

CEMP Guidelines for monitoring marine litter washed ashore and/or deposited on coastlines (beach litter)

(OSPAR Agreement 2017-05)

Source: EIHA 17/9/1, Annex 11

MSFD criterion: 10.1: Characteristics of litter in the marine and coastal environment

MSFD indicator: 10.1.1: Trends in the amount of litter washed ashore and/or deposited on coastlines, including analysis of its composition, spatial distribution and, where possible, source

1 Introduction

1.1 The reduction of pollution of the marine environment with litter is one of the significant environmental challenges facing society today.

1.2 Measures to reduce the input of marine litter and measures to remove litter from the marine environment are presently being implemented through activities at the OSPAR level (OSPAR Regional Action Plan) and on a national scale via the EU Marine Strategy Framework Directive (MSFD). To measure the effectiveness of these activities in reducing marine litter pollution and to assess if a Good Environmental Status (GES) is being achieved, indicators have been developed. One of these indicators is the amount of marine litter washed ashore and/or deposited on coastlines, referred to as beach litter. The indicator reflects changes in inputs of litter to the marine environment and is an indicator of the type and magnitude of litter pollution on the coastline and in adjacent marine waters.

1.3 The purpose of this document is to provide guidelines for a monitoring and assessment programme that allows effective detection of spatial differences and temporal changes in the litter encountered on beach litter monitoring sites. This litter can originate from the sea, through deliberate or accidental losses from vessels (including cargos and waste), and be transported to and deposited on the coast from the sea by winds and water currents. It can also be directly deposited on the coast by humans, e.g. tourists, fishermen, fly-tipping. Litter can also be deposited further inland on riverbanks, directly into rivers, on streets and in the countryside and consequently be transported by rivers and wind into the marine environment. In addition, sewage works may discharge litter items directly or indirectly, via rivers and sewage outlets into the sea. Marine litter (marine debris) is thus any persistent, manufactured or processed solid material discarded, disposed of, abandoned or lost in the marine and coastal environment.

2 Monitoring

2.1 Purpose

2.1.1 The collection of data on marine beach litter provides information on amounts, trends, materials and sources of marine litter. This information can be used to focus on effective mitigating measures and to test the effectiveness of existing legislation and regulations.

2.1.2 The data collected can be used to describe status as well as changes in abundance and composition of litter washed up or deposited on beaches in the OSPAR area.

2.1.3 The abundance of marine litter on OSPAR survey sites provides information on the magnitude of litter pollution in adjacent waters and coastal areas and can indicate spatial differences in litter pollution. Trends in the abundance of individual litter items or groups of items (i.e. fisheries related items, packaging, material class etc.) and in total litter abundance provide information on changes of the level of pollution.

2.1.4 The composition of the litter recorded on the beaches provides information on how common the different litter items (plastic bags, metal tins etc.) or litter material categories (plastic, wood etc.) are. This in turn provides information on the source of the litter and to a certain extent on its level of threat to the environment. Ingestible plastic material and material which leads to entanglement can be, for example, especially harmful to marine organisms. Spatial differences in composition between survey sites can relate to regional differences in sources or human habits. However, it is important to note that a given survey site or region can be subject to litter pollution from many sources. These sources can be local, regional or even distant, as litter is also, at least in part, transported to a given site or region by ocean currents and wind drift. Changes in composition supply information on changes in sources and changes in litter types (i.e. certain litter items becoming more abundant (e.g. plastic bottles replacing glass bottles) or the introduction of new litter items e.g. portable BBQs).

2.1.5 Information on abundance and composition of marine litter are both necessary for the implementation and assessment of measures appropriate to reduce litter pollution and can also be used to estimate the level of the effects of marine litter on the marine environment.

2.2 Quantitative Objectives

2.2.1 Targets and baselines have not yet been formulated for beach litter, although there is a commitment to do so in the North East Atlantic Environment Strategy. OSPAR agreed to substantially reduce marine litter in the OSPAR maritime area to levels where properties and quantities of marine litter do not cause harm to the coastal and marine environment (OSPAR North-East Atlantic Environment Strategy 2010). The present qualitative objective is that the amount of litter recorded during OSPAR beach litter surveys on 100m stretches of coastline should be declining.

2.2.2 Because of the large variation between the magnitude and composition of litter between sub-regions, which is related to the regionally different sources of litter, quantitative objectives on the amount of litter should be set at the subregional level. Nevertheless, marine litter pollution is a problem for the entire OSPAR region and objectives will be required for every subregion.

2.2.3 Temporal trends should be calculated for periods of at least six years. Spatial and temporal coverage of the beach litter surveys should be maintained at levels, which enable the calculation of amounts and trends for each individual sub-region.

2.2.4 A detailed description of the evaluation procedure for the statistical analysis of beach litter data used in the analysis tool Litter Analyst is presented here: <http://www.amo-nl.com/pdf/0Evaluation%20of%20procedure%20for%20beach%20litter%20data.pdf>. This report includes some information on the power of the analysis method used. A detailed analysis of the power of the monitoring programme is currently explored.

2.3 Monitoring Strategy

2.3.1 Within the OSPAR Litter Monitoring Programme all visible litter on the beach surface is counted on site on standard 100m stretches of coastline (survey sites). Surveys are generally carried out once every 3 months, resulting in four datasets per beach per year. Winter counts are not possible at some sites. The assessment of beach litter is based on a time-series of abundance of individual litter items recorded on the OSPAR beach litter survey sites.

2.3.2 It is important to understand the dynamics of beached litter to understand what beach litter monitoring records. In between any two beach litter surveys being undertaken, litter items that have been washed ashore by tides or deposited directly on to the beach can be buried, washed or blown away again by subsequent tides and winds. Also during strong wave action buried litter can resurface (Williams & Tudor, 2001) and litter can be blown onto a site from adjacent land or streets. Therefore, the amount of litter items recorded during any one survey will constitute a minimum value for litter being deposited at the site. However, on beaches in small bays, enclosed for example by rocky promontories, the dynamics of litter are different. Such sites can trap litter, which is subsequently only redistributed within the bay by wave and wind action.

2.3.3 The litter washed ashore is biased towards litter items that float and those that do not disintegrate dissolve or decay quickly in the marine environment. The main category of litter found on beaches is plastic and polystyrene, which often floats and does not disintegrate rapidly in water. The main components of the other common categories all float and/or decay slowly (wood, bottles, jars, light bulbs, paper cartons, tins and cans). The composition of litter recorded on beaches thus also reflects its ability to reach the shore. Metal and glass are therefore probably under-represented because they are more likely to sink than items made of plastic, polystyrene, rubber and wood. Paper is under-represented because it will generally disintegrate more rapidly in water than other materials.

2.3.4 Although only a proportion of what is disposed of into the sea reaches the shore, the abundance of the items found can be used as an indication of the level of marine litter pollution in a given area, if it is assumed that the floating portion of the litter constitutes a constant proportion of the total litter input. On beaches used intensively for recreation, the greater part of beach litter is often composed of items abandoned by beach visitors (e.g.: sweet and fast-food packaging).

2.3.5 The results of beach litter surveys supply information, which can be used to document the level of marine litter pollution and changes in abundance over time. The benefit of beach litter assessments is that they can not only be used to assess the amount, composition and trends of litter pollution, but also the sources and potential harm of the litter recorded.

2.3.6 Assessments are carried out at a litter item level and items can be related to sources. The abundance of items can be used to assess the major sources of litter for a given sub-region. Changes in the abundance of specific litter items or a selection of items, which originate from a given source, can be used to assess the effectiveness of measures implemented to reduce litter pollution from those sources.

2.3.7 The potential harm caused by individual litter items is, in many cases known, (e.g. their potential to be ingested, to entangle, to smother, or to disrupt or disturb habitats). The potential for harm of the litter recorded in a given region can therefore be estimated from the abundance of harmful items recorded on beaches in that region and the potential risk that these harmful items are encountered by marine life and humans.

2.3.8 Beach litter surveys can thus be used to measure if marine litter in the OSPAR maritime area is being reduced to levels where its properties and quantities do not cause harm to the coastal and marine environment. In addition, it can be used as a basis for the implementation of measures to reduce marine litter as well as for the measurement of their effectiveness.

2.4 Sampling Strategy

2.4.1 The [OSPAR Guideline for Monitoring Marine Litter on the Beaches in the OSPAR area](#), which was published in 2009, describes the litter sampling and counting method.



Figure 1: Beach litter surveys cover the whole beach from the water's edge to the back of the beach as defined, for example, by dunes or a sea wall.

2.4.2 Within the OSPAR Litter Monitoring Programme all visible litter on the beach surface is counted on site on standard 100m stretches of coastline (survey sites) on the North-East Atlantic coast. The whole 100m stretch of beach is surveyed, from the water's edge to the back of the beach, as defined by physical structures such as sea walls, the transition zone to dunes, etc. (**Fig. 1**). In some countries and at some sites additional 1000m stretches of beach were visually surveyed for a smaller selection of larger litter items (>50cm in any dimension). However, from 2017 onwards 1000m monitoring for larger items is not obligatory.

2.4.3 The reference beaches are mainly composed of sand or gravel and are exposed to the open sea. They should in most cases be accessible to surveyors all year round for surveying and removal of litter. However some sites, e.g. in the north of the OSPAR area, are not accessible or not possible to survey during the winter survey period. Beaches selected should generally be free of buildings all year round, and should not be subject to regular litter collection activities (i.e. beach cleaning). National coordinators of the surveys as well as surveyors have used expert judgement and local knowledge of coastal areas when selecting reference beaches.

2.4.4 The start and end points of the survey sites are marked clearly, to ensure that exactly the same survey site is monitored during each survey. Reference beaches are (normally) surveyed four times a year.

2.4.5 The survey periods are as follows:

- Winter (between mid-December and mid-January);
- Spring (April);
- Summer (between mid-June and mid-July); and
- Autumn (between mid-September and mid-October).

2.4.6 Preferably, the surveys on all reference beaches within a given region should be carried out inside the shortest timeframe possible within a given survey period.

2.4.7 Data on the amount of litter on a given stretch of coastline is recorded at item level. Items to be recorded are predefined by the [OSPAR Beach Litter Monitoring Guidelines](#). Each item has a unique OSPAR identification number. In each survey for a given beach the number of individual pieces of litter visible on the beach surface is recorded for each litter item. The survey forms allow for the registration of identifiable items, unknown items and litter fragments in different size categories. Litter items which cannot be identified (unknown items), are registered under the litter item "other" for the given material or use

category. A short description of these items is included on the survey form. Multilingual photo guides are available to assist surveyors with the identification and categorisation of litter items. All litter items are removed from the beach during the survey.

2.4.8 The items recorded are assigned to 11 categories according to the material they are made of (e.g. plastic, wood, metal, etc.), their use (e.g. medical, sanitary), and bagged dog faeces. In total, there are 112 predefined litter item types that are recorded during the 100m surveys:

- Plastic / polystyrene (54 items);
- Metal (15 items);
- Paper and cardboard (9 items);
- Wood (9 items);
- Sanitary waste (6 items);
- Cloth (5 items);
- Rubber (4 items);
- Glass (3 items);
- Pottery/ceramics (3 items);
- Medical waste (3 items); and
- Faeces (1 item).

2.4.9 Litter items categorised according to their use as either sanitary or medical are made of plastic, glass etc. and can be added to the relevant material categories during analysis if required. For example *cotton bud sticks*, which are a major component of litter in some regions, are predominately made of plastic. Each material or use category has the possibility of recording items, which cannot be identified as one of the other items on the OSPAR protocol. This means that all items present on the beach are recorded during the surveys and that new and upcoming items can be identified. It also enables the recording of items, which might be common at a local scale but rare on the scale of the OSPAR region.

2.4.10 Although the beaches surveyed are generally sandy, a number of other beach substrate types are included in the OSPAR Beach Litter monitoring system. These include rocky, boulder and shingle beaches as well as beaches with different levels of pebble, rock, shingle and vegetation coverage. Physical characteristics of the survey site influence deposition and retention levels of litter, for example rocky coasts with sandy bays have the potential to accumulate and retain more litter than long open sandy beaches. Furthermore, water currents, weather conditions and prevailing wind conditions have a significant influence on deposition and retention of litter and therefore litter abundance. This is also true of beach use and proximity to point and diffuse sources such as towns.

2.4.11 For these reasons the location and physical and geographical characteristics of each reference beach are recorded in detail. This information includes the proximity of possible sources of marine litter to the beach, as well as other factors that could help explain the amount, type, and composition of marine litter found. This data is stored in the [OSPAR Beach Litter Database](#).

2.5 Quality Assurance/ Quality Control

2.5.1 Detailed descriptions and photographs of all litter items as well as instructions on recording difficult items are included in a multilingual photo guide, which is part of the [OSPAR Beach Litter Monitoring Guidelines](#). The photo guide assures that all surveyors attribute the litter items encountered on the survey sites to the correct items in the OSPAR survey protocol.

2.5.2 National coordinators are responsible for further quality assurance. These quality control measures should include:

- a. training of surveyors using information in national languages
- b. quality control of the data before and after it is entered into the database
- c. the strict and consistent use of the OSPAR beach litter monitoring form and photo guide

d. the use of Litter Analyst for data validation and clean-up as well as to check for extreme values

2.6 Data reporting, handling and management

2.6.1 The reporting format can be viewed here: [OSPAR Beach Litter Monitoring Guidelines](#).

2.6.2 All data is entered directly into an online database (<http://www.mcsuk.org/ospar/>) at a beach monitoring site level by national coordinators. The data includes geographical, physical and topographical information on each individual site as well as the results of each survey on that site.

3 Assessment

3.1 Data acquisition

3.1.1 All raw beach litter data can be extracted from the online database (<http://www.mcsuk.org/ospar/>) as a CSV-file by selecting and downloading data according to spatial and temporal specifications. The database is open access.

3.2 Preparation of data

3.2.1 Data analysis software

The data from the beach litter surveys is normalised, aggregated and analysed by the software tool Litter Analyst, which is available for OSPAR users (<http://www.amo-nl.com/wordpress/software/litter-analyst/>). Litter Analyst is a standalone Windows program, developed in Matlab, for the statistical analysis of beach litter data from the [OSPAR Beach Litter Database](#). During 2017 Litter Analyst will be made available as open access software.

3.2.2 Litter Analyst is explained fully in its user manual (van der Meulen en Baggelaar, 2016). Litter Analyst reads and uses the CSV-files exported from the database. To accommodate for changes to items on the survey protocol in 2010, clustering of items is carried out by Litter Analyst (Baggelaar and Van der Meulen, 2014). Item clustering can, however, be selected as an option in Litter Analyst for other time periods too.

3.2.2 The data analysis period is set at six adjacent years, e.g. 2009-2014, conforming to the OSPAR/MSFD reporting periods. If desired, a statistical comparison of the mean total count of two adjacent 6-year periods can be performed by Litter Analyst.

3.2.3 The analysis is made on the top items that make up 80% of all litter recorded. This includes the most common 15 to 20 items recorded on a given beach or in a given spatial unit, for which a trend analysis is possible. This cut-off at 80% is necessary to ensure that the Mann Kendall trend test can function properly, and is not disturbed by too many zero counts.

3.2.4 Litter Analyst analyses the data for quarter year periods 1st January – 31st March, 1st April-30th June, 1st July-30th September and 1st October-31st December. Note; this does not comply with the beach litter survey periods and requires normalisation of the data. If in a specific quarter for a given beach the results of two surveys are available and no survey results are available in an adjacent quarter, Litter Analyst analyses one of the surveys as if it belongs to the adjacent quarter.

3.2.5 For a given quarter and beach, the results from at least 3 out of a possible 4 beach surveys must be available for the data to be used for analysis. This 75% condition ensures that the aggregated values per quarter remain balanced and comparable.

3.2.6 The beaches to be included in the analysis (e.g. within a nation, or within a subregion) can be selected in Litter Analyst. However, Litter Analyst only uses beaches, with at least 15 surveys in the given 6-year period in the analysis in order to ensure that the results are based on a sufficient number of surveys. The results of all beaches are weighted equally, when more than one beach is analysed. Litter Analyst normally performs data analyses at the beach level, but can also perform data aggregation at the national or sub-regional or regional level if required. Because of the regional differences in litter sources and the magnitude

of litter pollution, aggregation at the OSPAR regional level is considered less meaningful. National aggregation often appears to give good results (Schultz et al., in preparation). Sub-regional aggregation may also be useful but has a larger intrinsic spatial variation, which makes it more difficult to observe significant trends.

3.2.7 The data is aggregated according to eight material categories (plastic, metal, wood etc.) from which the items are made of, two use categories (sanitary and medical) and bagged dog faeces. In future, it is planned to aggregate data at the level of predefined sources.

3.3 Assessment criteria

3.3.1 Spatial and temporal assessment scale

3.3.1.1 As litter sources and amounts differ between regions, assessments at a sub-regional or national level are appropriate. Assessments at the survey site level can supply data for the analysis of local litter pollution.

3.3.1.2 Temporal trends should be calculated for periods of six years as determined by the reporting period of the MSFD. This relatively short period is possible because of the relatively rapid response of beach litter to changes in litter discharges. It provides up-to-date information on the state of the environment regarding beach litter. Spatial and temporal coverage of the beach litter surveys should be maintained at levels, which enable the calculation of amounts and trends for each individual sub-region.

3.3.2 Data availability and trend detection power

3.3.2.1 The number of survey sites and the number of surveys has increased since the start of the monitoring programme in 2001. This increase was particularly noticeable following 2011, in response to the implementation of the European Union (EU) Marine Strategy Framework Directive (MSFD). The present network of survey sites is more comprehensive.

3.3.2.2 Despite the overall increase in the number of survey sites, the specific sites used as well as the number of surveys undertaken per year at those sites have varied over time. The data can be used for individual sites or groups of sites from 2002 onwards. However, a more comprehensive analysis can be based on data from 2009 onwards.

3.3.3.3 For the trend analysis with Litter Analyst, at least 15 surveys per beach per 6-year period must be present for a beach to be selected for data analysis.

3.3.4 Baselines and reference levels

3.3.4.1 Reference levels for marine litter are zero, because marine litter was absent in the marine environment in the past before the presence of human activity.

3.3.4.2 Baseline levels have not yet been defined for beach litter. The baseline should be linked to the MSFD cycle of six years. The assessment used to determine the baseline should use all available data. The use of the data from the period 2007-2012 for the calculation of baselines (see EIHA Summary Record 2015) was not practical, due to changes in the set of survey sites and a general paucity of data in most regions in that period. For the Intermediate Assessment of Beach Litter 2017, data from the period 2009-2014 was used. The data only allowed for the assessment of one sub-region (southern North Sea) and two local areas (Northwest Spain and Swedish west coast). Consequently, the results of the evaluation can only be used to establish a baseline for the southern North Sea subregion. As many of the beaches have not yet been surveyed for a sufficiently long period, the determination of baselines will be delayed until sufficient data is available at a sub-regional level.

3.3.4 Targets

3.3.4.1 In the North-East Atlantic Environment Strategy (Strategy of the OSPAR Commission for the Protection of the Marine Environment of the North-East Atlantic 2010–2020) (OSPAR Agreement 2010-3) OSPAR agreed to “substantially reduce marine litter in the OSPAR maritime area to levels where properties and quantities of marine litter do not cause harm to the coastal and marine environment” and “by 2012, based on an evaluation of progress made and available data, establish sub-regional coordinated targets for marine litter”.

3.3.4.2 Subregional coordinated targets for marine litter have, however, not yet been formulated.

3.4 Spatial Analysis and / or Trend Analysis

3.4.1 The analysis tool, Litter Analyst, is used to analyse the data from the beach litter surveys (<http://www.amo-nl.com/wordpress/software/litter-analyst/>).

3.4.2 The analysis is made on the top items that make up 80% of all litter recorded. This includes the most common 15 to 20 items recorded on a given beach or in a given spatial unit, for which a trend analysis is possible. However, the analysis of data aggregated according to the material the items are made of two use categories (sanitary and medical) and bagged dog faeces is also possible. In future it is planned to aggregate data at the level of predefined sources. Spatial aggregation at the OSPAR sub-regional level and at the national level is also possible. Aggregation at the OSPAR regional level (NE-Atlantic) is possible, however, as the sources and amounts of litter vary considerably between OSPAR sub-regions and individual countries, it is not recommended.

3.5 Presentation of assessment results

3.5.1 The results of the analysis with Litter Analyst provide basic information required by policy-makers to address the problem of litter pollution in the OSPAR region. It provides information on the magnitude and composition of the litter recorded on survey sites as well as trends in the amount and changes in composition. The presentation of these data for the top items that make up 80% of all litter recorded provides information on the litter types and sources, which are the main cause of litter pollution in a given region. This information enables policy-makers to address litter pollution at source and measure the effectiveness of measures implemented to reduce input. However, the output from Litter Analyst requires some interpretation and processing in order to make it easily comprehensible for policy makers and the general public. Analysis and reporting should be carried out on the total of all litter recorded as well as at the item level, the material/use category level and, if possible, the source level. The minimum requirements for an assessment report are the analysis of composition, annual average abundance and trend analysis of abundance for a six-year period. The total abundance as well as the abundances of the most common items, which contribute to 80% of the total amount of litter recorded, should be used for this assessment. The results should be presented for each of the level one OSPAR reporting units and for the southern (level two reporting units L 2.2.2, L 2.2.5 & L 2.2.6) and northern (level two reporting units L 2.2.1, L 2.2.3, L 2.2.4 & L 2.2.7) parts of the North Sea.

4 Change Management

4.1 The Environmental Impacts of Human Activities Committee (EIHA) is responsible for the acquisition and storage of data, quality control and analysis and technical aspects are managed by the Intersessional Correspondence Group on Marine Litter (ICG-ML). It is also responsible for necessary adaptations to the monitoring system in order e.g. to improve its fulfilment of the requirements of the MSFD.

5 References

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