

European Marine Strategy Framework Directive  
Working Group on Good Environmental Status  
(WG-GES)

# Monitoring Guidance for Marine Litter in European Seas

**Draft Report**

**CHAPTER 4**

**FLOATING LITTER**

**July 2013**



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**Draft Guidance Report:**

TSG-ML was tasked to deliver guidance so that European Member States could initiate programmes for marine litter monitoring. As monitoring must be operational by 2014, first guidance was required by mid-2013. The draft Guidance report provides the basis for the marine litter programme however since new information continues to be compiled TSG-ML can review and update this guidance later in 2013.

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Final edition was done by Georg Hanke (co-chair, EC JRC), Stefanie Werner (co-chair, UBA), François Galgani (chair, IFREMER), Joana Mira Veiga and Maria Ferreira (EUCC).

**Disclaimer:** This report has been prepared by a group of experts nominated by EU Member States and Stakeholders. It aims to provide guidance for the implementation of MSFD Descriptor 10 on Marine Litter. It does not constitute an official opinion of the European Commission, nor of the participating Institutions and EU Member States.

## 4. Floating Litter

### 4.1. Introduction to Floating Litter

The monitoring of floating marine litter corresponds to indicator 10.1.2 within Descriptor 10 of the Marine Strategy Framework Directive.

The occurrence of man-made objects, mainly plastic, floating at sea has been described since long time ago (Venrick 1972, Morris, 1980). While significant actions in waste management and disposal have been taken, floating litter is still a concern. It poses a direct threat to fishes, marine mammals, reptiles and birds. Harm can occur through ingestion of whole items or pieces or by feeding on larger litter items. Entanglement can occur by bags, nets and other fishing gear. It can be assumed that marine macro litter is a precursor of marine micro litter.

### 4.2. Scope & key questions to be addressed

This Chapter compiles the existing protocols for the monitoring of floating marine macro litter. It then investigates their differences, applicability and other important elements. It identifies the needs for monitoring methods to be used for MSFD and analyses eventual shortcomings of the existing approaches in view of their application to monitoring under the MSFD. Following up on the tools developed in the MSFD TSG-ML 2011 report, it develops a proposal for protocols, in order to fill the recognized gap under Tool Code 10.1.2\_Water T1.

The protocols aim at harmonised monitoring approaches, in order to ensure data comparability between different programmes and across regions. This Chapter also addresses the issue on data quality assurance and control for trend analysis. It elaborates on the possibility to use monitoring data deriving from “windows of opportunity”. Finally, it investigates and describes the recent development of new monitoring methods as follow-up of the MSFD TSG 2011 report.

The fraction of litter discussed here, includes the floating items in the water column close to the surface, as caused e.g. by the temporary mixing of floating particles under the water surface due to wave action. Litter in the deeper water column is currently not recommended for routine monitoring and should be subject of research efforts.

### 4.3. Existing approaches for visual ship-based observation of floating litter

An assessment of different methodologies currently employed approaches has been made. These are used by HELMEPA, ECOOCEAN, Chile/Germany, UNEP, NOAA and by scientific research groups.

While the approaches for the different monitoring schemes are listed shortly, more detailed information can be found in the cited references.

#### HELMEPA

Helmepa uses a fleet of ships-of-opportunity in order to obtain voluntary monitoring data through a reporting sheet.

#### ECOOCEAN

Ecoocean is performing monitoring on behalf of the French marine authorities. The monitoring is done in parallel with monitoring of marine mammals in the North-western Mediterranean Sea.

## UNEP

UNEP guidance considers both, sampling of an area through a dedicated observation pattern and transect sampling for monitoring of surface floating litter (UNEP, 2009).

## NOAA

NOAA operates two approaches for voluntary observation of marine litter: one for yacht racers in the Pacific and a different one for use with the Office of Marine and Aviation Operation's fleet of ships (Arthur *et al*, 2011).

## University of Coquimbo, Chile

Several scientific publications have been made by Martin Thiel and collaborators (*e.g.* Hinojosa & Thiel, 2009). A strip transect approach is followed through observation from a ship bow.

## Other approaches

Other scientific research groups are using different protocols for their observation purposes (Ryan, 2013).

### 4.3.1. Discussion of observation protocol elements

The observation of floating marine litter from ships is subject to numerous variables in the observation conditions. They can be divided into operational parameters, related to the ship properties and observation location.

#### **Operational observation parameters:**

- Observation height
- Observation width
- Observation distance
- Observation angle
- Ship speed

#### **Environmental parameters:**

- Wind speed
- Sea state
- Light conditions
- Sun direction
- Viewing (quality of vision eventually impaired by fog, etc.)

#### **Marine litter object properties:**

- Location (INSPIRE compatible geographical coordinates)
- Lower size range (detection limit)
- Upper size range (detection probability)
- Categories
- Object properties
- Windage (protrusion from water surface)
- Object size
- Object shape
- Object description
- Object depth
- Source relations
- Ageing/weathering

- Biofouling
- Object colour

The processing of the collected information, starting from the documentation on board, its compilation, elaboration and further use should be part of a protocol in order to derive comparable final results. The format should allow a compilation across different observing institutes and areas or regions. This would allow a plotting of floating litter distribution over time and thus finally allow the coupling with oceanographic current models.

#### **Documentation**

- Datasheet
- Photographic
- App
- Data compilation

#### **Data analysis**

- Statistics
- Averaging
- Geostatistical analyses
- Modelling (with oceanographic current models)

#### **Data presentation**

- Map Plotting
- Graphs
- Density mapping

## **4.4. Categories for floating marine litter**

The reporting of monitoring results requires the grouping into categories of material, type and size of litter object. The approach for categories of floating litter is linked with the development of a “master list” with the categories for other environmental compartments (see Chapter 8). This allows cross comparisons.

### **4.4.1. Material and item categories**

The categories of items for floating litter should be, as far as practically, consistent with the categories selected for beach litter, seafloor litter and others. There are limitations to this, but in principal the derived data should allow a comparison across different environmental compartments, in particular between beach and surface floating litter. Therefore the list of item categories that should be adopted for floating litter corresponds to the Master List of items. For the practical use during the monitoring the list has to be arranged by object occurrence frequency so that the data acquisition can be done in the required short time. Tablet computer applications for facilitating the data documentation are under development.

### **4.4.2. Size categories**

When the recording of items is based only in the observation rather than collection, the size is the only indicative parameter of the amount of plastic material that it contains. The size of an object is defined here as its largest dimension, width or length, as visible during the observation.

The lower size limit is determined by the observation conditions. These should be harmonized so that a lower limit of 2.5 cm can be achieved. That size appears to be reasonable for observation from “ships-of-opportunity” and is in line with the size for beach litter surveys. This denotes that observation not achieving this minimum size limit cannot be recommended.

For reporting purposes several intermediate steps must be introduced as visual observation will not permit the correct measuring of object sizes. Only the determination of size classes is feasible.

The size determination/reporting scheme should enclose the following classes:

- 2.5 – 5 cm
- 5 - 10 cm
- 10 – 20 cm
- 20 – 30 cm
- 30 – 50 cm

The upper size limit will have to be determined by statistical calculations regarding the density of the object occurrence in comparison to transect width, length and frequency. In coherence with the beach litter surveys an upper limit of 50 cm is here provisionally proposed.

## 4.5. Strategy for monitoring of floating marine litter

### 4.5.1. Source attribution of floating marine litter

The MSFD COM DEC 2010/477/EU calls for the “...analysis of its composition, spatial distribution and, where possible, source...”. Due to the observation methodology, the source attribution for floating litter is challenging. The type of marine litter objects can only be noted during very short visual observation. Therefore, in difference to beach litter, it is likely that only rough litter categories can be determined.

The spatial distribution of marine litter instead gives, in combination about currents, tides and river information indications about the physical source, i.e. the litter input zone and its pathway, which is very valuable information about source strength and may help to design appropriate measures.

The monitoring of floating litter is very likely to be an iterative process during which in an initial phase hot spots and pathways are determined, while in an evolving monitoring program selected transects help with the quantification of trends.

### 4.5.2. Spatial distribution of monitoring

The monitoring of floating marine litter by human observers is a methodology indicated for short transects in selected areas. In a region with little or no information about floating marine litter abundance it might be advisable to start by surveys in different areas in order to understand the variability of litter distribution. The selected areas should include expected low density areas (e.g. open sea) as well as expected high density areas (e.g. close to ports). This will help to obtain maximum/minimum conditions and train the observers. 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.

Based on the experience obtained in this initial phase, a routing programme including areas of interest should then be established.

### 4.5.3. Timing of floating marine litter monitoring

The observation of floating marine litter is much depending on the observation conditions, in particular on the sea state and wind speed. The organization of monitoring must be flexible enough to take this into account and to re-schedule observations in order to meet (according to the protocols QA/QC section) appropriate conditions. Ideally the observation should be performed 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.

The initial, investigative monitoring should be performed with a higher frequency in order to understand the variability of litter quantities in time. Even burst sampling, i.e. high sampling frequency over short period, might be appropriate in order to understand the variability of floating marine litter occurrence.

For trend monitoring the timing will depend on the assumed sources of the litter, this can be e.g. monitoring an estuary after a rain period in the river basin, monitoring a touristic area after a holiday period.

The timing of the surveys will also depend on the schedule of the observation platforms. Regular patrols of coast guard ships, ferry tracks or touristic trips may offer frequent opportunities which thus also allow the use during the needed calm weather conditions. The sharing of information and experience from the investigative monitoring between local authorities, regions and at EU level will be important for the organization of a harmonized and cost effective monitoring of the European Seas!

## 4.6. MSFD Protocol for visual monitoring of floating litter

The protocol will provide a harmonized approach for the quantification of floating marine litter by ship-based observers.

The protocol has the scope to harmonize the monitoring of floating marine litter:

- In the size range from 2.5 to 50 cm,
- Observation width needs to be determined according to observation set-up,
- It is planned for use from ships of opportunity,
- It is based on transect sampling,
- It should cover short transects, and
- Also record necessary metadata.

### 4.6.1. Observation

The observation from ships-of-opportunity should ensure the detection of litter items at 2.5 cm size. The observation transect width will therefore depend on the elevation above the sea, the ship speed. Typically a transect width of 10 m can be expected, but a verification should be made and the width of the observation corridor chosen in a way that all items in that transect can be seen. Table 4 below provides an indication of the observation corridor width, with varying observation elevation and speed of vessel (kn = knot = nautical mile/h). The parameters need to be verified prior to data acquisition.

Observation elevation above sea	Ship speed 2 knots = 3.7 km/h	6 knots = 11.1 km/h	10 knots = 18.5 km/h
1 m	6 m	4 m	3 m
3 m	8 m	6 m	4 m
6 m	10 m	8 m	6 m
10 m	15 m	10 m	5 m

**Table 4:** Width of “observation corridor” based on observation height and ship speed (to be reviewed)

### 4.6.2. Data and metadata reporting

A harmonized reporting of monitoring results is crucial for the comparison of data. The data output from the application of the protocol, when using a computer interface, is a list of georeferenced objects according to a list of categories. The use of a portable computer device for documenting marine floating litter has clear advantage over paper documents. A specific application, based on the MSFD protocol for the monitoring of floating macro litter will be developed by JRC and field tested within the PERSEUS project.

For floating marine litter the unit of reporting will be: items/km<sup>2</sup>. This value can then be broken down into different object classes and size classes for a detailed data analysis.

Along with the litter occurrence data, a series of metadata should be recorded, including dereferencing (coordinates) and wind speed (Beaufort scale 1-12). This accompanying data shall allow the evaluation of the data in the correct context and should be compatible with the INSPIRE Directive in order to make data easily exchangeable and shareable.

#### 4.6.3. Quality Assessment /Quality Control

The wide spread acquisition of monitoring data will need some kind of inter comparison or inter calibration in order to ensure comparability of data between different areas and over time, for trend assessments. Approaches for this should be developed and implemented. This can be e.g. hands(eyes) –on training courses with comparisons of observations). Such events should be organized at EU level with further implementation at national scale then being organized in the EU Member States.

A methodology for calibrating observation quality by artificial targets may be devised through research efforts.

#### 4.6.4. Equipment

The equipment used for the monitoring of floating litter is very limited. Besides the transportation platform some instruments may facilitate the work:

- A system for visually marking the observation area,
- GPS for determination of ship speed and geographical coordinates,
- A tablet PC for documenting the results (including a dedicated application/program),
- A system for training and calibrating size classification.

### 4.7. Cost of monitoring of floating litter

Costs for the monitoring of marine litter by a dedicated activity could be high, due to the involvement of a vessel. Therefore it can be expected that the monitoring of floating litter will mostly be connected to other activities (see next section “Platforms-of-opportunity”). Though this can drastically reduce the operational costs (“close to zero”), marine litter observation needs dedicated personnel on board of the ships. The work can be done by volunteers, but in this case the proper training and following of protocols must be ensured. As no specific skills are need for observation, it can be done by personnel with different occupations on board a ship. In practise such monitoring is e.g. done by researchers quantifying marine mammal’s abundance. This requires careful planning, as the requirements for the two tasks might still deviate attention and may not be compatible e.g. because of different observation distances.

#### 4.7.1. “windows of opportunity”

The monitoring of marine litter can be done from any ship of appropriate size and speed moving on transects which are suitable for a sustainable monitoring of trends.

The placing of a dedicated person on board of a ferry for a selected short coastal transect repeated in appropriate intervals appears to be a very cost effective methodology, which can in short time provide a quantification of floating marine litter.

Other opportunities for observation can be: scheduled coastal oceanographic cruises, associated or not with monitoring of other MSFD Descriptors, coast guard patrols, ferries, touristic cruises, etc.. Of course the monitoring programme needs then to be adjusted to the available opportunities and some compromises for the ideal observation transect might be needed.



#### 4.7.2. Cost estimate

Trying to quantify the costs could denote to calculate e.g. the ferry shipping cost for a person; though in reality this may often be an in kind contribution by the ship owner company. Added to this would be the staff cost for a day of work (in case of availability of an appropriate ferry transect). The number of sites obviously depends on the marine and coastal extension of the country and its topography, population density, number of estuaries, etc..

<i>Type of Cost</i>	
<b>Manpower cost:</b>	0.5 man day/transect (including transfers)
<b>Equipment cost:</b>	ca. 250 € for tablet PC
<b>Processing cost:</b>	only need to download data
<b>Analysis cost:</b>	Plotting of data with a simple tool
<b>Reporting cost:</b>	5 man days for data preparation for a whole regional data set
<b>Note: The cost of manpower will vary significantly between countries and the available personnel.</b>	

**Table 5:** Estimation of costs of the different phases of monitoring floating litter through visual observation and considering “platforms-of-opportunities” (i.e. no cost associated to vessel)

## 4.8. Other methodologies

### 4.8.1. Aerial surveys

The opportunistic use of aerial surveys (e.g. for marine mammal observation/monitoring) has been considered. The minimum size of observed objects is at ca. 30 cm, therefore this approach might be adequate to the size fraction above 30 cm.

### 4.8.2. Net tow surveys for macro litter

Physical sampling of floating macro litter requires large net openings operated at the sea surface. Given the density of macro litter occurrence this would require significant dedicated ship time and specific equipment.

### 4.8.3. Riverine litter monitoring

It should be mentioned that the protocol is as well applicable for the monitoring of floating litter on rivers by observation from bridges or similar.

### 4.8.4. New methodologies

Closely related to the monitoring by human visual observation is the monitoring through image acquisition by digital camera systems and their subsequent analysis by image recognition techniques. The EC JRC is developing the JRC *Sealittercamera*, a system being temporarily deployed on Costa Crociere cruise ships in the Western Mediterranean Sea.

## 4.9. Conclusions: Key messages to MSFD implementation process

Key messages to MSFD implementation process:

- Monitoring Marine Litter suspended in the middle water column is not recommended
- The monitoring of large floating macro litter (> 50 cm) for MSFD purposes is not recommended
- The monitoring of floating marine litter in selected coastal transects is recommended
- Monitoring of floating litter should follow a specific protocol agreed on EU scale within the MSFD implementation process

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