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Agenda Item 5: Development of Guidelines for Monitoring Riverine inputs of Marine Litter

Guidelines for Monitoring Riverine inputs of Marine Litter

Note by the Secretariat

The 19th Meeting of the Contracting Parties to the Barcelona Convention adopted in 2016 the Integrated Monitoring and Assessment Programme of the Mediterranean Sea and Coast and Related Assessment Criteria (IMAP) (Decision IG. 22/7). Furthermore, the Roadmap and Needs Assessment for the 2023 Mediterranean Quality Status Report was adopted in 2019 during COP21 (Decision IG.24/4), and its implementation was detailed by the 8th Meeting of the Ecosystem Approach Coordination Group (9 September 2021; UNEP/MED WG.514/3).

The 10th Ecological Objective (EO10) of IMAP focuses on Marine Litter including two common and one candidate indicators. Common Indicator 22 focuses on beach marine litter. Common Indicator 23 addresses seafloor and floating marine litter, including microplastics, while Candidate Indicator 24 focuses on the effect of marine litter on marine biota having a particular focus on its impact (i.e., ingestion and entanglement) on marine turtles.

Rivers constitute the major pathways connecting land-based sources with the marine and coastal environments; the impacts of which are particularly evident for major rivers, as well as for small rivers, seasonal torrents and water streams. This is particularly evident in the Mediterranean Sea region. Taking into consideration that riverine inputs of marine litter are not properly addressed through IMAP as adopted in 2016, the Updated Regional Plan on Marine Litter Management in the Mediterranean (Decision IG.25/9, COP22) took the lead in introducing relevant provisions, and the Secretariat is further supporting this process through the implementation of the EU-funded Marine Litter MED II Project which aims in part to support the execution of pilots in targeted countries (i.e. Israel and Morocco), as well as to develop relevant guidelines. Should the latter yield good results and provided that the Contracting Parties are in agreement, IMAP could consider an update in the future to also include riverine inputs of marine litter either under the existing indicators or by introducing new one/s.

Considering the needs to fill the methodological gaps on all different aspects of marine litter monitoring, UNEP/MAP and its MED POL programme presented a first version of the guidelines for monitoring riverine inputs of marine litter during the CORMON Meeting on Marine Litter Monitoring on 31 May 2022 (UNEP/MED WG.534/4). Further to its review, the Meeting [1] requested MED POL to activate the Online Working Group on Marine Litter (OWG-ML) with the aim to further improving and updating the guidelines to mostly focus on the methodological elements of the visual observations for monitoring of macro-litter, as well as monitoring microlitter. The OWG-ML consists of 19 Experts (see Annex II) from Turkey, Spain, Italy, Croatia, Israel, Tunisia, France, Slovenia and JRC, was activated in September 2022, and four consecutive online meetings were organized on 2 November 2022, 14 December 2022, 9 January 2023, and 24 January 2023.

To that effect, the aforementioned guidelines for monitoring riverine inputs of marine litter were reviewed and updated during the aforementioned meetings of the OWG-ML, as well as in intersessional periods, under the leadership of MED POL, with a scope to address the recommendations of the CORMON Meeting on Marine Litter Monitoring (31 May 2022) and the experts' advice and recommendations.

This guideline extracts from the most commonly applied methodologies for monitoring riverine inputs of marine litter. At this stage, its focus is on monitoring macro- and micro-litter through the application of visual observations, surveys on the riverbanks, use of manta nets and water pumps. The present guideline aims to guide the technical personnel of the IMAP competent institutes and laboratories. It is submitted to the present CORMON on Marine Litter Monitoring (3 March 2023) for review and approval for further submission to the upcoming Meeting of the MED POL Focal Points foreseen in May 2023.

[1] UNEP/MEDWG.534/5: Report of the Meeting of the Ecosystem Approach Correspondence Group on Marine Litter Monitoring (Videoconference, 31 May 2022).

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List of Abbreviations / Acronyms

CI	Common Indicator
EU	European Union
FT-IR	Fourier-transform Infrared Spectroscopy
GPS	Global Positioning System
IMAP	Integrated Monitoring and Assessment Programme of the Mediterranean Sea and Coast and Related Assessment Criteria
JRC	Joint Research Centrum
MSFD	Marine Strategy Framework Directive
MED POL	Mediterranean Pollution Assessment and Control Programme
MED QSR	Mediterranean Quality Status Report
PVC	Polyvinyl Chloride
QSR	Quality Status Report
TGML	Technical Group for Marine Litter
UAV	Unmanned Aerial Vehicle
UNEP	United Nations Environment Programme
UNEP/MAP	United Nations Environment Programme / Mediterranean Action Plan
WGS	World Geodetic System

1. Introduction

1. The present guidelines are developed by UNEP/MAP and its MED POL Programme, with the assistance and expert knowledge of 19 Mediterranean Experts representing Turkey, Spain, Italy, Croatia, Israel, Tunisia, France, Slovenia and JRC, in the framework of the EU-funded Marine Litter MED II Project. The Marine Litter MED II Project addresses challenges and solutions with regards to the operational aspects and monitoring processes of implementation of the updated Regional Plan on Marine Litter Management in the Mediterranean. The project envisages to expand marine litter monitoring and assessment efforts also to riverine inputs, focusing on filling the knowledge and data gaps through the execution of targeted pilots in Israel and Morocco, and the development of a guideline for monitoring and assessing riverine inputs of marine litter, further, to taking stock of existing efforts and initiatives (e.g., UNEP[2], JRC/RIMMEL[3] and EU MSFD TGML) and aiming to adjust them to the Mediterranean needs.

2. The Guidelines for Monitoring Riverine Inputs for Marine Litter aim to supplement, support and enrich the Integrated Monitoring and Assessment Programme of the Mediterranean Sea and Coast and Related Assessment Criteria (IMAP). The data acquired from the present guidelines will prepare the ground for expanding the marine litter Common Indicators under IMAP auspices, also to include new indicators such as riverine inputs, and to contribute to the extent possible to the development of assessment reports in the framework of UNEP/MAP.

3. The guidelines describe sampling methodologies for both macro- and micro-litter, and in particular plastics, originating from rivers around the Mediterranean. It also defines and describes laboratory techniques and analysis pertinent to the identification, characterization, and quantification of macro- and micro-litter, aiming to provide technical guidance and harmonized approaches to the Contracting Parties of the Barcelona Convention, including for the development of dedicated national monitoring programmes.

2. Riverine inputs of marine litter

4. Several studies have been dedicated to documenting and assessing riverine inputs of marine litter entering into the marine environment (van der Wal et al., 2015; González et al., 2016; Crosti et al., 2018; Schirinzi G.F et al., 2020). All conclude that riverine systems play a major role in transporting land-based plastic waste into the world's oceans (van Emmerik, T., et al., 2020). Once plastics enter the estuary, the combination of riverine and tidal dynamics determines the fate of plastics and its entrance to the marine environment (Tramoy et al., 2020). Rivers have been identified as major pathways that connect land-sources of plastics with the marine environments.

5. Freshwater bodies such as lakes and reservoirs and rivers are impacted by plastics contamination in the same way as the marine environment. Despite the relevance, the current understanding of transport processes, loads and impacts of marine litter in freshwater bodies is limited, mainly because data are lacking and most published data on freshwater plastics come from individual projects which apply different sampling and analysis techniques. Discrepancies of several orders of magnitudes between the estimations of plastic fluxes from land to the sea are attributed to methodological oversimplifications that amplify errors in the process leading from the individual quantification of plastic litter in rivers to the calculation of global river budgets (Weiss et al. 2022). The lack of harmonization hampers the comparison and ultimately the synthesis of data.

[2] United Nations Environment Programme (2020). Monitoring Plastics in Rivers and Lakes: Guidelines for the Harmonization of Methodologies. Nairobi
[3] https://mcc.jrc.ec.europa.eu/main/dev.py?N=simple&O=380&titre_page=RIMMEL&titre_chap=JRC%20Projects

3. Methods for monitoring riverine inputs of marine litter

6. River mouths can provide substantive information on the accumulation and composition of litter entering into the marine ecosystem. However, the sampling location may largely influence the results. For example, it is not recommended to sample directly at the estuary or the river deltas (which is largely influenced by the seawater inputs), but rather in a location a bit more upstream. The ideal sampling location (Figure 1) can be determined based on the available information that will be in place regarding the site area and the sampling location opportunities such as the presence of bridges, pontoons or any elevated area that facilitates the observation of litter and the deployment of sampling devices. If the sampling location cannot be performed in the riverine mouth, it is very important to measure the distance between the sampling area to the mouth of the river and assess if there are new sources of littering between the observation point and the sea. In addition, is important to investigate also small ditches, not tributaries of bigger rivers, which could be used as illegal dumping sites and during floods the accumulated litter are directed into the sea.

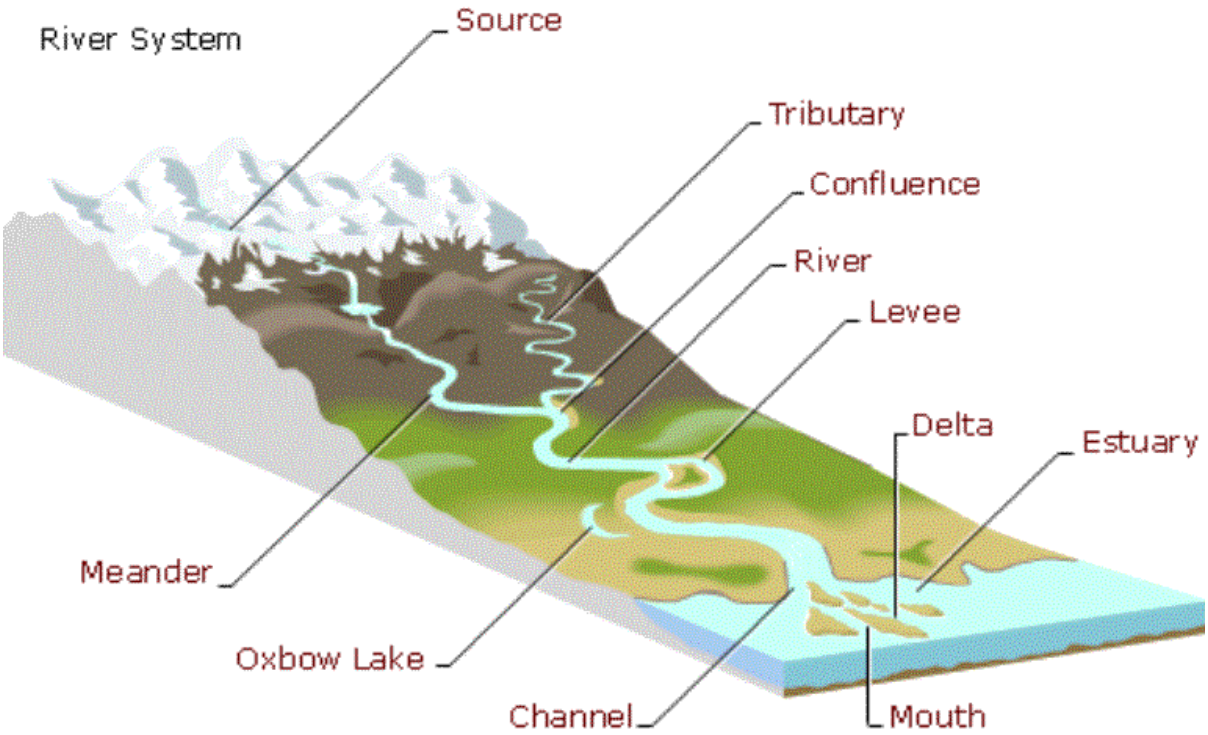

Figure 1: Riverine structure (Extracted from: https://www.geographypods.com).

7. Sampling period is another important aspect when monitoring riverine inputs of marine litter. Riverine areas are subject to complex flow dynamics and are influenced by the tides and freshwater discharges. Flow velocity and direction may change on hourly timescales, which in turn influences litter and plastic transport and export to the marine environment. Ideally, the monitoring should focus on relatively frequent and long-term monitoring in a modest number of locations, rather than sampling sporadically in several locations. Monitoring should be taken during average conditions. In addition, considering that most of the items would reach the sea during floods, and that during such events monitoring is impossible, it is recommended to assess, for each monitored river, the flux of items both in normal and flood conditions. Use of GPS tracker in rivers, simulating flux macro plastic items, should be considered prior starting the visual monitoring project (Manghi et al., 2022).

8. The use of available metadata (e.g., river discharge, salinity, particulate and dissolve organic matter, nutrients, typical fish populations, pollutants etc.) enables the development of an adequate and efficient plan based on the available monitoring resources. Information on the most common activities carried out around the sampling area can also provide substantive information on the type of litter that is expected to be found and which area (e.g., agricultural areas, city infrastructures, industries, population density, sewage treatment etc.) would be relevant for the implementation management measures. Moreover, importance must be given to the administrative borders between the districts to avoid any possible disagreements.

9. This guideline focuses, describes and elaborates on four (4) basic categories of monitoring strategies that can be applied for micro- and macro-litter through the application of: (i) visual observation; (ii) collection of macro litter on the riverbanks; (iii) use of manta nets; and (iv) use of water pumps.

10. A brief overview of the aforementioned methods is presented hereunder focusing on consistent, widely used and cost-effective methods that could be considered for use by the Contracting Parties for this purpose around the Mediterranean.

4. Monitoring of macro-litter in rivers

4.1 Monitoring floating macro-litter through visual observation

11. In the marine environment, methodologies and protocols for visual observation at sea have been proposed by several institutions and scientific research groups such as European Commission (EC JRC, 2013), NOAA Marine Debris Program (NOAA, 2013) and UNEP/MAP (2016). Visual counting of plastic litter can be performed in both marine and freshwater environments, consisting of a rather simple method to determine litter transportation. Despite the shortcomings that visual observation may impose (e.g., submerged floating items are not visible in turbid rivers and items can only be identified during the shore time they float by), it is a low-cost option which enables high frequency monitoring in many sites.

12. To acquire more accurate data on plastic composition and mass transportation, it is advisable to perform also physical samplings using nets where possible, to convert the measured transport in items per unit of time to actual mass transport.

13. The European Commission Joint Research Centre (EC JRC) within the RIMMEL project[4] developed a harmonized collaborative approach using a tablet computer application for the collection of data in river estuaries. The methodology is based on visual observations using a common agreed list of litter items and size categories. The RIMMEL Application allows real time data acquisition during monitoring sessions, thus providing a tool for data collection and reporting.

14. A similar method for observation and collection of information could be harmonized through the development of relevant region-wide agreed reporting templates. The use of a smartphone application is an option, and it could be further developed at a later stage such as to facilitate data collection and harmonization.

[4] The RIMMEL Project was a JRC Exploratory Research Project, executed in 2015-2017, aiming to quantify floating macro litter loads through rivers to marine waters, by collecting existing data, developing a European observation network, deploying a camera system and using the resulting data to build a statistical inverse model of litter loading based on the characteristics of the catchments.

4.1.1 Site selection and preparation

15. The selection of an elevated position is recommended to start the visual observations (e.g., bridges, piers, pontoons). Taking into consideration the river width and the number of people being involved in the sampling, the sampling area should be divided into respective sections. The definition of observation section width (i.e., the section which the observer uses for identification the identification of the litter items) would allow the estimation of litter fluxes in relation to the river section total width (i.e., distance between the two margins at the monitoring). The height and width from the sampling location influence the width of the section that can be observed comfortably; therefore, the width equal to the observation height generally is recommended. In order to avoid over or under estimation of object fluxes, it is important that the total observation width (also in different sections), comprise at least of half of the river, starting from the riverbank to the center of the river. Preferably, measurements should be performed over the total width of the river to avoid harsh extrapolations, if needed with the help of additional observers.

16. Visual observations methodologies present some limitations such as weather conditions, sun orientation, the height of the observation site (i.e., from bridges or vertical distance), as well as characteristics of the litter items (i.e., color, size, shape, and floatability).

17. In the framework of the EU Marine Strategy Framework Directive (MSFD), floating macro-litter monitoring refers to items greater than 2.5 cm, due to their buoyancy properties and capability of floating or suspending in the river surface layer. Therefore, the height of the selected observation site (i.e., vertical distance between observer's eyes and river surface) should allow the detection of litter items down to 2.5 cm. The use of binoculars might help in the identification of litter items if necessary (wide angle binoculars, max x5). Nevertheless, as river characteristics and bridges vary greatly between locations, the deployed protocol should be always fine-tuned to the respective needs and site specificities. In order to enable data comparability, it is important, based on the observation height and section width, to set up a "best" value. The best value is the size which cannot be missed, if floating, from the observation point. Objectively, in order to assess the 2,5-5 cm class, the observation point/s cannot be higher than 10m and the section width larger than 15m.

18. To design a monitoring campaign or programme, the location of the observed site should be considered. For example, it is easier to visualize macro-litter from bridges, and ideally the surveyor/s should be located in elevated structures for a favorable angle of view. For rivers with broad width and in which relevant stable structures are not in place, the visual observations could be undertaken from a vessel[5] (González-Fernández et al., 2018).

4.1.2 Sampling duration and frequency.

19. The river surface water speed must be measured when establishing the duration of the sample as well as for the surface flux calculation later. For rivers with considerable variation in flow velocity, such as riverine areas (Figure 1), it is recommended to take measurements at least once per hour. Surface water speed can be then used to assess marine litter density values.

20. The load of litter transportation will influence optimal observation duration. For rivers with more than 1,000 items per hour, it is recommended to measure one or two minutes per section. For rivers with less than 100 items per hour, it is recommended to measure at least 15 minutes per section (UNEP 2021).

[5] MEDSEALITTER Project, Deliverable 3.3.2: Shared protocols for marine litter monitoring (January 2018).

21. The duration of each measurement should be equal to one hour divided by the number of sections. In addition, frequent samplings will provide an expected high temporal variability in litter loads, thus weekly or bi-weekly observations are recommended, covering low and high waters (JCR 2018). The sampling frequency could be modified in line with the local/national conditions (e.g., proximity to the sampling site, numerous riverine structures, etc.).

4.1.3 Data collection

22. Each visible floating and superficially submerged plastic piece must be counted, independent of its size. An estimation of the minimum average size of plastic debris must be taken into consideration and if the item is uncertain in terms of description, it is recommended that the item is not counted as plastic.

23. Preferably, the counted litter should be normalized over time and space to arrive at a plastic transport profile over the river width, and total plastic transport in items per unit of time (items per hour). The number of items per hour per section provide the spatial variation over the river width, and the sum of the sections provide the total number of floating pieces of plastic per hour over the whole river width. Alternative unit could be also considered consisting of items/time/river width thus, extrapolating density at the level of the river mouth.

24. To categorize the observed items, the common agreed MED POL list for beach marine litter items (IMAP Common Indicator 22) is recommended in order to ensure comparability. The MED POL list can be modified locally and could be used after possible adaptation to narrow down the available options in line with the items that are mostly recorded in the respective riverine areas (Annex I). The JRC/TGML Joint List of Litter Categories could be also used, provided being compatible with the respective MED POL list.

4.1.4 Meta data

25. The river surface flow velocity must be measured several times during the survey, and certainly every time that an alteration is observed. The assessment of the river water surface (e.g., turbulence and presence of natural foam), wind direction and intensity, cloud/rain (during the day of observation, one day before, and also considering monthly averages), light conditions (e.g., reflections, direction of the sun and shades), tidal conditions and visibility (e.g., fog) must also be recorded.

26. For each observed section, the GPS coordinates (grades and thousandths, GG, GGGGG) must be recorded in WGS 84.

4.2 Monitoring litter deposited on riverbanks

27. The proposed monitoring on riverbanks is based to a great extent on the methodologies for monitoring beach marine litter, after being adapted to the needs for monitoring litter deposited on riverbanks. So far, several studies have been undertaken where the beach litter protocol was adapted for usage on riverbanks (Schone Rivieren, 2017; Bruge et al., 2018; Van Emmerick et al., 2020; UNEP, 2020; Cedre, 2022).

4.2.1 Site selection and preparation

28. Riverbanks of interest are located along watercourses that cross anthropized areas (e.g., urban, industrial or agricultural areas) (Figure 2). The riverbanks may be located in the estuary or immediately above it, at a sufficient distance to prevent marine litter entry.

29. Riverbanks, where survey sites are located, should be selected on the basis of the following criteria:

a) **Safety:** the site must be safe for operators (unstable bank, too steep, too much vegetation, etc.);
b) **Site location:** it must be located beyond the limit of the possible entry of marine litter from the sea (resulting from the action of wind, currents, or waves);
c) **Site length[6]:** depending on the site condition and accessibility as well as on litter density, the site length may vary from 10 to 50 or even up to 100m, provided that the selected site length remain the same throughout the monitoring campaign;
d) **Accessibility:** the site should be accessible all year round (except during exceptional event like flood or overflow);
e) **Presence of litter:** the site should have litter deposited without being an accumulation area (Figure 2). Sluices, weirs and pumping stations in the vicinity of the location should be considered since those can influence the litter present in the riverine environment. The riverbank can be submerged temporarily with higher water levels to allow deposition of litter;
f) **Absence of clean-up activities:** the site should not be subject to any other litter collection activities.

4.2.2 Sampling unit and frequency.

30. The sampling unit may vary from 10, to 50 or up to 100 meters, measured as a straight line parallel to the back of the riverbank. The whole stretch is surveyed, from the water edge to the back of the bank, defined by physical structures such as towpath, vegetation, highest bank line, etc. Permanent reference points must be used to ensure that exactly the same sampling unit is monitored during each survey.

31. To align with the beach marine litter monitoring, it is proposed to conduct the surveys once every 3 months, resulting in four datasets per riverbank per year (one per season). The proposed survey periods are January (Winter); April (Spring), July (Summer) and October (Autumn). It should be noted that winter surveys may be compromised due to flooding events whereas summer surveys can be complicated by the presence of vegetation (density and height). The vegetation on riverbanks may vary considerably over seasons and thus influence the litter "trapping" capacity, and the relevant seasonal fluxes.

[6] The selection of the site length should accommodate the widest available riverbank stretch.

Figure 2: Example of riverbanks of interest for monitoring marine litter (©Cedre).

Figure 3: Example of marine litter deposited on the bank (©Cedre).

32. Circumstances may lead to inaccessible and unsafe situations for surveyors (e.g., heavy winds, flood, river traffic, etc.). In some areas, it may not be possible to search down to the water line due to the presence of unsafe conditions (e.g., unstable sediment, slope to steep, etc.) (Figure 4). The surveyors have to stop at the stable sediment limits.

33. The safety of the surveyors must always come first, and it is highly recommended that the surveys are conducted by trained surveyors.

4.2.3 Data collection

34. All **visible** marine litter items larger than 2.5 cm found stranded on the riverbank **or trapped** in the vegetation (but not deep into /or covered by the vegetation deposits), within the sampling unit must be collected and counted (see Figure 5). The marine litter items to be surveyed include identifiable litter types and associated pieces of these types, as well as unknown items and unknown marine litter fragments (Figure -6). It is important that every item is counted. The presence of chemical pollutants (e.g., paraffin wax and other pollutants such as oil) and industrial plastic pellets should also be recorded.

Figure 4: Unstable muddy sediment limiting sampling down to the water line (©Cedre).

35. In situations, where large amounts of marine litter items are found or survey conditions are difficult (e.g., rain, heavy winds, snow, etc.), the collected marine litter can be stored in bags and sorted and counted in a sheltered place or indoors. In this case, care should be taken to prevent fragmentation and/or entanglement of the litter items, which would affect the number of items counted.

36. To categorize the observed items the common agreed MED POL list for beach marine litter items (IMAP Common Indicator 22) could be used after possible adaptation to narrow down the available options in line with the items that are mostly recorded in the respective riverine areas (Annex I). The JRC/TGML Joint List of Litter Categories could be also used.

Figure 5: Marine litter collected, to be further classified and characterized (©Cedre).

4.2.4 Meta data

37. The same sampling site should be monitored for all surveys planned in the monitoring programme. Coordinates of the sampling site must be recorded in WGS 84 (DMS, DD). The length and width of the sampling site must be recorded in meters. Additional descriptive information (e.g., natural or artificial bank; meandering or straight stream; nature of the back of the site, etc.) can be recorded.

38. For each survey, weather conditions should be recorded (wind strength and orientation) and where possible recent water flux and/or level and river width.

39. For each survey, information on particular events (flooding, storm events, etc.) or on change site morphology (erosion, vegetation coverage, etc.) that may have influenced the survey, should be provided.

40. The IMAP InfoSystem reporting templates for IMAP Common Indicator 22 (beach macro-litter) could be used to enable data reporting after minor adjustment, including the development of a dedicated information repository reflecting the different site characteristics.

41. The proposed reporting unit for collecting data is items / 100m.

Figure 6: Marine litter classification and categorization phase (©Cedre).

5. Monitoring of micro-litter in rivers and river outlets

5.1 Sampling microplastics in river outlets with the use of manta net

42. The Manta Net or Manta Trawl is the most commonly used sampling equipment for monitoring floating microplastics at sea (Figure 7). This tool is specifically designed to collect samples from the sea surface layer. The use of Manta Net allows the sampling of large volumes of sea water, retaining at the same time the target material (i.e., microplastics); however, its application in rivers is more complicated because of the risk of clogging. A light small net with buoys is currently tested in by the Israel Oceanographic and Limnological Research Institute (IOLR) in the framework of the EU-funded Marine Litter MED II Project. Further information will be acquired with the finalization of the pilots in 2023. In the general context, the sampling duration and manta mouth width can be adapted according to litter concentration and river flow.

43. Despite the overall guidance provided under the present guidelines to monitor upstream, inside the riverine structure, sampling of microplastics with manta net is proposed to be carried out outside the river gradient; thus, enabling integration with the existing IMAP-based national monitoring programmes for IMAP Ecological Objective 10 and its Common Indicator 23, as well as data comparability.

44. UNEP/MAP MED POL has elaborated detailed guidelines[7] for monitoring floating microplastics at sea with the use of manta net agreed region-wide since 2021[8]. The said guidelines could comprise the basis in terms of methodological and laboratory elements; however, it should be noted that there is a fundamental difference in the methodology, as when it comes to its application in rivers, the area of interest is the mouth of the river outside of the river gradient. In this regard, when focusing on sampling of floating microplastics in rivers, it is advisable to conduct the sampling in calm river conditions, preferably when wind intensity is less than three (3) Beaufort (approximately 13-19 km/h).

Figure 7: Manta net being operated in calm sea, outside of the bow wave caused by the spinning of the propeller (Photo: © Christos Ioakeimidis, UNEP/MAP).

5.1.1 Manta net properties

45. The Manta Net or Manta Trawl is the most commonly used sampling equipment for monitoring floating microplastics at sea. This tool is specifically designed to collect samples from the surface layer of the sea. However, it can be also used for monitoring riverine floating microplastics, especially in the water mouths outside of the river gradient.

[7] UNEP/MED WG.490/7: Monitoring Guidelines/Protocols for Floating Microplastics (Meeting of the Ecosystem Approach Correspondence Group on Marine Litter Monitoring (CORMON Marine Litter), Videoconference, 30 March 2021).
[8] UNEP/MED WG.490/7: Meeting of the Ecosystem Approach Correspondence Group on Marine Litter Monitoring (CORMON Marine Litter), 30 March 2021.

46. The use of Manta Net allows the sampling of large volumes of water, retaining at the same time the target material (i.e., microplastics).

47. Mouth size and length: The Manta Net (see Figure 7) consists of a rectangular metal floating device from which a net cone is attached, having a final collection sock (or any other relevant collection equipment) at its very end where the microplastics and the organic matter are collected. The dimensions of the mouth of the metal device are not pre-determined, it is however advisable to always maintain a ratio equal to ½ between the height and the width of the mouth of the metal device. The most common dimensions of the mouth of the Manta Net are 50 cm in width and 25 cm in height, however other dimensions are possible. These dimensions refer to the inside size of the mouth, the part to which the 2.5 m net in length is connected. The outer part is wider assuming an overall truncated pyramid shape.

48. Mesh of the net and cup/sock: The net cone, which is attached to the floating metal device, should be made out of a net with a mesh size of approximately 330 μm. In order to avoid problems of regurgitation following clogging, especially in eutrophic waters, it is necessary to constantly check the effectiveness of sampling. Optional, for areas with high gelatinous organisms and zooplankton, a metal net (mesh 1-2 cm) could be added in front of the mouth of the manta net.

49. Dimensions of the wings: Two metal wings are attached right and left from the metal device to ensure that the Manta Net is always kept floating on the sea surface (Figure 7). The dimensions of the wings depend on the weight of the mouth since they are used to ensure the buoyancy of the instrument. Therefore, it depends on the weight of the metal floating device. In most cases, each wing has the same dimension in length as the metal mouth. A size of 40–70 cm in length is generally expected, In any case, they should be sufficiently large to keep the Manta Net afloat.

5.1.2 Use of the manta net in rivers

50. The Manta Net could be either lowered slowly from the boat or the vessel to the river mouth and is left afloat or could be deployed by stable structures (e.g., rivers over the river mouths). However, the latter option (deployment from stable structures) may require significant labor-intensive effort because of the considerable weight of the sampling device (manta net).

51. According to the dimension of the boat it is possible to tow the net from stern or from the side. If the net is lowered to stern, the distance between the boat and the Manta Net should be at least 50-70 m. If the net is lowered on the side, of the boat the net should be kept at the distance of around 3 m. When possible, it is suggested to use non plastic material rope in order to avoid contamination. The pull of the manta net from the side of the vessel or the zodiac may be another option (Figures 8 and 9). It is extremely important for the manta net to be left outside of the bow wave caused by the spinning of the propeller because this turbulence will significantly influence the amount of collected microplastics as well as the contamination due to paint chips from the vessel (Figure 8).

5.1.3 Designing a monitoring campaign

52. Method for sampling: A proper design of the monitoring surveys should include an area close to the river mouth, outside of the river gradient. Sampling should be carried out preferably at 3 stations located at different distances from the river mouth (e.g., 0.5, 1.5, 3 Naut. Miles) set along an orthogonal line to the coast. Once the boat/vessel is positioned at the sampling point, the manta net is lowered and trawled for approximately 10 to 20 minutes (the exact timing should depend on issues relevant to the clogging of the Manta Net) along a straight transects, with a speed approximately of 1-2 knots. In order to allow the Manta Net to properly filter the water and thus have its whole mouth submerged into the sea, under no circumstances the speed should exceed 3 knots. The 10- to 20-minute trawl must be conducted in the opposite direction to the surface current or in any case opposite to the wind direction.

53. *Optional:* In case of large quantities of organic matter, mucilage and gelatinous zooplankton are present during the sampling, it is suggested to split the sampling time into two hauls (e.g., x2 hauls of 10-minute duration). The two hauls should be merged to have an equivalent to one haul (e.g., 1 haul of 20 minutes).

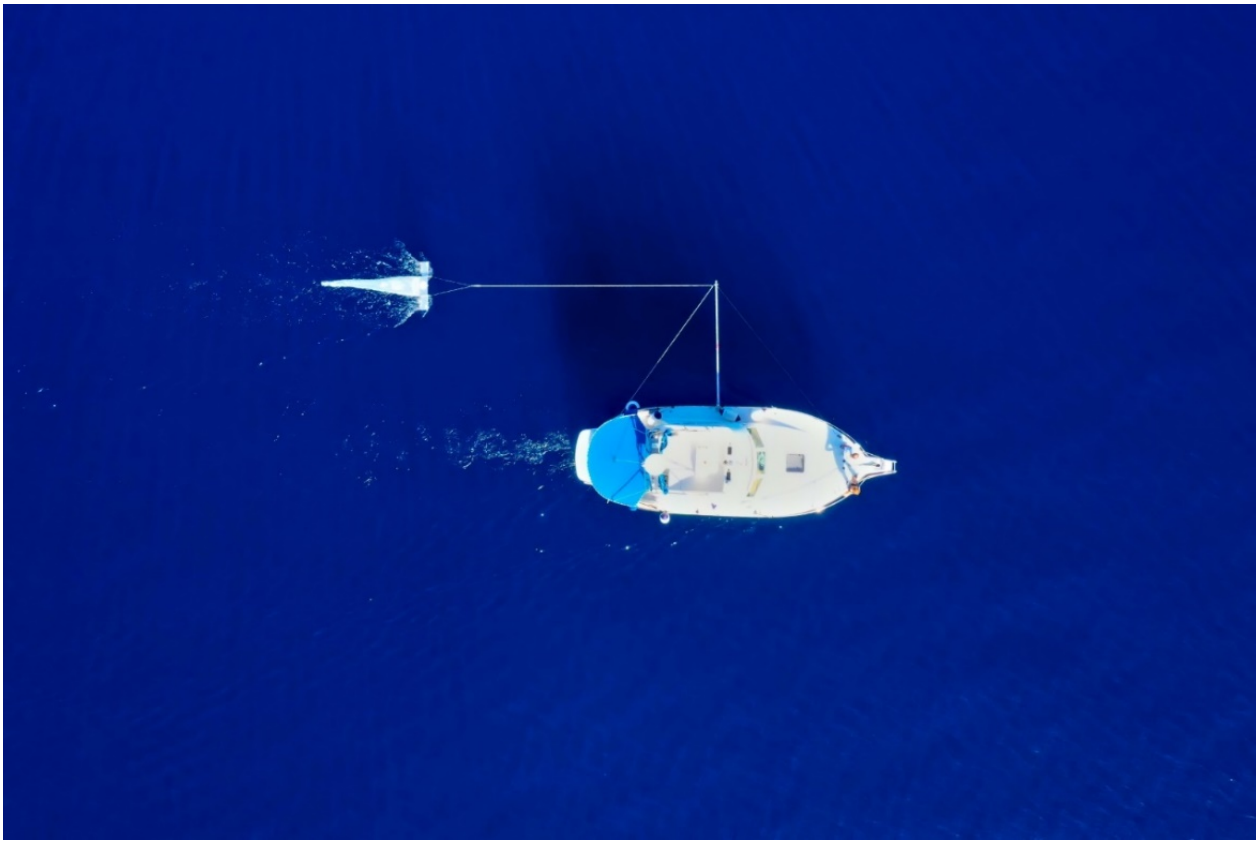

Figure 8: A manta net being pulled from the side of the vessel (Credit © Stipe Muslim, Croatia)

Figure 9: A manta net being pulled from the side of the vessel (Credit © Cecilia Silvestri & Marco Matiddi, Italy)

54. The monitoring of the weather conditions (i.e., wind direction and precipitation) is advised on a daily basis for a period of 2-weeks ahead of the sampling campaign, as relevant measurement could provide a comprehensive idea about the river flow. Relevant data can be obtained by existing meteorological stations etc.

55. GPS Coordinates: For each trawl the GPS coordinates (grades and thousandths, GG°, GGGGG) at the beginning and end of sampling must be recorded in WGS 84 format. Additional GPS coordinates (e.g., every 10 minutes) are most welcomed as will allows to confirm, or not, the rectilinear transect and even to determine a more accurate length of the trawl. In case of large quantities of organic matter and relevant organic gel are present during the sampling, it is suggested to decrease the sampling time into two 10-15 minutes hauls.

56. Position of the survey stations: The position of the stations for riverine monitoring must be determined according to the characteristics of the survey area (i.e., storage areas for local riverine hydrodynamic conditions, distance from direct input sources, such as river mouths, etc.). The number and position of the survey stations will be established in order to have a better representation of the entire region, considering areas of both high and minimum anthropogenic activity/impact. The criteria for choosing the position of the transects must be recorded on dedicated sampling sheets.

57. Replicates: Because of the variability of riverine floating microparticles distribution, it is necessary to increase the data representativity. Further, it is strongly recommended to carry out replicates from the same sampling point. Three replicates for each station are recommended. Each replicate must be conducted following the transect in the opposite direction to the riverine surface current or in any case opposite to the wind direction, approximately parallel to the first one.

5.1.4 Calculating the Surveyed Areas

58. The surface area of the surveyed water: The calculation of the amount of microplastics should be expressed in number of microplastic particles per square meter based on the following methodological approach:

The surface areas of surveyed water (S) is calculated using the following formula:

$$S = D \times W$$

Where: D: is the distance of the sampled rectilinear transect
W: is the width of the mount of the Manta Net

* It is possible to calculate D by using a flowmeter, or GPS coordinates, or vessel instruments

59. *Optional:* It is also possible to calculate the filtered volume (m^3) by: (i) multiplying the area of the mouth of the net by the distance covered during the tow; or (ii) applying the appropriate formula of the flowmeter as follow:

(i) $V = D \times A$

(ii) $V = N \times A \times c$

D: is the distance of the sampled transect (m)
N: is the number of turns of the propeller recorded by the flow meter during the transect;
A: is the area of the mouth of the used Manta net;(width x height)
c: is a constant value, typical of each flowmeter.

It should be noted that the filtered volume using a flowmeter is more accurate, but the flowmeter needs a continuous maintenance, and it can stuck during sampling. For this reason, the square meter measure must be always calculated.

5.1.5 Sample Collection and Storage

60. Once brought back to the boat or the vessel, the net must be rinsed each time, with fresh/brackish water from the outside to the inside, from its part close to the mouth towards the collection sock, in order to concentrate all the natural and man-made materials to the cod-end. The collection sock is removed, and the material is transferred into a 250 or 500ml glass bottles for subsequent qualitative and quantitative analysis (Figure 10). The sock/cup should be washed, from the outside, using distilled water or fresh/brackish water, and from inside using only distilled water, in order to collect all the material stacked among the mesh. Larger pieces of biological material, including e.g., leaves, bugs, larger algae or wood are picked out of the samples with metal tweezers and carefully rinsed on a metal sieve (< 330 µm). Macro-plastics are picked out and rinsed in the same way, but instead of discarding them, they could be counted and stored for further analysis. It is important to separate macro-plastic from the sample in order to avoid fragmentation.

61. The samples can then be stored in refrigerators (but not in freezers), protected from light and heat. It is possible to add a fixative (i.e., 70% ethyl alcohol), solely in order to prevent the decomposition of the organic matter present (e.g., zooplankton, phytoplankton, etc.), which would release unpleasant odors during the analysis of the samples. This procedure it is not suggested because it can change the microplastic colour.

Figure 10: Microplastic and organic matter collected in a metal sieve just after the sampling (Photo: © Christos Ioakeimidis, UNEP/MAP).

5.1.6 Laboratory Analyses of Samples Collected at Sea:

62. The analysis is aimed at identifying and quantifying the different microplastic particle (as non-degradable) found present in the sample/s.

5.1.6.1 Cross Contamination

63. All laboratory equipment should be ensured to be made of glass or metal as much as possible in order to prevent the contamination of the sample, with microplastic particles deriving from the potential plastic equipment, as well as to avoid microplastic fragments from sticking to the walls of the equipment. To avoid this carefully rinsing of the equipment with distilled water should be ensured. The use of distilled water during all the wash/rinsing steps should be ensured. during all laboratory steps. Furthermore, particular attention must be paid to the cleaning of the working area in order to avoid contamination of the sample with microplastic particles, mainly fibers, being present in the atmosphere or being generated from relevant plastic equipment. To this extent, important precautions should be taken to limit the risk of contamination such as:

a) Avoid wearing synthetic clothes which could release plastic fibres (such as fleece or stretch fabrics in lycra - polyamide) during the laboratory analyses and wear pure cotton clothes. Always wear a 100% cotton lab coat.
b) Avoid the exposure of the sample into the atmospheric air, and thus ensuring to cover the corresponding laboratory spaces to avoid contamination.
c) Do not leave windows open while analysing the samples.
d) Reduce personnel in the lab during operation.
e) Use of laminar flow cabinet is recommended.
f) Cover the petri dish during the first stereomicroscopic analysis with a glass.
g) Place a damp filter paper in a petri dish in the working area for a blank control in every step representing the whole process of treatment.

5.1.6.2 Equipment at the Laboratory

64. The following equipment will be required during the laboratory analysis:

Requirement:	*Optional:*
• 5 mm metal sieve; • 300 µm metal sieve; • Drying oven; • Filtration device; • Petri dishes (glass); • Jars/Beakers (glass); • Tweezers; • Distilled water; • Micrometre; • Stereoscope.	• *Micrometer;* • *Additional sieves for size classes;* • *Oxygen Peroxide or Potassium hydroxide;* • *Drying oven or hot plat or hot bath;* • *Laminar flow cabinet;* • *Vacuum pump system and fiber glasses membrane;* • *Hot needle, optical microscope, FT-IR or RAMAN spectroscopy.*

5.1.6.3 Five Steps at the Laboratory

65. The following **five steps** should be followed during the analysis of the samples:

66. Step 1: Wet Sieving:

a) Pour the sample through a stacked arrangement of 5mm and 330 µm metal mesh sieves.
b) Optional: in order to subdivide the items in different size classes it is possible to stack additional sieves (e.g., 1 mm).
c) Pinse the container where the samples are stored several times with distilled water, in order to recover all the microplastics.
d) The fraction consisting of plant or animal residues larger than 5 mm (retained by the sieve with the larger mesh) must be thoroughly rinsed with distilled water.
e) Optional: In the presence of large quantities of organic matter, incubate samples on hot plate, hot bath, or oven (≤ 40°C) adding supplementary 15% H2O2 or KOH 10% to the sample while evaporate, until all organic matter is digested. Be careful not to exceed 40 °C degree.
f) For the digestion process, the jars with the collected samples should be kept at room temperature for 5 days or less according to the digestion rate. Jars should be covered with aluminum foil or glass dish during the digestion processes.

g) Optional: The digested matter can be filtered on GF/C fiber glasses membrane under vacuum pump, rinse the funnel several time and the membrane with distilled water to remove the organic matter.

67. Step 2: Transfer Sieved Solid Material:

a) Once the sample is filtered, transfer all solids collected in the 330 μm sieves into a Petri dish with the help of a spatula and minimum rinsing with a squirt bottle containing distilled water.
b) Ensure all solids are transferred into the glass jars.

68. Step 3: Visual Sorting of Samples:

a) Place the Petri dish under the stereomicroscope and proceed with the identification of microplastics. For this, plastic items are counted through visual sorting of the sample, and it is recommended to move the Petri dish top-down from the left to the right and vice versa, to facilitate the particle count, perform two rounds of visual sorting under the stereomicroscope
b) Filaments with a length > 5mm must still be counted.
c) In case of suspected micro-items, hot needle or optical microscope or spectroscopy equipment should be used to detect if it is plastic material.
d) Optional: For size categorization and in order to subdivide the collected items in different size classes put a sheet of graph paper under the Petri dish, this procedure can also be performed with a micrometre inserted in the eyepiece or with an image analysis software (i.e., Image J) which helps in the measurement of identified microplastics.
e) During the entire visual sorting of samples, a blank control will be done for this, an uncovered Petri dish with a filter inside it will be left beside the stereomicroscope and will be inspected for potential airborne contamination after each sample. Colour and shape of identified particles in the blanks will be recorded. If the blank is contaminated, micro-litter items with similar characteristics (e.g., shape, colour, polymer type), the amount of this micro-items should be excluded from the results of the same bath.

69. Step 4: Categorization and Classification:

a) The identified microplastic particles should be categorized and classified.
b) The microplastic particles which are identified in the glass Petri dish should be divided and counted based on the shape (i.e., fiber, filament, film/sheet, fragment granule, pellet, foam) and colour (Figure 11).
c) Types of shapes used in microplastics characterization:
    i. Fiber: only from textile. They are very flexible with different thicknesses and colours. They can be made by natural or synthetic material.
    ii. Filament: filiform element elongated, threadlike, thin, and less flexible than a fiber, made by artificial polymer (e.g., fishing line).
    iii. Film/sheet broken soft plastic piece as foil, they are thinner and more flexible; than fragments (e.g., pieces of plastic bags).
    iv. Fragment: broken and hard plastic piece, thick, with an irregular shape.
    v. Granule: spherical shape, with a regular round shape bead.
    vi. Pellet: only from industrial origin, irregular, round shapes, and normally bigger in size, than granule.
    vii. Foam: soft consistency irregular or spheroid shape (e.g., polystyrene, rubber silicone).

70. Attention should be given in distinguishing Fibres (from textile) and Filament (threadlike artificial polymer: i.e., fishing line), as the first one should pass through a 330 μm mesh and are more susceptible to originate from airborne contamination.

71. Figure 12 highlights the differences between Fibres and Filament, while fibers are generally thinner in diameter, with frayed edges and it is often ending in helical winding. In addition, the fibers, when approached with a needle bend and deform (Figure 12: 1 red fiber and 2 blue fibers).

72. On the other side, filaments have generally a well-defined shape: cylindroid with clear margins, and the colour is more uniform. Furthermore, the filaments are stiffer than the fibers and less deformable (Figure 12: 2 filaments in blue).

73. The colour of each microplastic particle should be recorded based on the following approach: white, black, red, blue, green, and other colour (Figures 13 and 14). In case of biofouling or degradation, yellow must be included in the white category and brown in the black category, whereas orange and pink in the red category. The "*other colour*" category includes all the remaining colours which cannot be specified, or in case an item has different colour on two sides. Furthermore, when a fragment is made up of two different colours depending on the side this must be always included in the "*other colour*" category. A more specific differentiation is possible when it has relevance for a specific purpose (e.g., project etc.)

74. Finally, for each colour identified, the transparency must be specified, with the proceeding column of the data file indicating if the pieces are opaque or transparent.

75. Step 5. Reporting units

The reporting units for microplastics abundance from water samples are:

Option 1: Number of Microplastics per Surveyed Area
(No, Particles / km^2 | No, Particles/ m^2)

Option 2: Number of Microplastics per Volume
(No, Particles / m^3)

76. Information referring to shape and colour of microplastics identified, are useful for source identification.

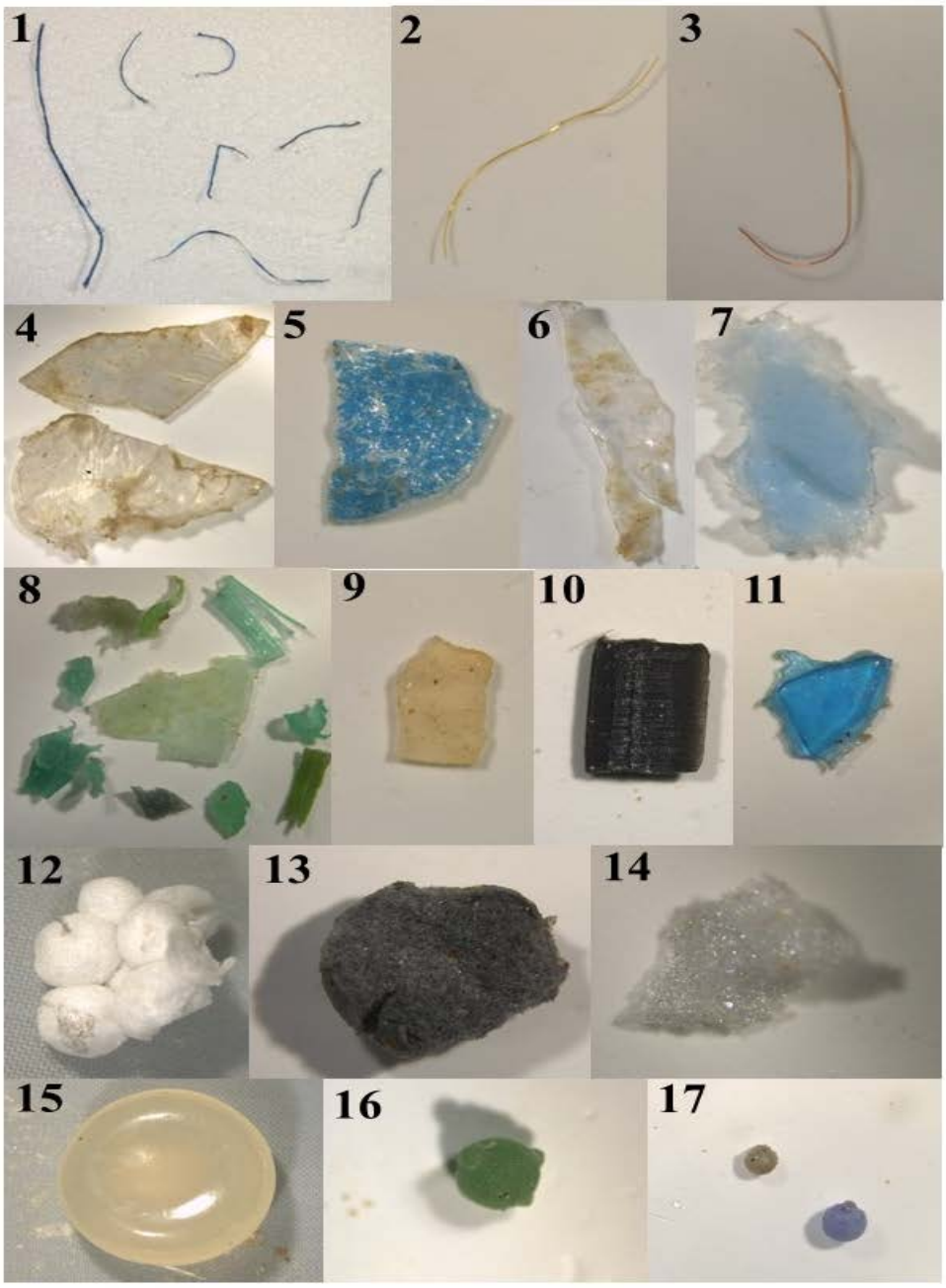

Figure 11: Common shapes of microplastics. (1: fibers, 2-3: filaments, 4-7: films, 8-11: fragments, 12-14: foams, 15: pellet, 16-17: granule) (Photo: © Ülgen Aytan, Turkey).

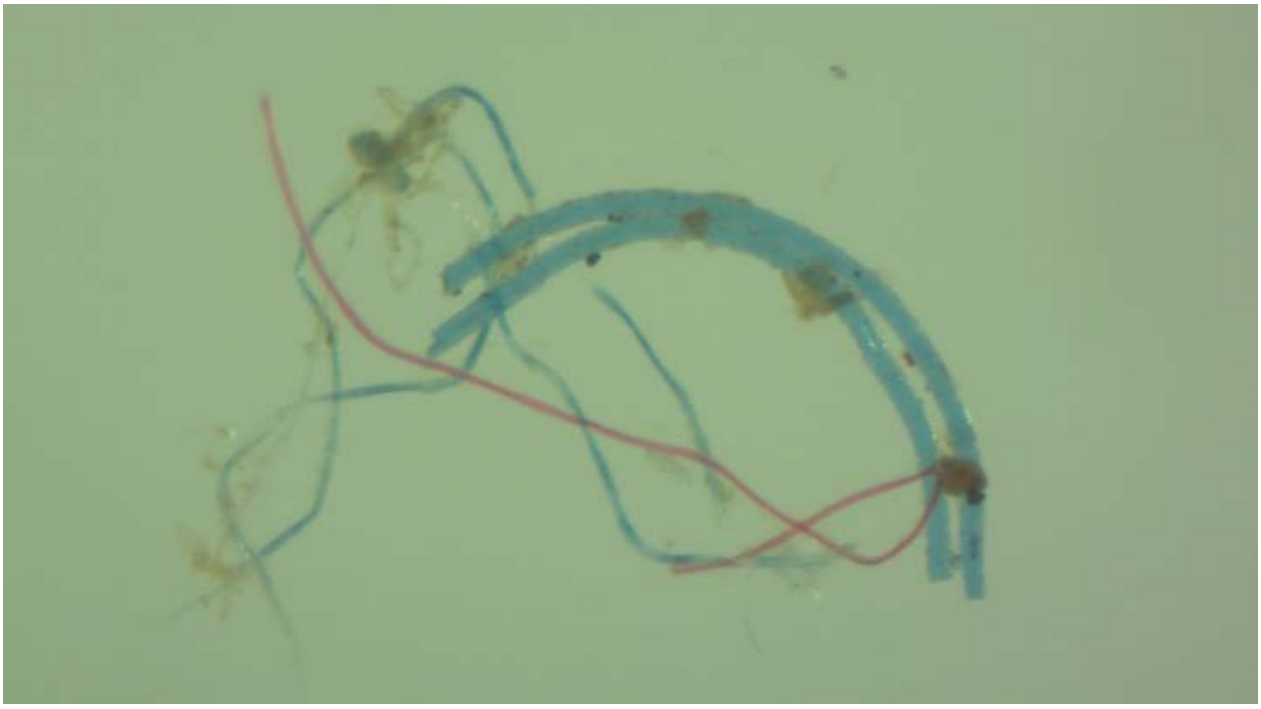

Figure 12: Differences between fiber and filament microplastics (Photo: © Marco Matiddi, Italy).

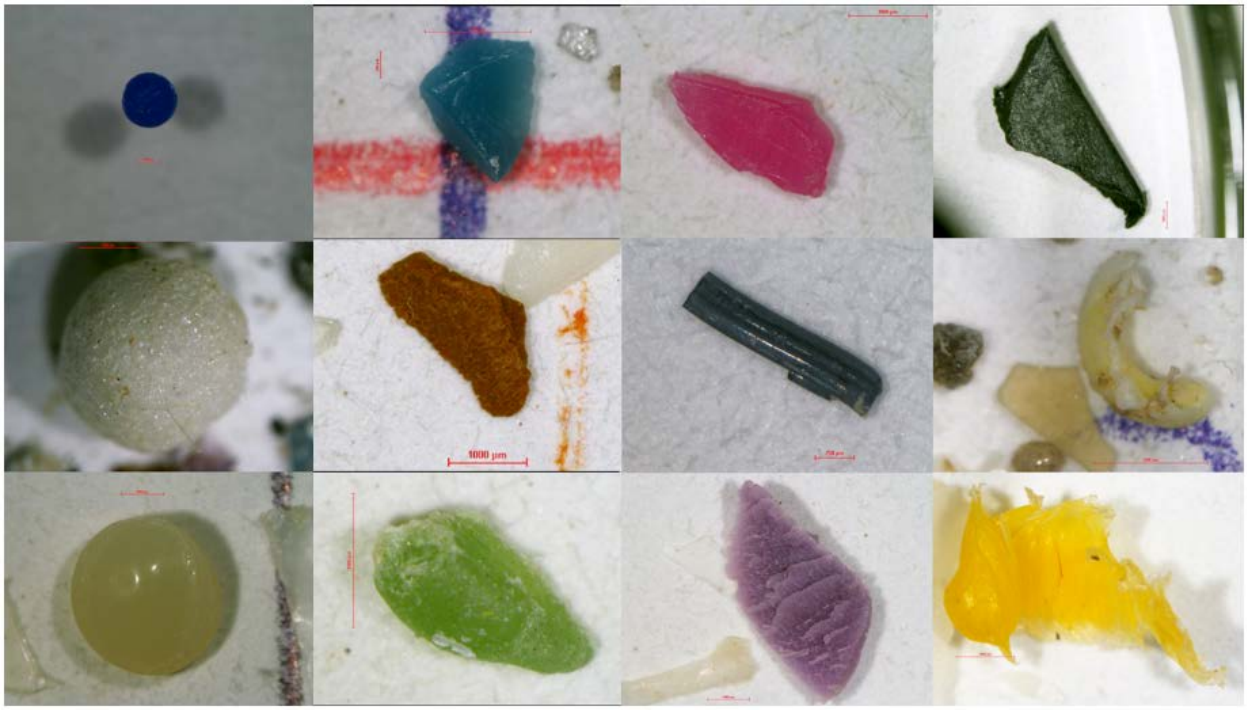

Figure 13: Different colors of microplastics (Photo: © Ofrat Rave, Israel)

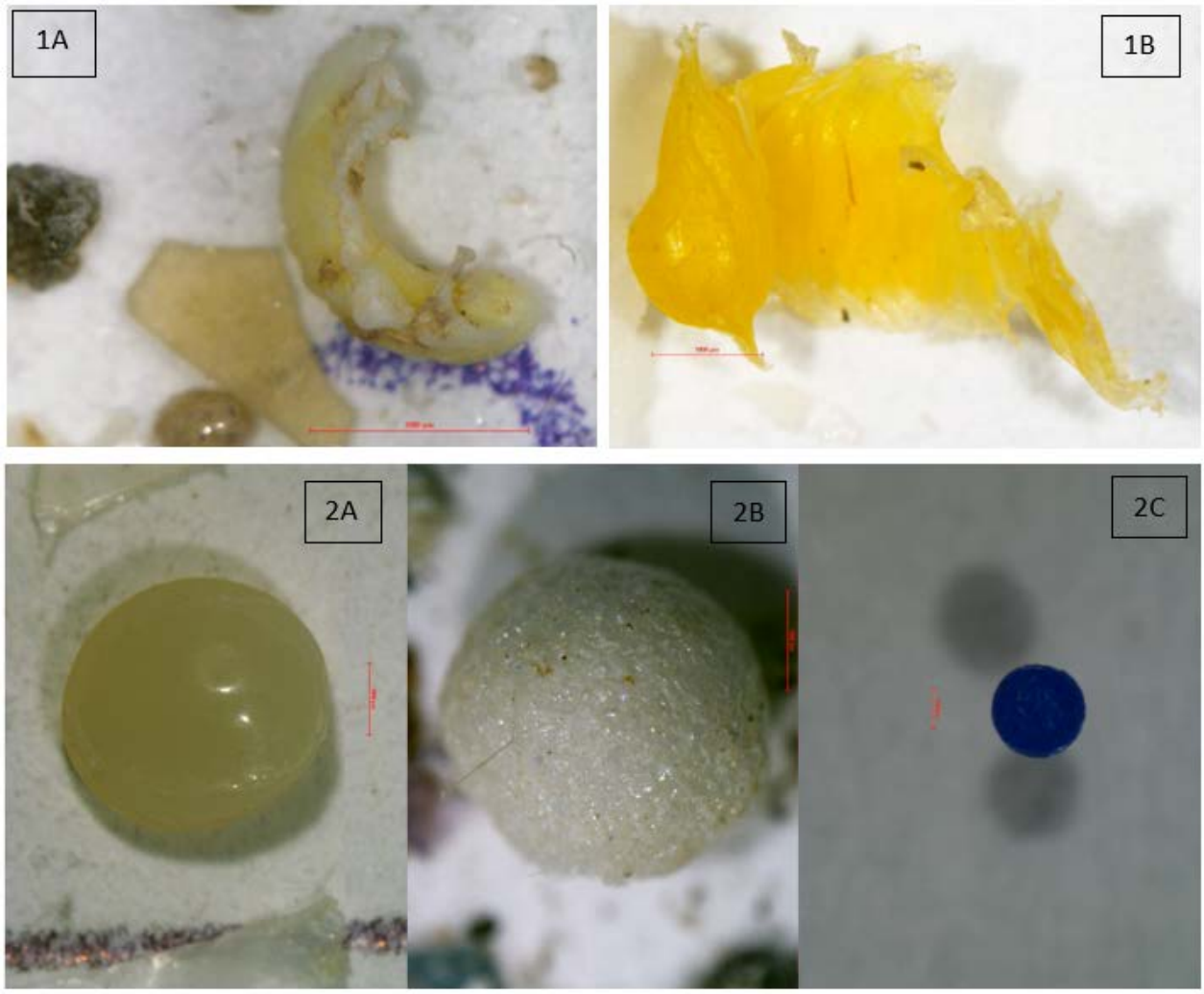

Figure 14: Examples of color categorization for microplastics: [1A] a colored microplastic degraded because of biofouling that should be regarded as “white”; [1B] a yellow-colored microplastic which should be considered as “other color”;[2A] a pellet which should be considered as “white” (scale bar 1000µm); [2B] A white-colored foam (scale bar 1000µm); [2C] a colored blue granular (scale bar 250µm). (Photo: © Ofrat Rave and Yael Segal Israel)

5.1.7 Keynotes

77. Spectral optical procedures such as Fourier-transform Infrared Spectroscopy (FT-IR) or Raman spectroscopy are very important techniques to differentiated microplastics from non-plastic materials and further verifying plastic polymers which is also necessary for obtaining useful information regarding sources of sea surface plastics. These instruments can perform counting, shape measurement and material identification simultaneously but they are expensive so not all laboratories can afford them. For laboratories that have the possibility to use them, in the case that time and resources do not allow analysis of all samples, the recommendation is to proceed with a representative spectroscopic analysis for a subsample of 10% of the total, choosing the suspected microparticles to verify visual identification.

78. A list of additional physical and chemical parameters of the water column are recommended (non-mandatory) by means of a multiparametric, integrated sampling, which are hereunder listed:

a) Depth (m);
b) Temperature (^{o}C);
c) Salinity (psu);
d) Oxygen (dissolved oxygen – percentage of saturation);
e) pH; and
f) Transparency (m).

5.2 Sampling microplastics in the water column with the use of a water pump

5.2.1 Water pump properties:

79. The filtration system consists of the following parts: water pump (gasoline or electric), PVC or coated pipes, flow meter, basket/cage for retaining larger particles (1-2 cm) – prefiltration system, filtration system or stainless-steel sieve/s (100 μm and/or 333 μm), a lead weight (for keeping the filtration in place), ropes from natural materials.

80. Sieve or filter mesh size: for filtration of the river surface/water column, a mesh size of 100 or/and 300 μm is suggested. Ideally, the 300 μm filter should be above 100 μm, in this way the larger mesh filter retains larger particles, and the fine filter (100 μm) retains smaller particles.

81. Water pump characteristics:

a) Small size and light weight;
b) Enough capacity to take a single sampling (at least 130 l/min or 7.8 m³/h or higher);
c) To be as quiet as possible;
d) Have as the highest possible autonomy of operation with a full tank;
e) To pump water from a height of 10 m and above;
f) Attach a filter system preferably of 1000μm 300μm and 100μm9 (Figure 15);
g) Should have a mounted flow meter (Figure 26).

82. Water pumps have their advantages and disadvantages as presented hereunder:

Advantages:	**Disadvantages:**
a. Samples large volumes of water (minimum of 1 m³ of water)	a) Requires necessary equipment;
b. Relatively effortless	b) Requires fuel/batteries to work;
c. Allows the choice of different mesh size (suggested 100 – 300 - 1000 μm)	c) Potential contamination by the apparatus;
d. Use of three replicate samples	d) May fragment and break pieces and particles into smaller sized pieces/particles;
e. Easy calculation of concentration, expressed in unit: number of items/m³.	e) May be difficult to carry between sampling locations.

[9] The different filters are attached in a custom-made way (Figure 15). Additional filter sizes can be also used depending on the condition of the river and the capacities of the respective laboratories.

Figure 15: Custom-made set up for the deployment of the series of different filters during the sampling operations (© CEDEX,2021).

Figure 26: A small and light weight water pump with a mounted flow meter (© IWRS, 2022).

5.2.2 Use of water pumps in rivers

83. When the use of manta net for sampling microplastics in the river surface is not possible due to high loads of organic matter, or other reasons, the use of water pumps is a viable and suggested option yielding very good results (Prata et al. 2018; Tamminga et al. 2019; Bordós et al. 2018). The use of water pumps is a static sampling approach allowing sampling from an anchored boat, riverbank, or stable structures (e.g., bridges etc.) (Figure 17) (Bordós et al. 2018; Prata et al. 2018).

Figure 17: Sampling microplastics from a bridge, using a water pump (© IWRS, 2020).

84. When addressing sampling, different approach is applied attributed to the differences in density of fresh and saltwater environments, which may respectively lead to different distribution patterns for microplastics in the water column (i.e., generally, microplastics will be deeper in the water column when in freshwater environment). To this extent, depth and location may need to be adjusted depending on the sampling location and salinity (Prata et al. 2018).

85. Pump sampling consist of pumping water manually or using a motor through an inline filter. With the use of water pumps, the water samples can be taken from different depths with different volumes. Due to the high variability of microplastic spatial distribution, the covered sampling area is limited and using a pump may not be representative. Therefore, taking multiple replicates is suggested (Zhang et al. 2018). However, pumps can be used to collect large volumes of water, which may be an advantage in areas where the density of microplastics is suspected to be low (Crawford and Quinn 2017).

86. In comparison to the use of manta net and because in fresh and/or brackish waters environments, microplastics are present along the whole water column[10], the use of water pumps can provide more reliable and representative results. In addition, and for future consideration, monitoring with waters pumps could also support/complement or be implemented in parallel with the sampling of microplastics in the sediment of the rivers.

a) To this date, there are no detailed guidelines or a common approach for monitoring floating microplastics using water pumps in riverine areas, and especially in surface fresh waters at Mediterranean level, and the present guidelines aim to address relevant aspects and provide guidance to concerned Mediterranean laboratories, institutes, and public authorities. Few studies have presented water pump sampling schemes that were based on a submersible or a jet pump, including stainless steel filters.

b) Zhao et al., 2014 and Wang et al., 2017 used low voltage pumps to filter freshwater through small mesh size (32-50 µm) stainless steel filters. They could only sample small water volumes, because of the small mesh size and possibly the characteristic of the lakes or estuaries. In the Baltic Sea, Setala et al. (2016) applied a high-performance submersible pump with 100 µm and 300 µm filters. These mesh sizes enabled them to filter 2 m^3 of water, providing better representativeness. The number of microplastic particles was clearly higher with the finer mesh size filter, especially in the case of plastic fibres. Fischer et al., 2016 also highlight that smaller particle are represented in greater abundance. From the above 3 options, the use of high-performance submersible pump with the use of 2 filters one of which of 100 µm seems to provide more representative results.

5.2.3 Designing a monitoring campaign

87. The design of the monitoring campaign can be pretty much in line with the respective design when applying the manta net. In this regard, the content of chapter 5.1.3 of is valid and of great use also when applying water pumps.

88. Sampling should be carried out preferably at 3 stations located at different distances from the river mouth. The locations of the stations should be considered *vis-à-vis* the potential pollution sources (e.g., cities, wastewater treatment facilities, industrial installations, etc.). Among the three (3) stations, it

[10] Because of low (or even no) salinity in fresh and/or brackish waters, microplastics are not explicitly concentrated in surface waters layers as it is the case at sea.

is proposed, if possible, that one (1) station is used as "control" station (e.g., close to the water spring of the river or the tributary).

89. Method for sampling: Once the location is positioned, the PVC hose with a lead weight and the filtration system is lowered from a bridge or a boat. To prevent clogging of the 100 μm mesh or/and 300 μm mesh size filter, a use of a basket above the system can be used (a 1 cm pre-filter). All sieves should be made of stainless steel. Pumping of water is linked with exceeded sampling time and effort. To obtain good representativeness it is recommended that at least 1000 litres (1 m^3) are pumped, three (3) times, through the series of connected filters. Larger volumes of water (more than 1000 litres) could be also considered, and particle count should be calculated to 1m^3. Water quantity should be measured by a flowmeter.

90. Based on the experience of the Institute for Water of the Republic of Slovenia (IWRS) from relevant samplings in rivers, two main separation steps are proposed:

a) First Step: Entails a reduction step that allows to reduce clogging with organic matter with the use of a steel basket (bigger mesh size – e.g., 1 cm) (**Error! Reference source not found.Error! Reference source not found.**).
b) Second step: Entails sampling through a filter system using fine mesh size stainless sieves or filters (300 μm and/or 100 μm) (Figure 193). This filter system is within steel basket (**Error! Reference source not found.**).

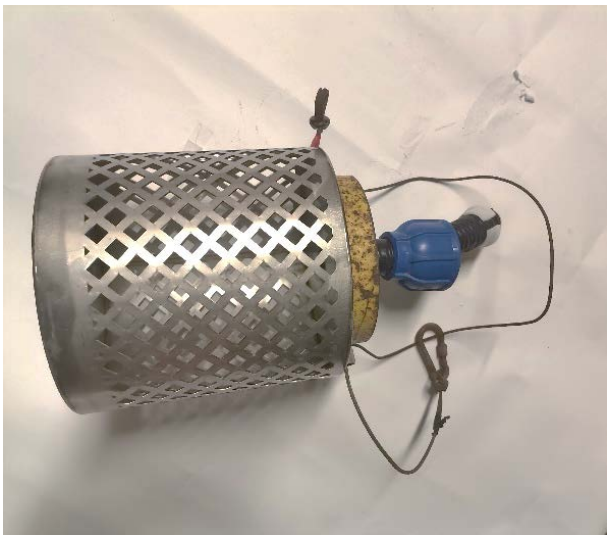

Figure 18: Use of a steel basket for prevention of clogging the sampling device (© IWRS, 2022).

Figure 193: A PVC hose with a filter system with a stainless-steel sieve (100 μm) (© IWRS, 2022).

91. GPS Coordinates: *Same as in Chapter 5.1.3.*

92. Position of the survey stations: *Same as in Chapter 5.1.3.*

93. Multiple survey stations should be set at the river (e.g., one located at the river mouth, one before and one after an urban settlement; or one before and one after a wastewater treatment facility).

94. Replicates: At least 3 replicates per location are proposed with a minimum of 2-3 different sampling sites (locations). For example, one replicate at the river mouth, one before and one after an urban settlement; or one before and one after a wastewater treatment facility.

95. Density of microplastic particles in the river surface: The calculation of the amount of microplastics should be expressed in number of microplastic particles per cubic meter of filtered water:

The reporting units for microplastics abundance from water samples are: Option 1: Number of Microplastics per Volume (No, Particles / m^3)

5.2.4 Sample Collection and Storage

Same as in Chapter 5.1.5.

5.2.5 Laboratory Analysis of Samples collected using a water pump

Same as in Chapter 5.1.6.

5.2.6 Keynotes

Same as in chapter 5.1.7.

6. Summary of Advantages and Disadvantages for the proposed Methodologies

96. During the deliberations of the Online Working Group on Marine Litter (OWG-ML), fruitful and thorough discussions took place by the respective experts for all four (4) methodologies that are proposed and included in the present document. Further to the experts advise and recommendations, MED POL has extracted and reflected under the table hereunder the advantages and disadvantages of the respective methodologies towards providing guidance to the respective technical personnel of the IMAP competent institutes and laboratories, especially when concerning the selection of a methodology.

Methodology	Advantages	Disadvantages
Visual Monitoring ***(Chapter 4.1)***	a) It provides a good indication and collects information on the number of floating litters observed in a given period of time b) Cheap and easy method when observers are used.	a) Specific installations are required when observers are used (e.g., bridge with height above 10m). b) Resources are required (money and knowledge) when cameras are used, including the use of software. c) Difficult to monitor for several hours (tiredness for the case of observers). d) Litter may travel under the surface and thus are not detected. e) It is not feasible to count in storms/high waters when most of the waste is transported to the sea. f) Monitoring is possible only when rivers are in a "calm" status. g) Difficult identification of certain marine litter items (e.g., white plastic particles can be mistaken for white paper particles), as well as of the items closer to the lower size limit (2.5-3 cm).
Macro-litter on Riverbanks ***(Chapter 4.2)***	a) Cheap in operation and quick data acquisition. b) Harmonization of beach litter items through the use of the MED POL list for beach marine litter items. c) No special equipment is required.	a) Difficulty to sample the full 100 m stretch. b) Extrapolation (from 10m to 100m) distorts data consistency and respective findings. c) Collection and calculation of marine litter that was not yet transported to the sea.
Use of Manta Net ***(Chapter 5.1)***	a) Easy installation and sampling. b) Good level of knowledge for this sampling technique around the Mediterranean. c) Very good link with the UNEP/MAP Guidelines for Monitoring Floating Microplastics. d) Integration with the monitoring stations for floating microplastics. e) Comparability with the data from the sea surface.	a) Sampling outside of the river gradient, so outside of the river structure. b) When sampling micro-litter on the river surface many particles may be missed from the sampling due to lack of salinity (micro-litter floats in the entire water column). c) The manta net may collect a lot of organic material which may results in acute clogging or making laboratory analysis difficult and time consuming.
Use of Water Pumps ***(Chapter 5.2)***	a) Different depths can be pumped. b) $1m^3$ or more can be pumped (all results should be converted to number/m^3). c) If the pump is small, it is easy to transport it.	a) Does not provide information on floating microplastics (sampling in conducted in the water column. b) Possible fragmentation of particles due to the pump (avoid using pumps that contain blades). c) Extrapolation may give wrong assessment findings/results (i.e., when less than $1m^3$ is pumped). d) Limitations on pumping due to the power of the pump (pumping height/length)

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Annex I
MED POL List for Beach Marine Litter Items

Annex I: MED POL List for Beach Marine Litter Items

Value	Description	Macro-Category
G1	4/6-pack yokes, six-pack rings	Plastic/Polystyrene
G3	Shopping bags incl. pieces	Plastic/Polystyrene
G4	Small plastic bags (e.g., freezer bags incl. pieces)	Plastic/Polystyrene
G5	The part that remains from rip-off plastic bags	Plastic/Polystyrene
G7/G8	Drink bottles	Plastic/Polystyrene
G9	Cleaner bottles & containers	Plastic/Polystyrene
G10	Food containers incl. fast food containers	Plastic/Polystyrene
G11	Beach use related cosmetic bottles and containers (e.g., Sunblocks)	Plastic/Polystyrene
G13	Other bottles, drums and containers	Plastic/Polystyrene
G14	Engine oil bottles & containers <50 cm	Plastic/Polystyrene
G15	Engine oil bottles & containers >50 cm	Plastic/Polystyrene
G16	Jerry cans (square plastic containers with handle)	Plastic/Polystyrene
G17	Injection gun containers (including nozzles)	Plastic/Polystyrene
G18	Crates and containers / baskets (excluding fish boxes)	Plastic/Polystyrene
G19	Vehicle parts (made of artificial polymer or fiber glass	Plastic/Polystyrene
G21/24	Plastic caps and lids (including rings from bottle caps/lids)	Plastic/Polystyrene
G26	Cigarette lighters	Plastic/Polystyrene
G27	Cigarette butts and filters	Plastic/Polystyrene
G28	Pens and pen lids	Plastic/Polystyrene
G29	Combs / hairbrushes / sunglasses	Plastic/Polystyrene
G30/31	Crisps packets/sweets wrappers/Lolly sticks	Plastic/Polystyrene
G32	Toys and party poppers	Plastic/Polystyrene
G33	Cups and cup lids	Plastic/Polystyrene
G34	Cutlery, plates and trays	Plastic/Polystyrene
G35	Straws and stirrers	Plastic/Polystyrene
G36	Heavy duty sacks (e.g., fertilizer or animal feed sacks)	Plastic/Polystyrene
G37	Mesh bags (e.g., vegetables, fruits and other products) excluding aquaculture mesh bags	Plastic/Polystyrene
G40	Gloves (washing up)	Plastic/Polystyrene
G41	Gloves (industrial/professional rubber gloves)	Plastic/Polystyrene
G42	Crab/lobster pots and tops	Plastic/Polystyrene
G43	Tags (fishing and industry)	Plastic/Polystyrene
G44	Octopus pots	Plastic/Polystyrene
G45	Mesh bags (e.g., mussels nets, net sacks, oyster nets including pieces and plastic stoppers from mussel lines)	Plastic/Polystyrene
G46	Oyster trays (round from oyster cultures)	Plastic/Polystyrene
G47	Plastic sheeting from mussel culture (Tahitians)	Plastic/Polystyrene
G49	Rope (diameter more than 1cm)	Plastic/Polystyrene
G50	String and cord (diameter less than 1 cm)	Plastic/Polystyrene
G53	Nets and pieces of net < 50 cm	Plastic/Polystyrene
G54	Nets and pieces of net > 50 cm	Plastic/Polystyrene
G56	Tangled nets/cord	Plastic/Polystyrene
G57/G58	Fish boxes	Plastic/Polystyrene
G59	Fishing line (tangled and not tangled)	Plastic/Polystyrene

Value	Description	Macro-Category
G60	Light sticks (tubes with fluid) incl. Packaging	Plastic/Polystyrene
G62/G63	Buoys (e.g. marking fishing gear, shipping routes, mooring boats etc.)	Plastic/Polystyrene
G65	Buckets	Plastic/Polystyrene
G66	Strapping bands	Plastic/Polystyrene
G67	Sheets, industrial packaging, plastic sheeting (i.e. non-food packaging/transport packaging) excluding agriculture and greenhouse sheeting	Plastic/Polystyrene
G68	Fiberglass items and fragments	Plastic/Polystyrene
G69	Hard hats/Helmets	Plastic/Polystyrene
G70	Shotgun cartridges	Plastic/Polystyrene
G71	Shoes and sandals made of artificial polymeric material	Plastic/Polystyrene
G73	Foam sponge items (i.e. matrices, sponge, etc.)	Plastic/Polystyrene
G75	Plastic/polystyrene pieces 0 - 2.5 cm	Plastic/Polystyrene
G76	Plastic/polystyrene pieces 2.5 cm > < 50 cm	Plastic/Polystyrene
G77	Plastic/polystyrene pieces > 50 cm	Plastic/Polystyrene
G91	Biomass holder from sewage treatment plants and aquaculture	Plastic/Polystyrene
G253	Single-use plastic masks (e.g. used for protection from COVID-19)	Plastic/Polystyrene
G254	Single-use plastic gloves (e.g. used for protection from COVID-19)	Plastic/Polystyrene
G124	Other plastic/polystyrene items (identifiable) including fragments	Plastic/Polystyrene
	Please specify the items included in G124	Plastic/Polystyrene
G125	Balloons, balloon ribbons, strings, plastic valves and balloon sticks	Rubber
G127	Rubber boots	Rubber
G128	Tyres and belts	Rubber
G134	Other rubber pieces	Rubber
	Please specify the items included in G134	Rubber
G137	Clothing / rags (e.g., clothing, hats, towels)	Cloth
G138	Shoes and sandals (e.g., Leather, cloth)	Cloth
G141	Carpet & furnishing	Cloth
G140	Sacking (hessian)	Cloth
G145	Other textiles (including pieces of cloths, rags, etc.)	Cloth
	Please specify the items included in G145	Cloth
G147	Paper bags	Paper/Cardboard
G148	Cardboard (boxes & fragments)	Paper/Cardboard
G150	Cartons/Tetrapack Milk	Paper/Cardboard
G151	Cartons/Tetrapack (non-milk)	Paper/Cardboard
G152	Cigarette packets (including transparent covering of the cigarette packet)	Paper/Cardboard
G153	Cups, food trays, food wrappers, drink containers	Paper/Cardboard
G154	Newspapers & magazines	Paper/Cardboard
G158	Other paper items (including non-recognizable fragments)	Paper/Cardboard
	Please specify the items included in G158	Paper/Cardboard
G159	Corks	Paper/Cardboard
G160/161	Pallets / Processed timber	Processed/Worked Wood
G162	Crates and containers / baskets (not fish boxes)	Processed/Worked Wood
G163	Crab/lobster pots	Processed/Worked Wood

Value	Description	Macro-Category
G164	Fish boxes	Processed/Worked Wood
G165	Ice-cream sticks, chip forks, chopsticks, toothpicks	Processed/Worked Wood
G166	Paint brushes	Processed/Worked Wood
G171	Other wood < 50 cm	Processed/Worked Wood
	Please specify the items included in G171	Processed/Worked Wood
G172	Other wood > 50 cm	Processed/Worked Wood
	Please specify the items included in G172	Processed/Worked Wood
G174	Aerosol/Spray cans industry	Metal
G175	Cans (beverage)	Metal
G176	Cans (food)	Metal
G177	Foil wrappers, aluminium foil	Metal
G178	Bottle caps, lids & pull tabs	Metal
G179	Disposable BBQ's	Metal
G180	Appliances (refrigerators, washers, etc.)	Metal
G182	Fishing related (weights, sinkers, lures, hooks)	Metal
G184	Lobster/crab pots	Metal
G186	Industrial scrap	Metal
G187	Drums and barrels (e.g., oil, chemicals)	Metal
G190	Paint tins	Metal
G191	Wire, wire mesh, barbed wire	Metal
G198	Other metal pieces < 50 cm	Metal
	Please specify the items included in G198	Metal
G199	Other metal pieces > 50 cm	Metal
	Please specify the items included in G199	Metal
G200	Bottles (including identifiable fragments)	Glass
G202	Light bulbs	Glass
G208a	Glass fragments >2.5cm	Glass
G210a	Other glass items	Glass
	Please specify the items included in G210a	Glass
G204	Construction material (brick, cement, pipes)	Ceramics
G207	Octopus pots	Ceramics
G208b	Ceramic fragments >2.5cm	Ceramics
G210b	Other ceramic/pottery items	Ceramics
	Please specify the items included in G210b	Ceramics
G95	Cotton bud sticks	Sanitary Waste
G96	Sanitary towels/panty liners/backing strips	Sanitary Waste
G97	Toilet fresheners	Sanitary Waste
G98	Diapers/nappies	Sanitary Waste
G133	Condoms (including packaging)	Sanitary Waste
G144	Tampons and tampon applicators	Sanitary Waste
G--	Other sanitary waste	Sanitary Waste
	Please specify the other sanitary items	Sanitary Waste
G99	Syringes/needles	Medical Waste
G100	Medical/ Pharmaceutical containers/ tubes	Medical Waste
G211	Other medical items (swabs, bandaging, adhesive plaster etc.)	Medical Waste
	Please specify the items included in G211	Medical Waste

Value	Description	Macro-Category
G101	Dog faeces bag	Faeces
G213	Paraffin/Wax	Paraffin/Wax
Presence of pellets	Please say Y or N	
Presence of oil tars	Please say Y or N	
Number Items	Number of items in the category expressed as number of objects / 100m	

Annex II
Marine Litter Experts - Members of Online Working Group on Marine Litter who Contributed to the Development of the Guidelines

Experts - Members of Online Working Group on Marine Litter who Contributed to the Development of the Present Document

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