are characterized by a low to moderate slope (~1.5-4.5 °); they have clear access to the sea (not blocked by breakwaters or jetties); they are accessible to survey teams throughout the year; they are ideally not subject to cleaning activities. Furthermore, the selected beaches are situated in the vicinity of ports or harbours, river mouths, coastal urban areas, tourism destinations; and in relatively remote areas.

Frequency and timing of the surveys. Surveys are carried out at intervals of three months in autumn (mid-September to mid-October), winter (mid-December to mid-January), spring (April) and summer (mid-June to mid-July).

Sampling unit. In each survey, the sampling unit used is a 100-metre stretch from the strandline to the back of the beach. The back of the beach is identified using coastal features such as the presence of vegetation, dunes, cliff base, road, fence or other anthropogenic structures such as seawalls (either piled boulders or concrete structures). Two (2) sections of a 100-metre stretch on the same beach are monitored, separated at least by a distance of 50m.

Litter size limits and classes to be surveyed. During the surveys, all macroscopic beach litter items larger than 2.5 cm in the longest dimension are collected and counted, ensuring the inclusion of caps, lids and cigarette butts.

Identification and classification of litter. All items found on the sampling unit are collected and are categorized in accordance with the 'MEDPOL Beach Litter Survey Form' or the 'MSFD TG10 Master List of Categories of Litter Items'.

Quantification of litter. Results are expressed as counts of litter items per square meter (m²) or counts of litter items per 100-metre stretch of beach.



Figure 3. The sampling unit for monitoring litter on beaches.



Microlitter

Microparticles, mainly microplastics, comprise a very heterogeneous assemblage of pieces that vary in size, shape, colour, specific density, polymer type, and other characteristics. Within the framework of the Marine Strategy Framework Directive, the Technical Group on Marine Litter (MSFD TG10) has developed guidelines on monitoring microplastics in beach sediments (Galgani et al., 2013).

Sampling. Microplastics should be monitored at the front of the shore (strandline) and where possible on sandy shores (0.1 - 0.0125 mm diameter). Separate samples should be collected to monitor two size classes of microplastics: large microplastics with size in the range of 1-5 mm; small microplastics with size in the range of 20 µm - 1 mm. Samples should be collected from the upper 5 cm of the beach sediment. A minimum of five replicate samples should be collected starting from the strandline. Each replicate should be separated by at least 5 m. In addition the replicates should be distributed in a stratified random manner so as to be representative of the entire beach or of a specific beach section. Regarding large microplastics (1 – 5 mm), they should be sampled by stacking together a 5 mm sieve with a 1 mm sieve to achieve sample volume reduction. Small microplastics (20 µm - 1 mm) should be collected from the top 5 cm of sand, using a metal spoon. The collection of approximately 250 ml of sediment is recommended. The sediment should be stored in metal or glass containers.

Sample processing. Density separation is being recommended for the extraction of the microplastics with the use of a concentrated saline NaCl solution (1.2 g/ml).

Sample analyses. Microplastics are commonly identified either by using Fourier-Transform Infrared Spectroscopy (FTIR) with ATR (Attenuated Total Reflectance) or Raman Spectroscopy. The latter is a

relatively easier and faster semi-automated technique. Most Raman instruments are able to match the sample spectra to a spectral library to identify the specific polymer. Raman Spectroscopy does not work well with smaller or dark-coloured microplastics and FTIR Spectroscopy may have to be used. The identification of microplastics can be performed also with visual inspection under a microscope, however this method is prone to serious errors.

Classification and quantification. Microparticles are characterized by size, type (fragments, pellets, filaments, films, foam, granules, styrofoam), shape and colour. Results are being expressed in number of microplastics or microparticles per cm³ of strandline.

Figure 4. Visual inspection of microparticles under a microscope.



4.2 MONITORING MARINE LITTER ON THE SEA SURFACE

Macrolitter

For macrolitter on the sea surface, visual observation is the most common methodology used and relies on competent and dedicated observers. The floating macrolitter surveys can be carried out from different types of vessels, ranging from small- or medium-sized boats to large ships, including platforms of opportunity such as ferries and cargo ships. In many cases, these surveys are carried out simultaneously with other research surveys such as cetacean observations.



The guidance documents that have been produced within the IMAP and the MSFD recommend the following methodological approach:

Site selection. The selected areas should include: low density areas (e.g. open sea); high density areas (e.g. close to ports); other selected areas (e.g. in estuaries), in the vicinity of cities, in local areas of touristic or commercial traffic. Incoming currents from neighbouring areas or outgoing currents should be considered.

Frequency and timing of the surveys. At least two surveys, one in autumn (mid-September to mid-October) and one spring (April) should be carried out. Ideally the visual observations should be carried out after a minimum duration of calm sea, so that there is no bias by litter objects which have been mixed into the water column by recent storms or heavy sea. In addition, the wind speed should be less than 2 Beaufort.

Survey area. The survey area is defined by the transect width and length. The transect length will be determined from the latitude and longitude of the transect start and end points obtained by GPS. Typically a transect width of 10 m is expected, however depending on the observation level of the surveyor for the predefined ship speed of 2knots (3.7 km/h) the following transect widths might be used:

Table 1. Observation width from different observation levels above the sea for a ship speed of 2knots.

Observation level of the surveyor above the sea	Observation width (ship speed = 2knots)
1 m	6 m
3 m	8 m
6 m	10 m
10 m	15 m

Visual observation considerations. The observation from boats should ensure the detection of litter items in the size range of 2.5 cm to 50 cm, therefore the speed of the boat should not be higher than 3 knots. The observation, quantification and identification of floating litter items must be made by a dedicated observer who does not have other duties at the same time. The transect length should correspond approximately to 1 h of observation for each survey. The ideal location for observation is often the bow area of the boat. The observation direction must be perpendicular to the boat track (see Figure 5). The surveyor should conduct the survey from the glare-free side of the vessel and to avoid the hours of the day when the sun is low on the horizon (sunrise and sunset), since visibility is not good enough due to glare and/or reflection.

Litter size limits and classes to be surveyed. Litter items in the size range of a 2.5 cm (in the longest dimension) to 50 cm should be monitored and reported. However, in order to understand the relevance of larger than 50 cm items in the statistical evaluation of data, these should be also recorded. Given that



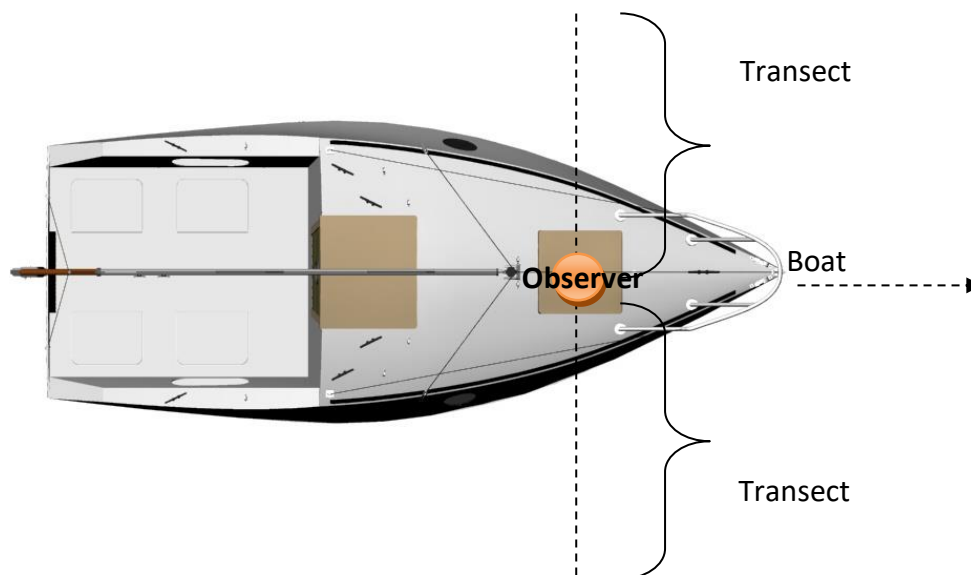
visual observation will not permit the correct measuring of object sizes, the following size range classes should be reported for each recorded litter item:

- A. 2.5cm-5cm
- B. 5cm-10cm
- C. 10cm-20cm
- D. 20cm-30cm
- E. 30cm-50cm
- F. >50cm

Identification and classification of litter. All items observed on the survey area should be classified and recorded in accordance with the 'MSFD TG10 Master List of Categories of Litter Items'. The occurrence of groups of floating litter items should be recorded along with their location as these could provide useful information with regards to accumulation areas.

Quantification of litter. The unit in which litter should be assessed on the sea surface is number of items and it should be expressed as counts of litter items per square kilometre (litter items/km²). In order to compute the exact surveyed area, GPS coordinates must be recorded regularly (every min) to obtain an accurate measurement of the travelled transect.

Figure 5. The ideal location of the observer for performing a floating litter survey.



Microlitter

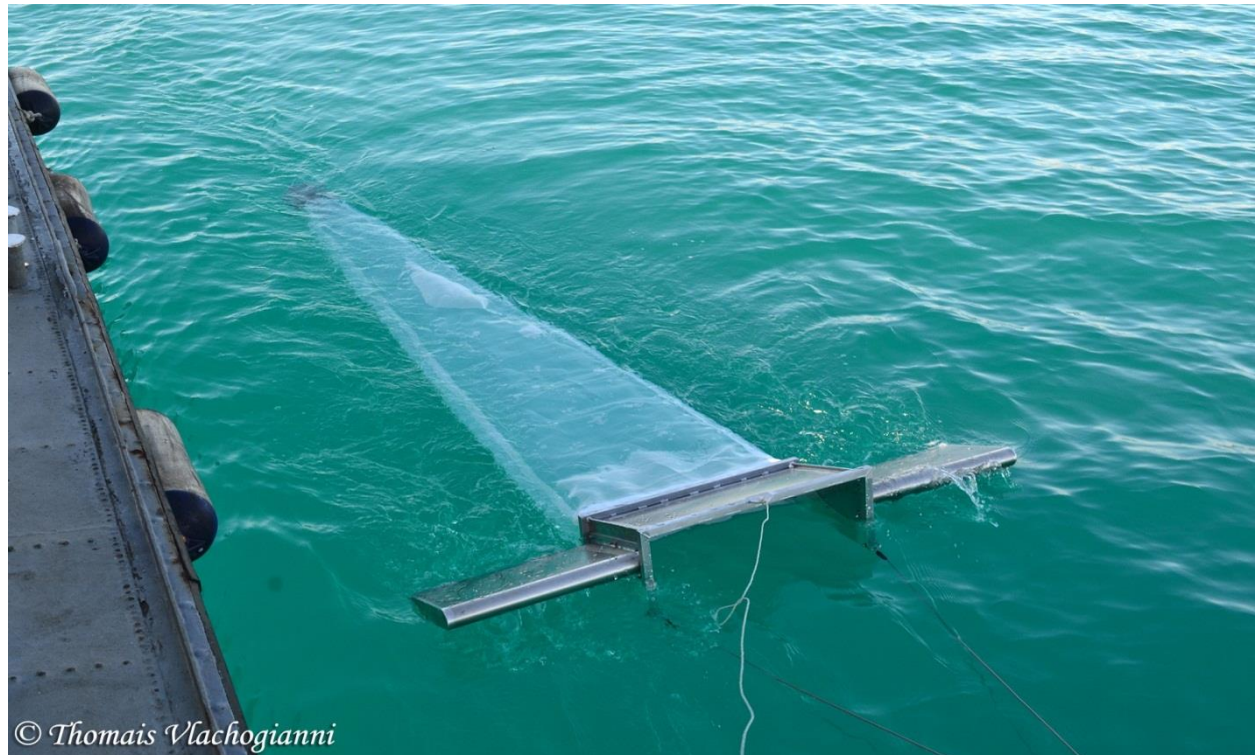
The most commonly used approach for monitoring floating micro-litter entails the use of a Neuston nets and manta nets that sample the microlitter.

Sampling. The MSFD Technical Group on Marine Litter recommends a manta net with 333 µm mesh size and a length of 6 m in order to ensure inter-comparability of obtained results. A 30-min sampling duration



is suggested, at a vessel speed kept under 3 knots. Start and end position points should be recorded from the ship's GPS. All tows should be conducted from the ship's side and beyond the ship's wake. After the completion of each tow the net has to be washed thoroughly with seawater in order to collect all particles in the cod end. The sample collected in the cod end should be rinsed with seawater on a 300µm metallic sieve and transferred in glass jars in 70% ethanol solution for analysis.

Figure 6. A manta net sampling floating microplastics.



Sample analysis. Microplastics are commonly identified either by using Fourier-Transform Infrared Spectroscopy (FTIR) with ATR (Attenuated Total Reflectance) or Raman Spectroscopy. The latter is a relatively easier and faster semi-automated technique. Most Raman instruments are able to match the sample spectra to a spectral library to identify the specific polymer. Raman Spectroscopy does not work well with smaller or dark-coloured microplastics and FTIR Spectroscopy may have to be used. The identification of microplastics can be performed also with visual inspection under a microscope, however this method is prone to serious errors.

Classification and quantification. Microparticles are characterized by size, type (fragments, pellets, filaments, films, foam, granules, styrofoam), shape and colour. Results are being expressed in number of microplastics or microparticles per square kilometre (items/km²).



4.3 MONITORING MARINE LITTER ON THE SEAFLOOR

Macrolitter

The most widespread approaches to monitor litter deposited on the seafloor include underwater visual surveys with scuba/snorkeling, bottom trawl surveys and image acquisition surveys with the use of submersibles or Remotely Operated Vehicles (ROVs). The latter methodological approach requires expensive equipment and thus underwater visual surveys with scuba/snorkeling and bottom trawl surveys are the ones recommended by the guidance documents produced within the framework of IMAP and the MSFD.

Underwater visual surveys with scuba/snorkeling at shallow seafloor (0-20 m)

Site selection. Sites should be selected to ensure that they: consider areas that might accumulate litter; avoid areas of risk (presence of munitions and other hazardous waste), sensitive or protected areas; do not exert impacts on any endangered or protected species; avoid areas with strong currents or waves; avoid navigation routes of vessels that might put divers in danger. Sites should be chosen following a two-fold approach: (i) selecting sites that meet certain criteria (e.g. are close to ports, river mouths, cities, etc.); (ii) choosing randomly from a large number of sites.

Survey area & sampling unit. The survey area is defined by the transect width and length. Surveys are conducted through two (2) line transects for each sampling site. The line transects are defined with a nylon line, marked every 5 meters with resistant paints, that is deployed using a diving reel while scuba diving. Distances should be determined either by laying out a 100 m tape measure or alternatively by laying a 100 m length of weighted rope across the bottom. The start and end point of each transect should be identified with marker buoys and recorded using a GPS. The length of the line transects could vary between 50 m to 200 m and the width from 4 m to 8 m, depending on the depth, the depth gradient, the turbidity, the habitat complexity and the litter density (see table below).

Table 2. Suggested transect lengths and widths for underwater visual surveys, taking into consideration the environmental conditions and the litter densities.

Debris Density	Environmental Conditions	Sampling Unit (length x width)
0.1 – 1 items / m ²	Low turbidity & high habitat complexity	20 m x 4 m
0.1 – 1 items / m ²	High turbidity	20 m x 4 m
0.01 – 0.1 items / m ²	In every case	100 m x 8 m
< 0.01 items / m ²	In every case	200 m x 8 m



Frequency and timing of the surveys. At least two surveys in autumn and spring should be carried out. The proposed surveys periods are: autumn (September-October) and spring (April).

Size classes to be surveyed. The following size range classes will be reported for each recorded litter item:

- A. $< 5\text{cm} \times 5\text{cm} = 25\text{cm}^2$
- B. $< 10\text{cm} \times 10\text{cm} = 100\text{cm}^2$
- C. $< 20\text{cm} \times 20\text{cm} = 400\text{cm}^2$
- D. $< 50\text{cm} \times 50\text{cm} = 2500\text{cm}^2$
- E. $< 100\text{cm} \times 100\text{cm} = 10000\text{cm}^2 = 1\text{m}^2$
- F. $> 100\text{cm} \times 100\text{cm} = 10000\text{cm}^2 = 1\text{m}^2$

Identification of litter and classification of litter. When conducting underwater visual surveys with scuba, lighter litter items should be collected (while larger items should be just marked), brought ashore and entered in the recording sheet. All items observed on the survey area should be classified and recorded in accordance with the 'MSFD TG10 Master List of Categories of Litter Items'.

Quantification of litter. The unit in which litter should be recorded is number of items and it should be expressed as counts of litter items per square kilometre (items/Km²).or items per square metre (items/m²).

Figure 7. Litter items collected at an underwater visual survey with scuba.





Bottom trawl surveys (200-800 m)

Site selection. Sites should be selected to ensure that they: comprise areas with uniform substrate (ideally sand/silt bottom); consider areas that might accumulate litter; avoid areas of risk (presence of munitions), sensitive or protected areas; do not exert impacts on any endangered or protected species. Sites should be chosen following a two-fold approach: (i) selecting sites that meet certain criteria (e.g. are close to ports, river mouths, cities, etc.); (ii) choosing randomly from a large number of sites.

Survey area. With regards to the sampling area, a depth stratified sampling scheme with random selection of trawling sites (same positions each year) within each stratum should be used. The sampling strata are the depth zones: 10-50, 50-100, 100-200, 200-500 and 500-800 m. The number of stations in each stratum is proportional to the surface of these strata. The size of the sampling area should be defined by each surveying team on the basis of the resources available for this task.

Frequency and timing of the surveys. At least two surveys, one in autumn and one in spring should be carried out. The proposed surveys periods are: autumn (September-October) and spring (April). The hauls should be ideally performed during daylight. The daylight period is defined as the time between 30 minutes after sunrise and 30 minutes before sunset.

Trawling operation. Given that surveys might be performed with otter trawl fishing fleets or research vessels which use different gear, it is evident that handling operations and parameters (such as type of mesh, mesh size of cod end, etc.) during the surveys cannot be standardized. Nevertheless, the following recommendations should be followed as close as possible:

- **Haul position & orientation:** The hauls should be positioned following a stratified sampling design, including at least three strata from the following ones: 10-50, 50-100, 100-200, 200-500 and 500-800 m. The hauls should be made over the same position in each sampling survey. The depth variations during the haul will not exceed $\pm 5\%$ relative to the initial depth. The discrepancies to this target should be recorded. As far as possible, the hauls will be rectilinear.
- **Haul speed & duration:** The vessel speed should be 3 knots during the haul. However, if the skipper indicates that a slightly different speed is appropriate for optimal gear operation (depends on net characteristics) the vessel speed will be altered accordingly. In any case, vessel speed, hauling depth and geographical position should be continuously monitored during the haul (e.g. every 5 min). The haul duration is fixed at 30 minutes on depths less than 200 m and at 60 minutes at depths over 200m.
- **Haul start and end definition:** The start of the haul is defined as the moment at which the trawl geometry (vertical and horizontal) is stabilized. In the absence of electronic equipment (acoustic devices like SCANMAR, etc.) the actual start time will be indicated by the skipper. The end of the haul is defined as the moment at which warp hauling begins.
- **Gear characteristics:** Cod-end mesh size and head rope length should be recorded.



Size classes to be surveyed. The following size range classes should be reported for each recorded litter item:

- A. $< 5\text{cm} \times 5\text{cm} = 25\text{cm}^2$
- B. $< 10\text{cm} \times 10\text{cm} = 100\text{cm}^2$
- C. $< 20\text{cm} \times 20\text{cm} = 400\text{cm}^2$
- D. $< 50\text{cm} \times 50\text{cm} = 2500\text{cm}^2$
- E. $< 100\text{cm} \times 100\text{cm} = 10000\text{cm}^2 = 1\text{m}^2$
- F. $> 100\text{cm} \times 100\text{cm} = 10000\text{cm}^2 = 1\text{m}^2$

Identification of litter and classification of litter. When conducting underwater visual surveys with scuba, lighter litter items should be collected (while larger items should be just marked), brought ashore and entered in the recording sheet. All items observed on the survey area should be classified and recorded in accordance with the 'MSFD TG10 Master List of Categories of Litter Items'.

Quantification of litter. The unit in which litter will be recorded will be number of items and it will be expressed as counts of litter items per square kilometre (items/Km²).

Microlitter

Microplastics monitoring on the seafloor is commonly performed by recovering a sample of relatively undisturbed surface sediment from the seafloor using any of the following instruments: Van Veen grab sampler, multi-corer, box core, etc. A small sample of sediment, ideally 250 ml is transferred to a metal or glass container for subsequent density separation and FTIR Spectroscopy (see para on microplastics in Chapter 6).

4.4 MONITORING MARINE LITTER IN BIOTA

Monitoring marine litter in relation to biota refers mainly to monitoring ingestion of litter by different species and entanglement of different species in marine litter items. The most widespread approach for monitoring marine litter in biota focuses on determining the ingested items by marine species.

The guidance documents produced within the framework of IMAP and the MSFD describe the following protocols for ingested litter: protocol for monitoring litter ingested by sea turtles (stranded *Caretta caretta*) and protocol for monitoring litter ingested by fishes. Given the diversified approaches for processing and analysing biota samples and the ongoing work towards harmonizing marine litter monitoring in biota, the present document will not address in detail this issue but will provide a general overview of the overall approach.

The methodological approach for sampling strategies vary according to the species, the size of the organisms and the desired analytical level. Generally, the whole organism is analysed when small invertebrates/fish species are being investigated, whereas for larger organisms the gastrointestinal tract or faecal pellets are the main samples to be analysed. Once the samples are processed, the marine litter



items are identified and classified in accordance with the 'MSFD TG10 Master List of Categories of Litter Items'.

The results of the analysis of marine litter ingestion are expressed as follows:

- Presence/absence of litter in the whole organism/ gastrointestinal tract /faecal pellets;
- Occurrence (%) of individuals that have ingested marine litter among a subpopulation/population/species;
- The abundance (N) and weight (g) of marine litter (macro- and micro-litter) ingested per individual (N items/individual; g/individual) as a total and per category of litter.

Figure 8. Investigation of ingested litter by commercially found fish species with the use of a stereoscopic microscope.



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5 OVERVIEW OF BEST PRACTICE MARINE LITTER MEASURES

The Barcelona Convention Regional Plan for Marine Litter Management in the Mediterranean was the first legally-binding plan adopted at Regional Seas Programme level. The Regional Plan provides for a set of measures and implementation timetables to prevent, reduce and mitigate the adverse effects of marine litter on the coastal environment and marine environment. The measures provided in the Regional Plan are of policy, legal, institutional, regulatory (including economic incentive instruments) and technical nature, addressing different aspects of marine litter prevention and management from land and sea-based sources. They impose clear obligations regarding the waste management hierarchy, closure of illegal dumping/dumpsites, shift to sustainable consumption and production patterns, removal of existing marine litter using environmental sound practices, reporting on implementation of measures as well as enforcement of national legislation. A considerable number of measures are to be implemented by the Contracting Parties by 2020 at the latest.

The Marine Strategy Framework Directive requires EU Member States to ensure that, by 2020, "properties and quantities of marine litter do not cause harm to the coastal and marine environment". To fight marine litter, Member States have drawn on a number of existing EU laws, notably on waste management, urban waste water or port reception facilities, as well as on international agreements and the action plans of the Regional Sea Conventions. The programmes of measures for marine litter have to be seen in the wider context of developments at EU level, which have led to the adoption of the Circular Economy Package, the European Strategy for Plastics and landmark agreement to slash plastic pollution from single-use items. This agreement signs off on measures that include bans on single-use plastic cutlery, plastic plates, plastic straws, cotton bud sticks made of plastic and plastic balloon sticks. Furthermore, oxodegradable plastics and food containers as well as expanded polystyrene cups are also expected to be banned. These new measures reinforce the application of the 'polluter pays' principle and also impose an Extended Producer Responsibility regime for fishing gear to ensure that manufacturers, and not fishermen, bear the costs of collecting nets lost in the sea.

Several initiatives carried out at European Regional Seas level have sought to gather information on marine litter best practice measures in order to concretely support the implementation of the Barcelona Convention Regional Plan and the EU Marine Strategy Framework Directive. In this respect, one of the most recent related initiatives has been the Interreg Med ACT4LITTER project (<https://act4litter.interreg-med.eu/>).

ACT4LITTER sought to offer concrete solutions to prevent and mitigate the impacts of marine litter and, specifically plastics; and in this respect, the project elaborated a comprehensive list of showcases of applied measures that fall within one of the following categories: regulatory policy instruments (command and control instrument) which address waste management issues (solid waste management laws and regulations, etc.); economic or market-based policy instruments (e.g. taxes and tariffs, liability instruments, payment for ecosystem services; subsidies, deposit refund schemes, environmental agreements; voluntary schemes such as EMAS, ISO 14001, Ecolabel, etc.), other voluntary agreements,



awareness raising and environmental education campaigns, removal and cleanup actions. ACT4LITTER identified a list of one hundred showcases of marine litter measures, with a particular focus on prevention measures. All identified measures were grouped into different categories (see Table 3) and they were fully mapped in order to provide valuable information with regards to their operationalization on the ground. Paragraphs 5.1-5.20 provide indicative examples of marine litter measures per category. The ACT4LITTER measures list as well as some other useful resources such as the MARLISCO Guide for reducing marine litter (in Arabic) can be found in Annex I and Annex II, respectively.

Table 3. *Marine litter measures categories (adapted from ACT4LITTER).*

No	Measure category
1	Actions to phase out microplastics
2	Actions to reduce cigarette butts on beaches
3	Adopt-a-beach schemes
4	Awareness raising campaigns
5	Banning specific items and activities
6	Cleanup campaigns and removal actions
7	Derelict fishing gear management schemes
8	Design for lifecycle
9	Eco-labelling and Environmental Management Systems
10	Fishing for litter schemes
11	Imposing a fee/tax/levy
12	Improving and enforcing the solid waste related policies and regulatory frameworks
13	Improving port reception facilities for the delivery of waste from ships
14	Improving wastewater management systems
15	Marking and retrieval of fishing gear
16	Promoting best practices for recreational fishing
17	Promoting best practices for tourism and recreation
18	Promoting extended producer responsibility schemes (e.g. deposit-refund systems)
19	Promoting the replacement of single-use plastics
20	Upcycling and/or recycling



1 Actions to phase out microplastics

These refer to lead to a phase-out of microplastics, either by imposing legislative bans on microplastics or by voluntary agreements of industry for their phase-out.

2 Actions to reduce cigarette butts on beaches

These refer to specific actions that can reduce the amount of cigarette butts discarded on beaches i.e. educational and awareness raising activities targeted to community members promoting responsible behaviours; providing smokers with an easily accessible and reusable means to dispose of their cigarette butts responsibly such as cone-ashtrays; development of policies designed to significantly reduce the amount of cigarette butts thrown onto the beach by smokers, including fees and bans or the establishment of an extended producer responsibility schemes for cigarette butts.

3 Adopt-a-beach scheme

This is a measure designed to foster volunteer stewardship by encouraging volunteers to 'adopt' beaches, clean them up and survey them throughout the year, thus collecting valuable marine litter data essential for facilitating effective responses against marine litter. In order to assist the Contracting Parties to reduce marine litter on beaches along the Mediterranean coastline with the active involvement of civil society and public, the UN Environment/MAP has developed guidelines on how set up an adopt-a-beach scheme.

4 Awareness raising campaigns

This entails wide-ranging activities such as school interventions, communication campaigns, cleanups, workshops, summer schools, exhibitions and others, aiming to deepen public understanding on the issue of marine litter and catalyze change in their perceptions and attitudes towards waste.

5 Banning specific items and activities

This entails legislative actions for banning certain items or activities. Indicative examples are the measures foreseen under the upcoming EU Single-Use Plastics Directive that include bans on single-use plastic cutlery, plastic plates, plastic straws, cotton bud sticks made of plastic and plastic balloon sticks as well as oxodegradable plastics, food containers and expanded polystyrene cups.

6 Cleanup campaigns and removal actions

This measure refers to cleanup and removal actions implemented at the coast or at sea, with environmental friendly methods.

7 Derelict fishing gear management schemes

This measure refers to the involvement of fishermen in the collection and proper management of abandoned, lost and discarded derelict fishing gear. This measure may entail actions related to targeted recovery of 'ghost nets' (accidentally lost fishing nets that continue to catch marine organisms as they keep on drifting in the sea or along the bottom, often for very long periods) from the sea, with the direct involvement of fishermen and divers.



8 Design for Life Cycle

This approach challenges the product designers to consider the entire life of the product, including its recycling and disposal options. Design-for-life-cycle and eco-design within a circular economy context are all about smart, innovative and sustainable design solutions with minimal or no waste when a product is consumed, i.e. the design of a push-tap opening of metal beverage cans, the design of lids of beverage bottles or containers attached to bottles with a leash.

9 Ecolabelling and Environmental Management Systems

Ecolabelling is a voluntary method of environmental performance certification and labelling that is practised around the world. An ecolabel identifies products or services proven environmentally preferable overall, within a specific product or service category. An indicative example of ecolabel is the Blue Flag, which is one of the world's most recognised voluntary eco-labels awarded to beaches, marinas, and sustainable boating tourism operators. In order to qualify for the Blue Flag, a series of stringent environmental, educational, safety, and accessibility criteria must be met and maintained. An indicative example of an Environmental Management System is the ISO 14001:2015.

10 Fishing for litter scheme

This is a measure designed to encourage fishermen to bring ashore litter they catch while performing their daily fishing operations, not only leading to removal of marine litter but also raising awareness on the issue within the fisheries sector and the wider public.

11 Imposing a fee/tax/levy

One of the most common economic instruments used in the waste sector is the application of a tax or levy on waste sent to landfill. Landfill taxes/levies can help to tackle marine litter by increasing the price of landfill to encourage the diversion of waste to other forms of treatment that are higher up in the waste hierarchy, including closed-loop waste-management processes such as recovery, recycling or reuse. Furthermore, taxes/levies can be applied on specific items such as plastic bags.

12 Improving and enforcing the solid waste related policies and regulatory frameworks

This refers to command and control instruments which address waste management issues i.e. solid waste management laws and regulations.

13 Improving port reception facilities for the delivery of waste from ships

To limit and control discharges at sea, ports have to provide adequate facilities to collect all sorts of waste from ships. The relevant international norms are established by the International Convention for the Prevention of Pollution from Ships (MARPOL). However, while MARPOL provides a comprehensive framework, it does not provide effective enforcement mechanisms. In order to ensure a better enforcement of the MARPOL obligations the UN Environment/MAP has developed guidelines on the 'Provision of Reception Facilities in ports and delivery of ship-generated wastes'.

14 Improving wastewater management systems

This refers to technological solutions and innovations needed in order to ensure that wastewater treatment systems prevent effectively the leakage of microlitter into the environment.



15 Marking and retrieval of fishing gear

Fishing gears are marked to establish their ownership and legality of use. Gear marking is considered as an important tool to reduce abandoned, lost, or discarded fishing gear and to fight illegal, unreported, and unregulated fishing. Traditionally physical marking, inscription, writing, color, shape, and tags have been used for ownership and legality purposes, and buoys, lights, flags, and radar reflectors are used for marking of position. More recently, electronic devices are being used for easier location of the gear from a distance or unlimited tracking, even from the land.

16 Promoting best practices for tourism and recreation

This refers to the promotion of best practices within the tourism and recreation sector with regards to the prevention, reduction, reuse and recycling of waste. Indicative example is the “Responsible Beach Snack Bars” initiative, where beach snack bars voluntarily register on a list and commit themselves to comply with the ‘Decalogue of Good Environmental Practices’.

17 Promoting best practices for recreational fishing

This refers to awareness raising and educational activities aimed at promoting the implementation of responsible and environmental sustainable recreational fishing activities that minimize the loss of gear at sea and ensure proper waste disposal. In this respect some countries have developed national codes of practice for recreational fishing.

18 Promoting extended producer responsibility schemes

This measure refers to an environmental policy approach in which a producer’s responsibility for a product is extended to the post-consumer stage (waste) of a product’s life cycle, i.e. (i) Mandatory take-back system: A system that requires producers to take-back products. This may apply to products that are particularly complex or dangerous to reuse, recycle or dispose. In this case, the producer may include the costs of disposal in the price of the item; (ii) deposit/refund system: A charge is levied when the product is sold and then fully or partly refunded when the good or its container, are returned after use. Such arrangements can be mandatory or instituted on an entirely voluntary basis by producers themselves, where the recovery of items is sufficiently valuable.

19 Promoting the replacement of single-use plastics

Apart from legislative measures, there are voluntary measures that can enhance the abatement of single-use plastics. Voluntary measures at local scale can focus on setting up a deposit-refund scheme for a reusable alternative in collaboration with local businesses. An indicative example is the replacement of single-use coffee cups with reusable ones; customers pay a deposit for the coffee cup, which can be returned at stores that have joined this initiative and can be identified by a distinctive sticker placed on the store window.

20 Upcycling and/or recycling

This entails practices where by-products, waste materials, useless, or unwanted products are converted into new materials or products. Indicative examples include: recycling of packaging materials, upcycling of derelict fishing gear to yarn, using recovered plastic waste from the sea for construction purposes, etc.



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7 ANNEX I. THE ACT4LITTER MEASURES LIST



8 ANNEX II. THE MARLISCO GUIDE FOR REDUCING MARINE LITTER
