European Marine Strategy Framework Directive

Executive Summary of the Guidance on Monitoring of Marine Litter in European Seas

MSFD Technical Subgroup on Marine Litter

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List of Acronyms and Abbreviations

CEFAS	Centre for Environment, Fisheries and Aquaculture Science, UK
DG ENV	Directorate - General for the Environment
DG MARE	Directorate - General for Maritime Affairs and Fisheries
EcoQO	Ecological Quality Objective (OSPAR)
EEA	European Environment Agency
GES	Good Environmental Status
HELCOM	Helsinki Commission Baltic Marine Environment Protection Commission
HELMEPA	Hellenic Marine Environment Protection Association
Horizon 2020	EU Framework Programme for Research and Innovation
IBTS	International Bottom Trawl Survey
ICES	International Council for the Exploration of the Seas (CIEM)
INSPIRE	Infrastructure for Spatial Information in the European Community
JRC - IES	European Commission Joint Research Centre - Institute for Environment and Sustainability
MEDITS	Mediterranean International Trawl Survey
MS	EU Member States
MSCG	Marine Strategy Coordination Group
MSFD	Marine Strategy Framework Directive (2008/56/EC)
MSFD COM DEC 2010/477/EU	Commission Decision on criteria and methodological standards on good environmental status of marine waters (2010/477/EU)
NOAA	National Oceanic and Atmospheric Administration (US)
OSPAR	Convention for the Protection of the Marine Environment of the North-East Atlantic
QA/QC	Quality assurance / Quality control
R&D	Research and development
RSC	Regional Sea Convention
TSG-ML	Technical Subgroup on Marine Litter under the Marine Strategy Framework Directive
UNEP	United Nations Environment Programme
WG GES	Working Group on GES in relation to the MSFD
WG DIKE	Working Group on Data Information Knowledge and Exchange within the MSFD
WISE-Marine	Water Information System for Europe

1. Introduction

1.1. Scope of this summary

This executive summary of the document Guidance on Monitoring of Marine Litter in European Seas (EUR 26113 EN) provides an overview on the actual guidance document. It aims at enabling policy makers to rapidly access the content of the guidance document.

1.2. The issue of Marine Litter

Marine Litter is defined as any persistent, manufactured or processed material deliberately discarded or unintentionally lost to the sea and on the coastline. This includes those items transported from inland areas via rivers, drainage or sewage systems, and those conveyed via wind. These are materials of various origin, usage and composition where plastics are usually the main component.

Marine Litter is globally recognised as an emerging threat to the environment, having economic health and safety effects. The litter in the marine environment can lead to entanglement such as "ghost fishing" that is where lost and abandoned fishing gear entangles marine life. Dozens of marine species, including crustaceans, fish, marine birds, turtles and cetaceans, are known to have ingested plastic litter. This plastic refuse can litter over vast areas, covering large distances, acting as a vector for invasive species, and is not degradable. Thus, the impacts of marine litter are wide-ranging and extensive.

1.3. Guidance on monitoring of marine litter within the MSFD

The Marine Strategy Framework Directive (MSFD– 2008/56/EC) requires European Member States (MS) to develop strategies that should lead to the implementation of programmes of measures to achieve or maintain Good Environmental Status (GES) in European Seas. MS should establish monitoring programmes for the assessment of progress towards GES, for the various descriptors in Annex I. For Descriptor 10 – Marine Litter, there is a **lack of consistent and systematic data across Europe (with some exceptions) and existing surveys are either anecdotal and/or they use different approaches and methodologies**. In order to obtain reliable and comparable data, within regions and among neighbouring countries, it is important to **coordinate the monitoring programmes trans-nationally** and, whenever possible, **to harmonised methodologies to collect, record and report data**.

In 2010, following the Commission Decision on criteria and methodological standards on GES of marine waters (Commission Decision 2010/477/EU), the Marine Directors requested the Directorate-General for the Environment (DG ENV) to establish an Technical Subgroup on Marine Litter (TSG-ML) under the Working Group on GES (WG GES), to address these gaps and further develop Descriptor 10. The TSG-ML is led by DG ENV and chaired by IFREMER, the EC Joint Research Centre and the German Environment Agency. The group consists of MS delegates and invited experts from relevant organizations.

During 2011, the TSG-ML focused on providing advice through the report "*Marine Litter – Technical Recommendations for the implementation of MSFD requirements*", which described the options and tools available for the monitoring of marine litter in the different environmental compartments and a review of the existing monitoring programmes or surveys that generated data within Europe. MS have since requested a follow-up through an additional mandate of the TSG-ML.

The present document is the **Executive Summary** of the "Guidance on Monitoring of Marine Litter in European Seas", the output of the work of the TSG-ML between 2012 and 2013. The objective of such Guidance is to provide MS with recommendations and information needed to commence the monitoring of the MSFD Descriptor 10. It describes specific protocols and considerations to collect, report and asses data on marine litter, in particular beach litter, floating litter, seafloor litter, litter in biota and microlitter.

The Guidance document is divided in 8 sections:

- A short introduction to the need for such a document and its scope
- Chapter 2 – General Approaches & Strategies for Marine Litter Monitoring, addressing key aspects related to MSFD requirements, coordination at the Regional Level and general framework of a monitoring programme on marine litter;
- Chapter 3 – Beach Litter: guidance to monitoring litter deposited on the beach (Indicator 10.1.1);
- Chapter 4 – Floating Litter: guidance to monitoring litter in the water column (Indicator 10.1.2);
- Chapter 5 – Seafloor Litter: guidance to monitoring litter in the seafloor (Indicator 10.1.2);
- Chapter 6 – Litter in Biota: guidance to monitoring litter ingested by marine organisms (Indicator Chapter 8 – Litter categories: guidance on categorization of litter for a harmonised, comparable approach.
- 10.2.1) and other impacts of litter on biota;
- Chapter 7 – Microlitter: guidance to monitoring microlitter in the marine environment and biota (Indicator 10.1.3);

The TSG-ML will keep working throughout 2014, to further elaborate on outstanding issues, such as: assessment of harm; approaches to identification of land and marine-based sources, including monitoring of riverine litter. A subsequent document is expected to be published at the end of 2014 covering these topics.

2. General Approaches & Strategies for Marine Litter Monitoring

This chapter describes general issues associated with monitoring of marine litter. This includes advice on setting-up strategies to be used for monitoring planning, taking into account the MSFD requirements, knowledge development and costs of monitoring.

2.1. Requirements for Monitoring Programmes within the MSFD

An important milestone in the implementation of the MSFD is the establishment of monitoring programmes by 15 July 2014, related to the GES, indicators and targets. Article 11 of the MSFD provides legally binding requirements to establish and implement coordinated monitoring programmes for the on-going assessment of the environmental status of EU waters. WG GES initiates the development of a framework for coordinated monitoring programmes, which will provide data to assess whether GES and associated environmental targets are being achieved. This, in close cooperation with the Working Group on Data, Information Knowledge Exchange (WG DIKE).

The monitoring requirements for successfully implementing the MSFD-Descriptor 10 are dependent upon available measurement methodologies of demonstrated accuracy, able to deliver reliable data, at affordable costs. Besides already available monitoring methods, novel methods and automated monitoring devices can play a complementary role, improving the quality of monitoring results. The MSFD will be a powerful management tool, only if monitoring data are reliable, relevant to the purpose, and of comparable quality.

The MSFD has set out a list of needs for monitoring programmes, which have been further elaborated by the Marine Strategy Coordination Group (MSCG), resulting in a set of key principles and messages to be followed when designing the monitoring programmes. These are listed below, with comments on how the TSG-ML addresses these issues in the Guidance document.

The core purpose of coordinated monitoring programmes is the "on-going assessment of the environmental status" and related environmental targets in accordance with the MSFD strategies and management cycles. The recommended protocols are aimed at assessing environmental status and environmental targets. They provide quantitative data and allow assessment of trends. The beach litter protocol is designed to identify sources , using a detailed list of identifiable items, while other protocols do this, through their lists of items, and by modifying the sampling strategy (*i.e.* where and when to sample).

The monitoring programmes have to be "coordinated", "compatible", "coherent", "consistent" and "comparable". Most of the protocols proposed can be applied across the European scale to generate comparable data. They are to be used in a harmonised way with standard lists and definitions of items. The protocols for litter in biota cannot be identical across Europe, as they depend upon geographic distribution of specific species, but emphasize how to develop comparable, regional (or sub-regional) approaches. Where lab analysis of sample is concerned, for example, cooperation between (sub-)regions will increase efficiency and cost effectiveness.

Build upon and integrate already established monitoring programmes, under EU legislation, as well as under Regional Sea Conventions and other international agreements. Though marine litter monitoring has not been required previously by other EU directives, there is the potential to combine it with other monitoring programmes, whether associated or not to other MSFD descriptors. We refer to these combinations as “opportunities to reduce costs” and highlight them in throughout the Guidance document (*e.g.* Table 2).

Data and information, resulting from the monitoring programmes, should be made available for interoperable use, and feed into the "Marine Knowledge 2020" process. Many of the issues concerning data handling are the same for marine litter as for other MSFD descriptors. The comparable format is reached through harmonised protocols , including the recording of items into a specific set of categories, ensuring reporting units are comparable, with a common set of metadata . The availability of joint databases and portals is important to harmonising and an efficient use of the data.

Monitoring programmes need to adapt with appropriate reaction to changes in the marine environment and understanding of emerging issues. With marine litter an emerging issue, it`s expected that initial monitoring efforts will be needed to assess the extent, variability and spatial distribution of marine litter. The monitoring efforts can then be adjusted , to provide the necessary data most efficiently.. The proposed protocols cover several environmental compartments (beach, water surface, seafloor, sediment and biota) and the categories list should incorporate any new items that may arise.

Linking monitoring to assessment needs, including the use of risk-based approach as a basis for flexible monitoring design. A complete analysis of risk should include quantitative information on "harm". Where insufficient quantitative data is available, the risk-based approach is followed, assessing where litter likely to be most prevalent, or where the type of litter has the largest impact (e.g. microplastics). An analysis of harm will be a focus point for the work of the TSG-ML during 2013-2014. This will include a development of parameters for the items categories, linked to the potential risks of ingestion, entanglement, safety, etc. The TSG-ML will further develop approaches to link detailed categories of items with the most likely sources and other strategic parameters to aid design and monitoring measures.

Taking into account the differences in scientific understanding for each descriptor in the monitoring programmes and applying the precautionary principle[1]. We acknowledge in our description of protocols that there are different levels of maturity for different protocols. While the protocols for beach litter or ingested litter in birds have been in use for many years, methodologies such as ones for microparticles are currently an area for intense research. Nevertheless, we recommend that less mature protocols are not dismissed, as they may provide insight into critical, emerging issues, such as the trends and impacts of microplastics.

2.2. Monitoring at the Regional Seas' Conventions

Article 6 of the MSFD recommends Member States use existing, regional, institutional cooperation structures, such as those under the Regional Sea Conventions (RSCs)This will achieve coherence and coordination of marine strategies and build upon relevant existing programmes and activities. The RSCs have developed monitoring guidance and environmental, assessment schemes according to current programs and recommend that contracting parties use them for monitoring and assessment.

OSPAR: OSPAR is in the process of developing a Monitoring Framework combining monitoring for the MSFD with "regular" OSPAR monitoring. At present, coordinated monitoring is being carried out under the Coordinated Environmental Monitoring Programme, which includes beach litter. A special arrangement is in place for monitoring plastic particles in the stomachs of fulmars in the North Sea region. Further (Common) indicators are under development (e.g. IBTS seabed monitoring). OSPAR is in the process of compiling a list of common indicators across the region, including their own monitoring requirements, with an indication of (sub-) regional importance and applicability in 2013. This will feed into the review of the Joint Assessment and Monitoring Programme (JAMP) by 2014. To achieve this, OSPAR will differentiate between 'common indicators' and 'candidate indicators' as regards :

(a) inclusion in the next JAMP and ;

(b) concomitant implications for Contracting Parties' monitoring commitments and requirements.

In principle, 'common indicators' should be implemented by all Contracting Parties which are coastal states of the OSPAR maritime area,. Certain indicators may need to be regionally adapted to specific environmental conditions or pressures. Specific indicators may be applicable to only one or more particular OSPAR Regions.

[1] See COM (2000) 1 on the precautionary principle
http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2000:0001:FIN:en:PDF

HELCOM: Within the HELCOM convention area in the Baltic Sea the coordinated, joint monitoring programme is under review and will be agreed upon at the end of 2013. The revised HELCOM Monitoring and Assessment Strategy will focus on aligning the monitoring with the HELCOM ecological objectives, in order to follow up on the effectiveness of the Baltic Sea Action Plan. Following the HELCOM Ministerial Conference on 3rd October 2013, it was agreed to "develop common indicators and associated targets related to quantities, composition, sources and pathway of marine litter, including riverine inputs, in order to gain information on long-term trends, and carry out the monitoring of the progress towards achieving the agreed goals and to gain an inventory of marine litter in the Baltic Sea as well as scientific sound evaluation of its sources." Specific mention was made to the application of the protocols recommended by the TSG-ML, which should be used wherever possible.

Barcelona Convention: Within the framework of the Barcelona Convention, a Policy Document and the associated Strategic Framework for Marine Litter management was adopted in 2012. One of the most recent developments has been the elaboration of a draft Regional Action Plan on Marine Litter (May 2013, Barcelona). This will be legally binding once adopted by the Contracting Parties of the Barcelona Convention (planned in December 2013, in Istanbul). Article 12 of the Regional Action Plan refers to a Mediterranean Marine Litter Monitoring Programme which will be in synergy with the relevant international and regional guidelines, including those produced by the TSG ML, and will be prepared by 2014/2015. At the regional level MED POL will coordinate this activity and promote the appropriate methodologies. It will be responsible for the evaluation and dissemination of marine litter related information which has been provided by designated national agencies.

Bucharest Convention: The choice of monitoring parameters is related to the main environmental problems in the Black Sea region, re-evaluated every 5 years, and based on important reports. See the , State of the Environment of the Black Sea (SoE Report) and Report on the Implementation of the Strategic Action Plan for Environmental Protection and Rehabilitation of the Black Sea (BS SAP), initially adopted in 1996 and later amended in 2009. The BS SAP (2009) addresses the main areas of concern and their causes, through the aims of four Ecosystem Quality Objectives (EcoQO). Currently the Black Sea Commission elaborates on the new text of the Black Sea Integrated Monitoring and Assessment Program (BSIMAP) for the years 2013-2018.,This will undergo national consultation. The main approaches of the updated draft BSIMAP are harmonized with the MSFD, and are compliant with relevant assessment processes within the SoE Report. Marine litter is only mentioned as one of the descriptors, as well as the parameter of discharges under the EcoQO 4. Nevertheless, the methodology of its assessment (together with the assessment of underwater noise) is to be further developed as soon as the updated BSIMAP for 2013-2018 is adopted by the Black Sea Commission.

2.3. Establishing a monitoring framework for marine litter

2.3.1. Defining the aim and objectives of monitoring

Defining the aim and objectives of monitoring should precede any methodological selection and has profound consequences for the decision on what to measure, where and when to monitor.

All methods/protocols suggested in this report are primarily designed to monitor environmental status, and to measure progress towards GES. **The usefulness of the protocols for assessing the effectiveness and impact of measures depends on the characteristics of the measures**, i.e. if they are expected to have differential impacts in space (e.g. measures that can lead to a decrease amounts of litter in some geographical areas), time (e.g. decrease during some seasons) or composition of litter (e.g. measure that target specific items or sector that makes use of a type of items). **Most protocols suggested here can be modified to address the space and time variables**, e.g. by focussing monitoring in areas where litter amounts is expected to change as a result of the measures. As to the change in composition, the protocol should enable the identification of such items, i.e. this will be most clearly reflected through protocols that generate a high level of detail in the categorization of items, such as the protocol for beach litter.

A possible exception is when protocols are linked to other monitoring, programmes, such as the seafloor monitoring done during scientific trawl programmes (IBTS, MEDITS etc.). The resource efficiency of combined programmes comes with the cost of decreased flexibility of individual programmes.

2.3.2. Monitoring different indicators and compartments

The Commission Decision identifies Indicators to characterize marine litter, including microparticles, in the different marine environmental compartments (beach, water column, water surface and seafloor) and one indicator to determine impacts of litter on marine life (biota), emphasising that this indicator needs to be further developed. **Protocols are available for all Descriptor 10 - Indicators but with different levels of maturity**, *i.e.* the extent to which they are tested in the field and in common use. Fulfilling the monitoring requirements of the MSFD is a major undertaking and resources for monitoring can be limited. MSs are therefore faced with the decision of what to monitor, and whether it is essential to assess litter amounts in all of the environmental compartments mentioned above. It is then important to remember that these **different compartments can indicate different pathways and sinks for marine litter, and do not necessarily substitute each other**. Furthermore, biota indicators have a different but not less important function: they give an indication of possible harm. When considering a particular compartment to monitor, the nature and behaviour of the type of items should also be taken into account. Monitoring the seafloor it is more likely to capture trends in items that tend to sink, while lighter, smaller items may tend to float. Therefore, the monitoring of different compartments should be seen as complementary rather than alternative – *e.g.* a plastic bottle with cap on will tend to float, while without cap will tend to sink.

If no baseline exists yet, **we strongly recommend that research monitoring should be undertaken, through a small pilot, research or development projects in other compartments, in order to get baseline data** and be able to make an informed decision about future full-scale monitoring programmes.

2.3.3. Site selection strategies

The strategy used to select sites is partly a statistical/technical issue but foremost it is related to the purpose of monitoring, i.e. they should define the criteria for selecting the sites. The site selection strategy has as fundamental consequences for the monitoring analysis as has the selection of the survey method. On a fundamental level, one can either choose sites individually because they have certain characteristics of interest or through a representative strategy using a random selection of sites meeting certain characteristics. An example could be to choose sites that are close to harbours (to monitor effects of pollution form harbours), and/or sites that are situated in relatively remote areas, to monitor large-scale pollution levels without strong influence from local sources.

It is also possible to combine monitoring of marine litter with other existing studies or programmes but in such case the selection of sites is presumably designed for the purpose of the original monitoring programme, and the possibilities for representation of other areas are already defined. If attempting to use such a scheme, it is important to analyse the sampling strategy of the original programme to assess if this is suitable for litter monitoring too.

2.3.4. Data quality, handling and reporting

In order to ensure an adequate quality and integrity of marine litter monitoring data, **investments must be made in capacity-building of the regional, national and local survey coordinators and managers**. The use of quality control/quality assurance measures, such as intercalibrations, use of reference material where appropriate and training for operators should accompany the implementation of the monitoring protocols.

Data handling and reporting (for the MSFD) are still under consideration both at EU level as well as at Regional Sea level. Except for the record of data and units (*i.e.* standard categories of items), it is out of the scope if this Guidance to provide specific recommendations on data handling and reporting.

Data analysis of litter (as other descriptors of the MSFD) will need to be done at different spatial scales (national, sub-regional, regional and European scales). A data collation system through an online European-wide, relational database management system under the control and direction of the local managers would facilitate such analyses. Responsibility for review and approval of uploaded data

should be undertaken by the regional/national coordinator who will clarify any issues with local managers. This would ensure a high level of consistency within each region as well as create a hierarchy of quality assurance on data acquisition. The use of such a system would also support comprehensive analysis of the data providing the opportunity to undertake statistically robust comparisons through time and between survey locations.

The reporting process of data and information under the MSFD (Art 19.3) is being addressed by the WG DIKE and steered by DG ENV and the EEA. Both primary "Data" and interpreted "Information" will fall under the auspices of WISE-Marine, which is moving towards a distributed network system, with the intention that the data will be held at national level.

Special attention should be given to the position and role of the Regional Sea Conventions, both with respect to storage of ML data, QA/QC procedures as well as with respect to (coordinated) reporting and (sub) regional assessments - e.g. a central database for the OSPAR beach litter data already exists. Data input is carried out through the internet.

2.3.5. Knowledge development and research needs

There are still several gaps in the understanding of the processes and impacts associated with marine litter, which have been already identified in the 2011 report of the TSG-ML and include:

- Better understanding of the **origin and behaviour of litter** (e.g. degradation rates) and factors affecting its transport, including the need for models to identify sources, transportation, accumulation and degradation;
- Better understanding of **physical and chemical impact** on marine organisms, ecosystems and human populations, including the risk of transportation of invasive species;
- Better **quantification of impact on socio-economic systems** and ecosystem services;
- Improvement and implementation of **harmonised monitoring systems**, including establishment of baselines, extension of protocols to all MSFD regions.

The last point is partially addressed in the current Guidance document, especially in what concerns harmonisation, coherence and compatibility of monitoring systems to all European regions. Recently concluded projects (*e.g.* Pilot Projects commissioned by DG Environment) and on-going national and sub-regional research and European Projects (e.g. MICRO, CLEANSEA, ECsafeFood) have contributed, and are continuing to contribute, to a greater understanding of the other topics.

Two emerging issues are (i) the development of monitoring and assessment **tools for riverine litter** and (ii) the relation between **harm and risk**, which will be analysed by the TSG-ML, during 2013-2014.

Although much European-funded R&D, on the subject, is taking place many gaps in knowledge, regarding marine litter, still need to be covered and should be considered in future EU knowledge development programming (e.g. Horizon 2020).

2.3.6. The costs of monitoring

Prioritising the monitoring programmes to address the most significant risks, and finding more innovative and efficient ways of monitoring **will be key to meeting the MSFD monitoring requirements in an environment of economic constraint**. One such step is the relevance of criteria and indicators for measures/pressures as they directly link back to management.

A great number of factors influence the cost of monitoring marine litter: the cost of labour; laboratory analyses; equipment; etc. Indication of the magnitude of these costs has been included in the thematic protocols and is summarised in the Chapter 2 of the Guidance document (Table 1). As an illustration, the Netherlands and Germany spend between € 10.000 and 20.000 per year to run the beach litter monitoring of 4 sites, 4 times/year, including data management, analysis and reporting.

There are some ways to **reduce monitoring cost,** namely through **technical/methodological improvements; joint monitoring programmes of other MSFD descriptors; coupling data collection**

with on-going activities; and the use of volunteers. These aspects are further detailed in the guidance document.

Decision-making tools may also help design effective and efficient monitoring programmes (*e.g.* to determine the spatial and temporal resolution needed, or options for the integration of techniques). The **organisation for the governance of monitoring programmes** (*e.g.* delegation of responsibilities, allocation of resources, etc.), including **coordination of the different administrations involved**, to allow effective use of existing resources, transparency and accountability.

Integrated, multi-disciplinary, monitoring programmes should **maximise the use of existing resources** (*e.g*. ship time), by **improving the efficiency of existing programmes** (*i.e*. use of spare capacity). Moreover, **joint monitoring programmes** in (sub) regions may help forge **synergies between MS** on how they are monitoring and assessing the marine environment, and which can potentially reduce overall costs.

3. Harmonised protocols for the different compartments

Chapter 2 of the Guidance document provides a table containing an overview of the different protocols described It has a series of parameters and criteria that can support the decision of which compartments to monitor and which methodologies to adopt. The criteria include: the maturity of the protocol (i.e. the extension to which they have been applied and tested); ranges for total costs; equipment and expertise required; level of detail generated by the methodology in terms of marine litter items; the key limitations to applicability associated with the protocols; and the potential for coupling protocols with other programmes and on-going operations, in order to optimise cost-efficiency.

The remainder of the document focuses on assessing methodology and outcomes for monitoring all MSFD indicators, in relation to marine litter, and describing monitoring protocols recommended for each compartment. The TSG ML conclusions and recommendations are further developed and the Guidance document. In this executive summary, only the *key* conclusions and recommendations are provided.

3.1. Beach Litter

Beach litter monitoring is a highly developed monitoring tool to determine trends of litter in the environment. One of its strengths is that **it allows for a detailed assessment of litter composition and volume, providing information on potential harm and, to some extent, on sources of litter and the potential impact of measures**. The TSG-ML has evaluated existing litter monitoring methods along the coastline, and their capacity to fulfil the requirements of the MSFD. The TSG-ML recommends a harmonised method that can be applied along all regional coastlines, ensuring comparison of the results within and between regions. The recommended protocol is based on OSPAR beach litter monitoring programme, the UNEP and NOAA Guidelines for this type of surveys.

Shoreline Litter can be relatively easily assessed during surveys carried out by non-scientists, using unsophisticated equipment, and are thus a **cost effective way of obtaining large amounts of information**. The amounts of litter deposited on the shore, however, can vary greatly between sites and seasons, affected by hydrographical and geomorphological characteristics (*i.e.* larger amounts are deposited during the tourist season or during special events). Therefore, **surveys should focus on fixed sites and periods (*i.e.* season) and should take into account potential sources of litter to that site** (*e.g.* flooding in rainy seasons may increase the amounts). Sites can be chosen to reflect the amounts of litter in so-called reference areas and their proximity to litter sources.. By using temporal trends for assessments, both survey strategies give important information for managers.

This chapter further details criteria for selection of sites; frequency of the surveys; identification and categories of litter; recording and management of data; and quality control aspects. Costs of set-up and running of a beach litter monitoring programme will depend on the number and accessibility of sites and costs of employing professional personnel or use of volunteer surveyors. The TSG-ML provides an estimation of what is required for the different tasks and responsibilities. For the overall coordination of four survey sites ca. 330 hours will be necessary in order to set up the monitoring system, and about 250 hours/year will be required to maintain the programme.

In order to facilitate temporal and spatial comparisons within and across regions, it is recommended that standard litter survey methods are applied at local and regional levels and the assessment of its composition follows agreed categories of items. Further development of this protocol includes the development of a standard statistical analyses method and a refined method for the identification of sources.

3.2. Floating Litter

Monitoring by observation of floating litter items is being carried in Europe and elsewhere but using different approaches. This Chapter assesses existing approaches, and their applicability to the MSFD aims. **It proposes a protocol and categories for reporting that enable a harmonized monitoring approach and comparability between different programmes and across regions**.

The fraction of litter discussed here, includes the floating items in the surface water column. Litter in the deeper water column is not currently recommended for routine monitoring and should be the subject of research efforts. **The methodology is indicated for short transects in selected areas and has been designed for easy coupling with other existing programmes** (e.g. visual observation of cetaceans) **or even professional activities** (e.g. ferry tracks or coast guard patrols), provided they fulfil adequate conditions to apply the protocol (e.g. speed and height of observation allowing detection of a certain minimum size). The Chapter describes methodological aspects related to : the observation; data recording and management; quality control; general estimation of the associated costs; and details the use of opportunities to increase cost-efficiency.

Given the nature of the detection method, this approach may limit the level of detail for litter items (as compared with detail generated by beach litter protocol) but can provide **very valuable information on spatial distribution and indication of physical sources** (*i.e.* areas of input and pathways), which may be key in designing appropriate measures.

3.3. Seafloor Litter

The most common approaches for evaluating litter distributions on the seafloor use opportunistic sampling. It can be **coupled with regular on-going surveys** (in marine reserves, offshore platforms, etc.) **and programmes on biodiversity**, since methods for determining seafloor litter distributions (e.g. trawling, diving, video) are similar to those used for benthic and biodiversity assessments. The use of submersibles or Remotely Operated Vehicles (ROVs) is a possible approach for deep sea areas although this requires expensive equipment.

The TSG-ML recommends **that monitoring of litter on continental margins (< 800m depth) should be co-organised and coordinated within existing trawling programmes for the assessment of fish stocks: ICES/IBTS** (covering NE Atlantic and Baltic Sea) **and MEDITS** (covering Mediterranean and Black Sea) programmes. The sampling protocols are well developed and recently standardized protocols for categorization of items have been added to the manuals for the IBTS and MEDITIS. This will need to be organized within the EU through STEFC (Scientific, Technical and Economic Committee for Fisheries) and its Subgroup Research Needs (SGRN) with the support of the Data Center Framework (DCF) from DG MARE. The use of a central database for European trawl survey data (MEDITS, IBTS, ICES, DATRAS, etc.) may be used for collection of trawl survey data preceding a more specific litter data management system, still to be organised.

For the monitoring of **litter in shallow coastal areas** (< 20m depth), this Chapter describes a protocol based on underwater visual surveys with SCUBA/snorkelling applied to benthic fauna and can **complement on-going monitoring of special areas** (e.g. marine protected areas). Furthermore, recreational and professional scuba divers can provide valuable information on litter they see underwater and they are uniquely positioned to support benthic litter monitoring efforts.

Monitoring shallow waters and deep sea areas should be organized by MS considering the importance of sites and costs. On-going monitoring programmes (marine reserves, pipeline surveys, harbours or bays cleanings) and specific monitoring in areas of risk may provide valuable support to collect data. Methods based on scuba diving or video imaging are therefore provided to support these using harmonized protocols. The use of video imaging is described as a complementary protocol to be used in deep-seafloor.

3.4. Litter in Biota

This Chapter focuses on the Indicator Trends in the amount and composition of litter ingested by marine animals". The Commission Decision (2010/477/EU) expresses the need for further development of this indicator based on the experience in some sub-regions (e.g. North Sea), to be adapted in other regions and on emerging knowledge about other impacts beside the ingestion of litter by marine organisms. The TSG-ML has considered existing methodologies and species known to be impacted, in view of developing tools for investigating trends in ingested litter that cover all the MSFD marine regions but also other impacts, such as entanglement.

Any methodology involving particular species will depend on the geographic distribution of such species. As no single species can provide full coverage over all Europe's marine regions, a range of species is needed to monitor ingested litter. The selection of a species can, however, be suitable for a regional or sub-regional level. Detailed protocols are provided for litter ingested by sea-birds, marine turtles and fish.

The Birds-protocol is based on the monitoring of litter in Fulmars, which is a well-developed monitoring tool to determine trends in the amount and composition of litter ingested by marine birds. It is also suitable to be used as a floating litter indicator. The turtles-protocol has been recently developed, based on the protocol for fulmars. As for the Birds-protocol, its use depends on the distribution of the species considered but may be adequate for areas such as the Mediterranean. Ingestion in Fish is presently an area of intense research activity. The TSG-ML has decided to recommend a general protocol for application to measure trends and regional differences in ingested litter in benthic and pelagic fish.

Furthermore, ingestion occurrence in other species (e.g. cetaceans) - which are not yet fully tested and mature, to be recommended as protocols - and other approaches concerning impact in marine life (e.g. entanglement and use of litter as nesting material) are also reviewed.

3.5. Microlitter

Microlitter is considered in Section 4.4 of the MSFD descriptor 10: ''*Amount, distribution and composition of microparticles. The attribute will establish baseline quantities, properties and potential impacts of microparticles. Microplastics are likely to be the most significant part of this*.'' **Microplastics are widely dispersed in the environment** and are present in the water column, on beaches, on the seabed and in biota. Hence microplastics **are relevant to other protocols**, relating to the monitoring of larger items of debris but are treated in a separate section because their size requires specific methodology.

In this Chapter, a review of existing approaches is presented, which considers sampling design, methods of sample collection and identification of microparticles, and the extent of current usage which is important for comparative purposes. In order to give guidance for monitoring of microplastics in the marine environment, basic criteria and approaches are recommended, where possible, such that future quantitative estimates are as comparable as possible.

It is important to highlight that **microparticles represent an emerging area of scientific research and as yet there are few robustly tested and validated approaches**. Hence, in addition to providing recommendations that will be feasible and effective for MS at the present time, the TSG-ML also identifies areas where methods need developing. It is therefore essential that approaches are reviewed as our understanding and the literature on this topic evolve. Nevertheless, **the TSG-ML considers there are sufficient reliable approaches to initiate monitoring at the present time**, while advocating the need for workshops to inter-calibrate methods and review data collected, in order to refine specific monitoring and achieve the greatest level of efficiency.

To achieve the greatest efficiency **microparticles should be sampled alongside other routine sampling programmes** (*e.g.* chemical contaminants) **and in several cases can be implemented as an extension of the protocols suggested in this Guidance**. For example microparticles in beaches can be sampled at the time of the beach litter surveys or in parallel with any other routine intertidal monitoring (for chemical contaminants, biota). For biota it is not possible at this time to recommend specific organisms as indicator species of microparticles but methods are provided to sample organisms such as birds and fish and can, coupled with protocols, be recommended for Biota.

3.6. Classification of litter items in standard list of categories

In this chapter, a **"Master List" with categories to record occurrence of items is proposed for use in litter monitoring programmes in the European marine environment** and instructions provided on how to use it. It resulted from the comparison of lists of litter items used in on-going monitoring programmes, for the different compartments and associated to the protocols here recommended (*e.g.* OSPAR for Beach Litter; different existing approaches for floating litter; OSPAR/IBTS for seafloor litter;

CEFAS for microlitter). Most of the items and forms of litter that occur in the marine environment are included here but it allows for new items to be added.

The use of standard lists and categories of items will enable the comparison of results between regions and environmental compartments and enhance the value of the results of monitoring programmes. If the list is detailed enough it will be possible, to a certain degree, to infer about potential and/or most likely sources (e.g. fisheries, shipping), type of item (e.g. packaging, user item) or even related potential harm that items can cause (e.g. risk of entanglement, ingestion, etc.). This is a crucial step in helping to identify key priorities to tackle, design a programme of measures and support the monitoring of their effectiveness.

In the Guidance document more detailed information is available that will enable MS to commence the monitoring of MSFD descriptor 10.