

See discussions, stats, and author profiles for this publication at: <https://www.researchgate.net/publication/324586944>

Summary of methods to monitor and assess marine litter

Technical Report · July 2013

DOI: 10.13140/RG.2.2.16918.45129

CITATIONS

0

READS

391

2 authors:



Thomas Maes

Centre for Environment, Fisheries and Aquaculture Science

53 PUBLICATIONS 948 CITATIONS

[SEE PROFILE](#)



Eva Garnacho

Centre for Environment, Fisheries and Aquaculture Science

24 PUBLICATIONS 454 CITATIONS

[SEE PROFILE](#)

Some of the authors of this publication are also working on these related projects:



BEAST BONUS project [View project](#)



CLEANATLANTIC (tackling marine litter in the atlantic area) [View project](#)



This project has received funding from the European Union's Seventh Framework Programme (FP7 2007-2013) under grant agreement n° 289042.



MARine Litter in Europe Seas: Social Awareness and CO-Responsibility

D1.2 SUMMARY OF CURRENT METHODS OF MONITORING AND ASSESSMENT FOR MARINE LITTER



This project has received funding from the European Union's Seventh Framework Programme (FP7 2007-2013) under grant agreement n° 289042.





This project has received funding from the European Union's Seventh Framework Programme (FP7 2007-2013) under grant agreement n° 289042.



Document Information

Document D1.2 Summary of current methods of monitoring and assessment for marine litter
Revision: V0.5
Date: 24/07/2013
Author: Thomas Maes, Eva Garnacho (Cefas, P3)
Contributors: Demetra Orthodoxou (ISOTECH), Luigi Alcaro (Provincia di Teramo)
Security: PU

Document Information

This report deliverable summarises monitoring and assessment methods for marine litter. It also provides a guidance to general public informing on internationally agreed methods and protocols.

Approvals

Date	Partner
26/06/2013	Consortium
24/07/2013	Project coordinator and Manager final approval

Document History

Version	Date	Comments & Status	Author
V0.1	31/05/2013	First Draft	TM
V0.2	31/05/2013	Quality Control, posted on basecamp for comments	EMM
V0.3	26/06/2013	Revised version addressing partners comments	TM
V0.4	26/06/2013	Quality Control to send for coordinator approval	EMM
V0.5	24/07/2013	Revised version addressing coordinator comments	EG

List of annexes

Annex1_Links_to_relevant_information

Citation: Maes T, Garnacho E. 2013. Summary of current methods of monitoring and assessment for marine litter.. Deliverable D1.2 report. MARLISCO project. MARine Litter in Europe Seas: Social Awareness and CO-Responsibility. (EC FP7 Coordinated and support action, SIS-MML-289042), July 2013. 25pp



This project has received funding from the European Union's Seventh Framework Programme (FP7 2007-2013) under grant agreement n° 289042.



TABLE OF CONTENTS

1	EXECUTIVE SUMMARY:	5
1.1	REFERENCE DOCUMENTS:	5
1.2	LIST OF ABBREVIATIONS AND ACRONYMS:	6
2	INTRODUCTION:	7
3	THE MARINE LITTER LIFECYCLE:	10
4	MONITORING AND ASSESSMENT	12
4.1	POLICY-RELATED DRIVERS FOR MONITORING:	12
5	MARINE LITTER MONITORING FRAMEWORKS:	15
6	CONCLUSIONS: SUMMARY OF INTERNATIONALLY AGREED METHODS AND GUIDELINES FOR MARINE LITTER ASSESSMENTS:	16
6.1	LITTER CLASSIFICATION AND CATEGORISATION	16
6.2	QUANTIFICATION OF LITTER.....	18
6.3	BASIC TYPES OF MARINE LITTER SURVEYS:	19
6.4	THE MARINE STRATEGIC FRAMEWORK DIRECTIVE TSG10 AND ITS UPCOMING REPORT ON MONITORING GUIDELINES (SUMMER 2013)	19
	<i>ANNEX1_LINKS TO RELEVANT INFORMATION</i>	24



This project has received funding from the European Union's Seventh Framework Programme (FP7 2007-2013) under grant agreement n° 289042.



1 EXECUTIVE SUMMARY

This report summarises the marine litter issue in relation to monitoring and assessment. It includes a brief summary of current assessment and monitoring techniques within European Seas in order to provide information for other Work Packages. Gathering data on marine litter is a relatively new concept within the monitoring field. Therefore, this report should rather be considered as a generic overview and an introduction to the possible monitoring approaches. It includes links to relevant information sources. The guidance is intended to support litter monitoring by the general public or other non-research trained persons. Certain aspects of marine litter monitoring remain rather scientific and are too complex to be carried out by members of the general public. Specific guidelines for these types of survey have not been included. For more detailed information we recommend the protocols as described in the reports of the European MSFD GES Technical Subgroup 10 (TSG10), an overview of this report has been given in section 6.4. Further developments in marine litter monitoring are ongoing and will take a more definitive shape in the coming years. Hence it will be important to follow up progress of European and regional marine litter expert groups tasked with the improvement of our understanding of this relatively new problem in our marine environment.

1.1 Reference documents:

- Cheshire, A.C., Adler, E., Barbière, J., Cohen, Y., Evans, S., Jarayabhand, S., Jęftic, L., Jung, R.T., Kinsey, S., Kusui, E.T., Lavine, I., Manyara, P., Oosterbaan, L., Pereira, M.A., Sheavly, S., Tkalin, A., Varadarajan, S., Wenneker, B. and Westphalen, G. (2009) UNEP/IOC Guidelines on Survey and Monitoring of Marine Litter. UNEP Regional Seas Reports and Studies, No. 186; IOC Technical Series No. 83.
- Dixon, T. R., and T. J. Dixon 1981. Marine litter surveillance. *Mar. Pollut. Bull.* 12:289-295.
- EUR 25009 EN – 2011, Marine Litter Technical Recommendations for the Implementation of MSFD Requirements. MSFD GES Technical Subgroup on Marine Litter.
- Galgani, F. D. Fleet, J. Van Franeker, S. Katsanevakis, T. Maes, J. Mouat, L. Oosterbaan, I. Poitou, G. Hanke, R. Thompson, E. Amato, A. Birkun & C. Janssen 2010 Marine Strategy Framework Directive Task Team 10 Report Marine Litter, European Commission, Joint Research Centre, 48pp
- GESAMP 2010, IMO/FAO/UNESCO-IOC/UNIDO/WMO/IAEA/UN/UNEP Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection); Bowmer, T. and Kershaw, P.J., 2010 (Eds.), Proceedings of the GESAMP International Workshop on plastic particles as a vector in transporting persistent, bio-accumulating and toxic substances in the oceans. GESAMP Rep. Stud. No. 82, 68pp.
- Jęftic, L. et al. (2009). Marine litter: a global challenge. United Nations Environment Programme: Nairobi. ISBN 978-92-807-3029-6. 232 pp.
- Katsanevakis S, Verriopoulos G, Nikolaidou A, Thessalou-Legaki M, 2007. Effect of marine pollution litter on the benthic megafauna of coastal soft bottoms. *Marine Pollution Bulletin* 54: 771-778.
- Monitoring Guidance for Marine Litter in European Seas. MSFD GES Technical Subgroup on Marine Litter (TSG-ML). DRAFT REPORT, July 2013.
- Opfer, S., C. Arthur & S. Lippiatt. 2012. NOAA marine debris shoreline survey field guide. National Oceanic and Atmospheric Administration Office of Response & Restoration Marine Debris Program Silver Spring, MD.
- OSPAR Commission, 2010. Guideline for monitoring marine litter on the beaches in the OSPAR maritime area.
- Rees, G., Pond, K., 1995. Marine Litter monitoring programmes – a review of methods with special references to national surveys. *Mar. Pollut. Bull.* 30 (2), 103–108.
- Ribic, Christine A., Trevor R. Dixon, and Ivan Vining. 1992. Marine Debris Survey Manual. NOAA Technical Report NMFS 108. 92 pp.
- Ryan P. G., Moore C. J., van Franeker J. A. and Moloney C. L. 2009 Monitoring the abundance of plastic debris in the marine environment *Phil. Trans. R. Soc. B* vol. 364 no. 1526 1999-2012
- Sheavly S.B. 2007. "National Marine Debris Monitoring Program: Final Program Report, Data Analysis and Summary." Prepared for U.S. Environmental Protection Agency by Ocean Conservancy, Grant Number X83053401-02. 76 pp.



This project has received funding from the European Union's Seventh Framework Programme (FP7 2007-2013) under grant agreement n° 289042.



- STAP (2011). Marine Debris as a Global Environmental Problem: Introducing a solutions based framework focused on plastic. A STAP Information Document. Global Environment Facility, Washington, DC.
- Thompson, R.C., Olsen, Y., Mitchell, R.P., Davis, A., Rowland, S.J., John, A.W.G., McGonigle, D., Russell, A.E (2004). Lost at Sea: Where Is All the Plastic? Science, 304(5672): 838.
- UKMMAS. 2010. Charting Progress 2. Published by Defra on behalf of UKMMAS.

1.2 List of abbreviations and acronyms:

GES	Good Environmental Status
IBTS	International Bottom Trawl Survey
ICES	International Council for the Exploration of the Sea
IOC	Intergovernmental Oceanographic Commission
MEDITS	International Bottom Trawl Survey in the Mediterranean
MSFD	Marine Strategy Framework Directive
NOAA	National Oceanic and Atmospheric Administration
OSPAR	Oslo Paris Convention
ROV	Remote Operating Vehicle
TG10	Technical Group Descriptor 10
TSG10	Technical Sub-Group Descriptor 10
UK	United Kingdom
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNGA	U.N General Assembly
USA	United States of America



This project has received funding from the European Union's Seventh Framework Programme (FP7 2007-2013) under grant agreement n° 289042.



2 INTRODUCTION:

WP1 programme includes a brief summary of current monitoring and assessment techniques based on the work of the MSFD GES Technical Subgroup on Marine litter (TSG10) with the aim to provide information for other Work Packages and guidance to support marine litter monitoring by the general public or other non-research trained persons. This report summarises current assessment and monitoring techniques within European Seas. In order to include the most updated technical information for this deliverable the work plan was linked to MSFD TSG10 developments, and outputs from their 2013 technical meeting scheduled for the 14th - 16th May 2013, in Hamburg. The timing of the MSFD TSG10 technical meeting reporting coincided with D1.2 deadline in the DoW. Therefore, and in consultation with the coordinator, the submission of this report was delayed to accommodate the inclusion of the most recent technical outputs from MSFD TG10, and the review of the draft report by partners and coordinator to provide comments and feed into the final version of this report.

The term “Marine Litter” has been introduced to describe discarded, disposed of, or abandoned man-made objects present in the marine and coastal environment. It consists of articles that have been made or used by people and, subsequently, deliberately discarded or accidentally lost.

Marine Litter can be found all around the globe (Galgani et al, 2010) and originates from:

- Ocean-based sources:
 - Fishing vessels
 - Cargo ships
 - Stationary platforms
 - Fish farming installations
 - Pleasure crafts and other vessels

- Land-based sources:
 - Littering
 - Dumping
 - Poor waste management practices
 - Sewage and storm water discharges
 - Riverine inputs
 - Industrial facilities
 - Tourism
 - Extreme natural events



Marine litter was identified as an important pollution-related issue in most regions of the European Seas. However, marine litter is a worldwide growing pollution problem and has been recognized as a major concern not only nationally, but also internationally, requiring national, regional and global actions (QSR, 2010; UKMMAS, 2010; UNEP 2005; Jeftic et al., 2009).



This project has received funding from the European Union's Seventh Framework Programme (FP7 2007-2013) under grant agreement n° 289042.



Figure 1. Marine Litter, a global issue (NOAA)

The world's largest volunteer effort for the world's ocean and waterways is organised each year on a single day during the International Coastal Cleanup by the Ocean Conservancy. It provides a compelling global snapshot of marine debris collected and recorded at sites all over the world. In 2012, the Ocean Conservancy's International Coastal Cleanup mobilized volunteers from 97 countries and locations all over the world to clean coastal beaches and inland waterways.

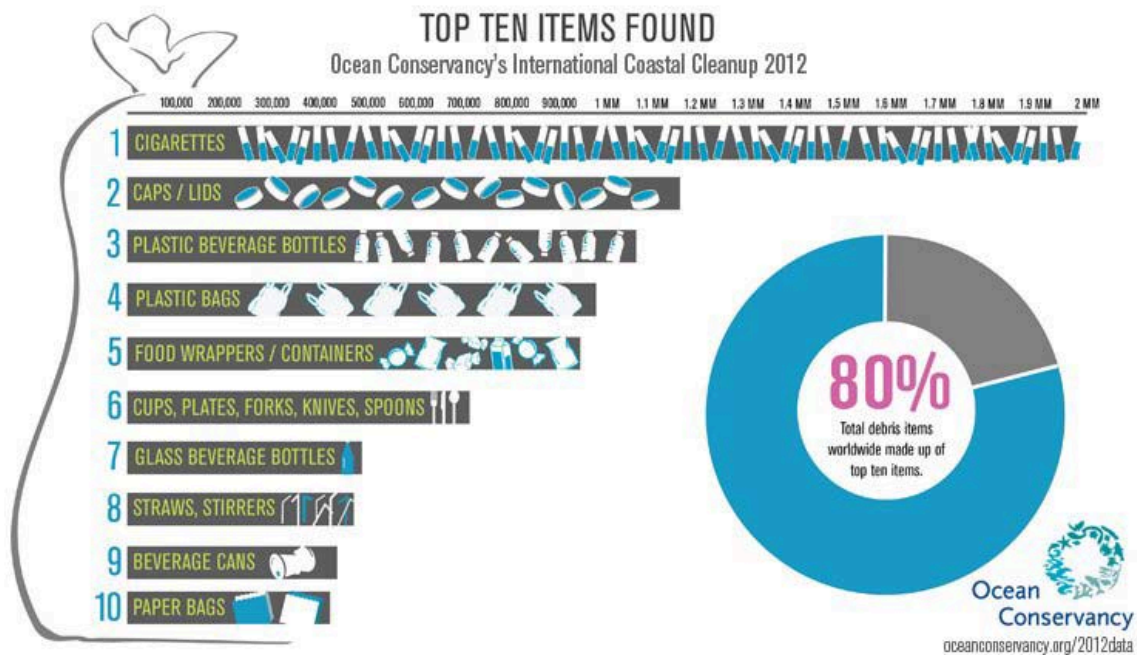


Figure 2. The Top Ten Marine Litter Items (International Coastal Clean-up 2012 data, Ocean Conservancy)

Figure 3. Marine litter, mainly plastic, poses a serious environmental threat to marine organisms, as well as a series of economic and social problems. The majority of marine litter is comprised of plastic materials—60-80% overall and 90% of floating litter (Sheavly, 2005).



This project has received funding from the European Union's Seventh Framework Programme (FP7 2007-2013) under grant agreement n° 289042.



Figure 4. Plastic litter on the shoreline (©Thomas Maes)

One of the most important deficiencies is the lack of long-term data on the marine litter issue. Very few studies can provide quantitative data over long time periods. A wide variety of approaches have been used to identify and quantify marine litter locally. The objectives underpinning marine litter monitoring programmes are quite diverse: better understanding of the risks, improved knowledge on impacts, more understanding of litter sources and sinks to support improved management and measures, targeting increased public awareness and, not the least, removal of litter leading to cleaner environments at local, regional, national and international scales. This variety in the purpose of monitoring programmes is matched by the diversity in the operational structure of those programmes (Cheshire et al., 2009).



This project has received funding from the European Union's Seventh Framework Programme (FP7 2007-2013) under grant agreement n° 289042.



3 THE MARINE LITTER LIFECYCLE:

A key challenge in developing guidelines for the assessment of marine litter is to identify the major processes that control the entry and /or removal of litter from the oceans and also the transformations that occur during the lifecycle of any given litter item. When litter enters the marine environment, it gets cast onto beaches, floats in the water column and/or sinks to the seafloor. Some of it gets removed and some of it decomposes after a very long time.

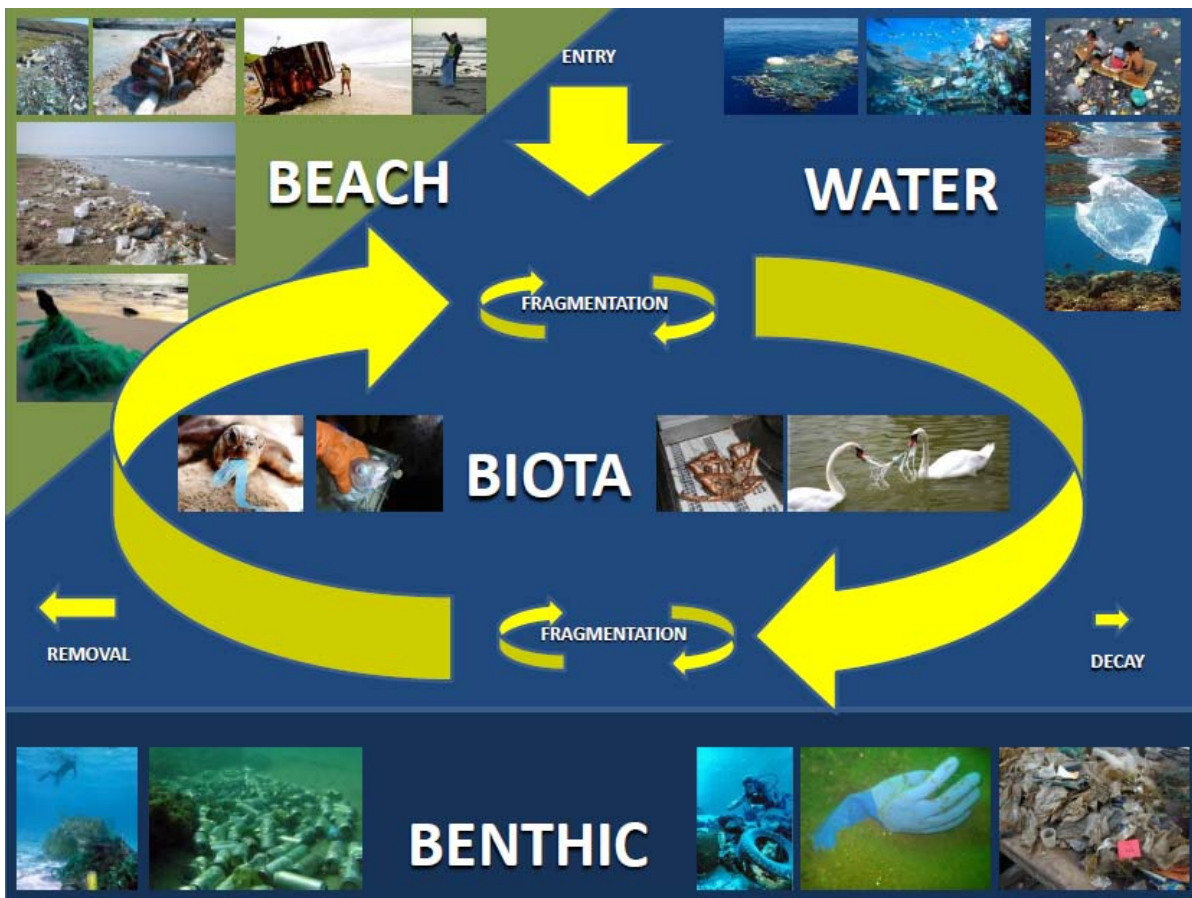


Figure 5. The Marine Litter Cycle

As well as large plastic litter items, there is growing concern about tiny plastic fragments known as microplastics (Thompson et al., 2004). The lightness and durability of plastic makes it a useful and versatile material for manufacturers and users, but it also makes it a long-term problem for the environment (STAP, 2011). Plastics accumulate because they don't biodegrade like many other organic substances. Although they don't degrade they do fragment in the environment, as a result of a combination of mechanical forces like waves and/or photochemical processes triggered by sunlight which is rather limited in the marine environment. This means that plastic slowly breaks down into smaller and smaller fragments, better known as microplastics (GESAMP, 2010). Consequently, we can now find marine litter of different sizes (μm to m) at the surface, in the water column, in sediments and, unfortunately, also in biota.



This project has received funding from the European Union's Seventh Framework Programme (FP7 2007-2013) under grant agreement n° 289042.

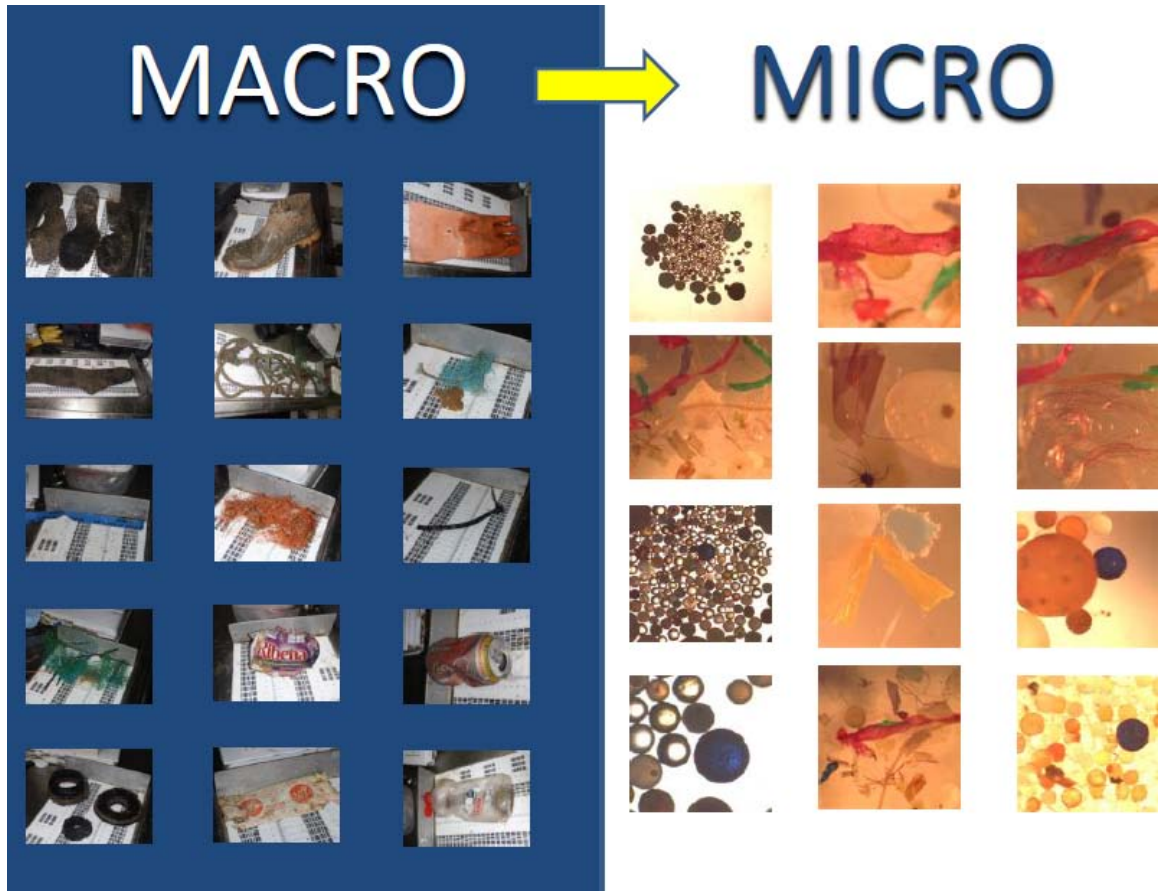


Figure 6. Macro & micro litter from Cefas surveys ranging between 35cm - 200µm

Although it is already clear that reducing the entry and release of plastics into the environment should be one of the first objectives, we need to gather details of compositions and origins of marine litter in order to target those sources which are the biggest contributors. Monitoring and assessment are necessary to assess the scale of the problem, to establish the main sources of marine litter, and to set priorities for actions. In order to do so there is an urgent need to develop harmonized methodologies. Measures taken to achieve reduction goals will include improvements in waste management, education, both of the general public and specific user groups, and legislation. Assessing the effectiveness of these measures requires further monitoring of both the amounts of plastic in the environment and the rates at which new plastic litter enters the environment.

Management of marine litter can be informed by obtaining good quality data on the size of each of the pools and the rates of exchange between them. This allows us to articulate a set of useful objectives for any national or international programme of marine litter surveys.

These being:

- i) To provide information about the sources of different types of litter, and
- ii) To quantify the amount of litter in different ocean systems.

The extent of the impact of marine litter is determined by its type and size and where it settles in the marine environment (seafloor, floating and beach). Factoring in that ocean circulation greatly affects the redistribution and accumulation of marine debris, as do the mass, buoyancy and persistence of the material (Moore et al. 2001), it is clear the potential impacts of marine litter are widespread and long-lasting. This has to be taken into consideration when selecting certain monitoring approaches as it will have implications on the type of assessment and assumptions one can make afterwards.



This project has received funding from the European Union's Seventh Framework Programme (FP7 2007-2013) under grant agreement n° 289042.



4 MONITORING AND ASSESSMENT

It is widely recognized that marine litter is a global problem which requires international cooperation and involvement of different stakeholders at all levels. Monitoring is crucial to assess the efficacy of measures implemented to reduce the abundance of marine litter, but it is complicated by large spatial and temporal heterogeneity in the amounts of litter and by our limited understanding of the pathways followed and its long-term fate. Even when sampling methods are similar, comparative studies are often compromised by a lack of information on factors influencing the depositional environment (prevailing winds, local and offshore currents, proximity to land based sources) for the different sampling areas. In such cases, even when differences in litter loads can be demonstrated between sites it is difficult to interpret these because the sources of the variability remain unknown.

The development and evaluation of global strategies for the management of marine litter are thus hampered by an inability to compare and contrast litter levels between different regions (Cheshire et al. 2009). Numerous reviews of monitoring methods for assessing litter in the marine environment have been published over the last decades (e.g. Dixon & Dixon 1981, Ribic et al. 1992, Rees & Pond 1995, Ryan et al. 2009, Cheshire et al. 2009, Opfer et al. 2012). The recent overviews by UNEP, in Cheshire et al. (2009), by NOAA, in Opfer et al. (2012) and by the EU Technical Sub Group 10 (EUR 25009 EN – 2011), are the most comprehensive and useful overviews for monitoring methods (see annex). The last one is especially relevant within the context of the MARLISCO project.

4.1 Policy-related drivers for monitoring:

The United Nations General Assembly (UNGA)

The problem of marine litter was recognized by the United Nations General Assembly (UNGA), which in its Resolution A/60/L.22 (Nov. 2005) calls for national, regional and global actions to address the problem of marine litter. This resolution recognises the lack of information and data on marine debris as one of the significant barriers in addressing the marine litter issue.

Without adequate monitoring methodologies, changes in accumulation rates and composition, trends over time and the effectiveness of measures are hard to assess. Although monitoring of marine litter is currently carried out within a number of countries around the world, the methods of survey and monitoring used tend to be very different, preventing comparisons and harmonization of data across regions or time-scales (Cheshire et al. 2009; EUR 25009 EN – 2011).

In order to confront this problem the Regional Seas Programme of UNEP launched, in full cooperation with the Intergovernmental Oceanographic Commission (IOC) of UNESCO, the development of the UNEP/IOC Guidelines on Survey and Monitoring of Marine Litter (Cheshire et al. 2009) that will assist policy makers and support efforts by regions, countries, Regional Seas Programmes and other relevant organizations to address the problem of monitoring and assessment of marine litter. These Guidelines include a comparative analysis of information from around the world on existing experience and methods for surveys, monitoring, reporting protocols and assessment of marine litter. A more recent review and analysis of UNEP's Global Initiative on Marine Litter highlights that significant efforts have been made by Regional Seas Conventions and Action Plans to quantify the problem, prepare action programmes and participate in an International Coastal Clean-Up Campaign.



This project has received funding from the European Union's Seventh Framework Programme (FP7 2007-2013) under grant agreement n° 289042.



The Marine Strategy Framework Directive (MSFD)

In June 2008, a framework for community action in the field of marine environmental policy was published. The European Union introduced the Marine Strategy Framework Directive (MSFD), which requires that Member States put in place measures to achieve Good Environmental Status (GES) in Europe's seas by 2020. The MSFD lists 11 GES Descriptors for the specific areas under which GES must be achieved. The Directive states the following in relation to marine litter: MSFD Descriptor (10): Properties and quantities of marine litter do not cause harm to the coastal and marine environment.

The key attributes of the descriptor as defined in the final MSFD task group 10 report are:

- Amount, source and composition of litter washed ashore and/or deposited on coastlines.
- Amount and composition of litter in the water column, including floating and suspended litter, and accumulation on the sea floor.
- Amount and composition of litter ingested by marine animals.
- Amount, distribution and composition of microparticles (mainly microplastics).

Marine litter is surveyed and assessed in the following environmental compartments: beach (or shoreline), water, seafloor, biota (in animals), and microparticles (Figure 6)

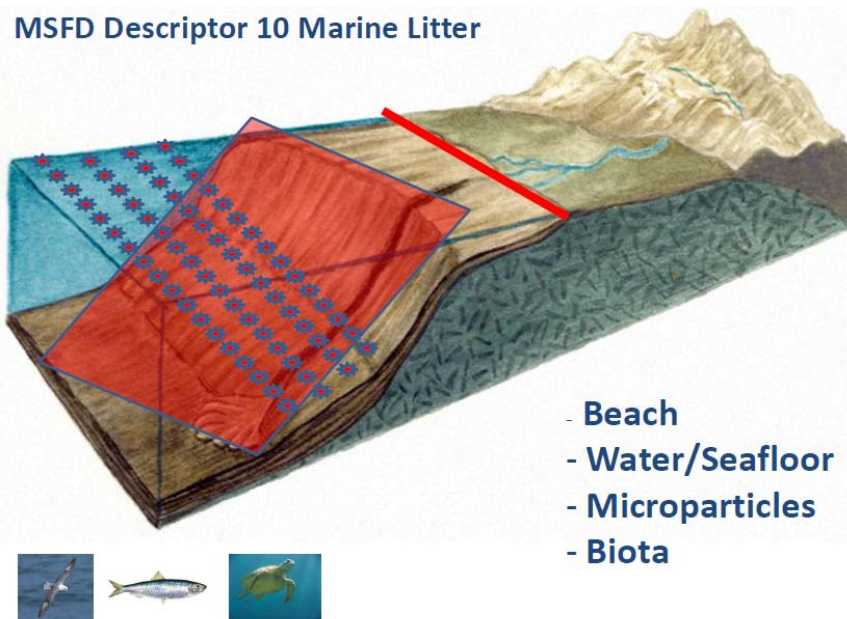


Figure 7. Environmental compartments of key attributes for marine litter MSFD Descriptors.



This project has received funding from the European Union's Seventh Framework Programme (FP7 2007-2013) under grant agreement n° 289042.



Several key requirements of the Directive need to take place at preset times:

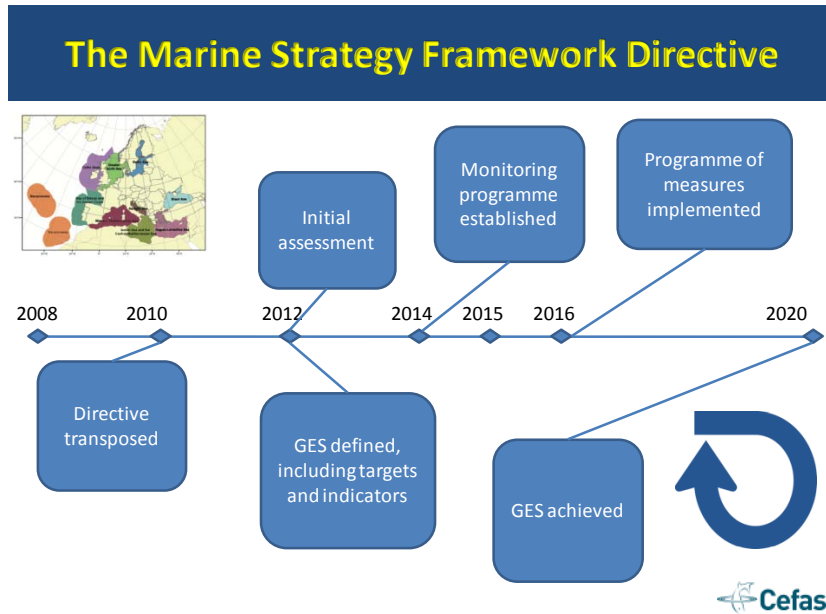


Figure 8. The MSFD Timeline

The challenges in developing a future monitoring programme for the assessment of marine litter capable of answering questions such as posed by the MSFD are to identify the quantities of litter in the marine environment, the major processes that control the entry and / or removal of litter from the oceans and the transformations that occur during the lifecycle of any given litter item (Sheavly, 2007).

Rio +20:

Litter pollution of the marine environment was also a main topic of the Rio +20 Earth Summit and found its reflection in the final declaration of June 2012: *"We further commit to take action to, by 2025, based on collected scientific data, achieve significant reductions in marine debris to prevent harm to the coastal and marine environment."* In this declaration, reference is also made to the follow-up of relevant initiatives and the adoption of coordinated strategies.

The Honolulu Strategy:

The Honolulu Strategy organised and published by UNEP and USA NOAA Marine Debris Programme, is an important strategic framework step towards addressing the marine litter issue on a global scale. Several efforts are being made by each of the Conventions for Europe's Regional Seas to prevent and reduce marine litter such as developing dedicated Regional Action Plans in order to contribute to the Honolulu Strategy.

The Message from Berlin:

The International Conference on Prevention and Management of Marine Litter in European Seas was held in Berlin, Germany, 10 – 12 April 2013. The Conference participants, which included a wide array of stakeholders, government representatives, businesses and regional organisations, analysed the issues at stake, reviewed current efforts and suggested ways forward in order to address marine litter. With monitoring in particular, the participants recognised the need to improve our scientific understanding of the sources, amounts, pathways, distribution, trends, nature and impacts of marine litter, including the effects of microplastics and their additives and absorbed substances on marine biodiversity and public health and identifying ways to better coordinate and improve marine litter data collection, including a view towards establishing an EU baseline.

A detailed review of existing policies that may be applied to mitigate the impact of marine litter is addressed by another Marlisco deliverable (D1.3).



5 MARINE LITTER MONITORING FRAMEWORKS:

Litter assessments need to be planned to ensure that they sit within and across the context of a broader regional management framework and are delivered consistent with the defined protocols. In turn, these protocols need to include the definition and specification of the survey location, choice of sampling units, methodology for collection, classification and quantification of litter and a process for data integration, analysis and reporting of results (Cheshire et al., 2009).

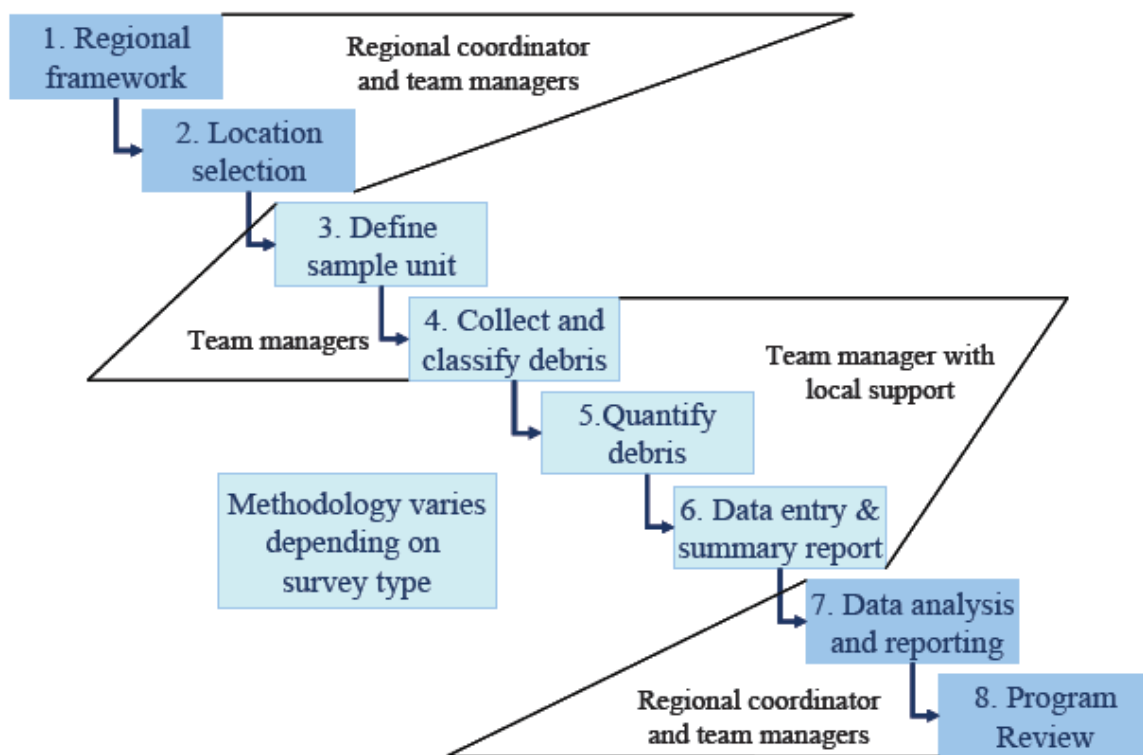


Figure 9. Steps in developing marine litter assessments (from Cheshire et al. 2009).



This project has received funding from the European Union's Seventh Framework Programme (FP7 2007-2013) under grant agreement n° 289042.



6 CONCLUSIONS: SUMMARY OF INTERNATIONALLY AGREED METHODS AND GUIDELINES FOR MARINE LITTER ASSESSMENTS:

As MARLISCO is a European FP7 project, the following summary guidelines are presented to support the establishment of a European MSFD framework within which litter assessments (beach, benthic and floating litter) can be conducted. The primary objective is to establish a framework for managing the integration of individual litter assessment activities across the broader public and across wider geographical regions. In this context, regions comprise the European marine areas (North East Atlantic, Baltic, Black Sea and Mediterranean).

6.1 Litter classification and categorisation

In order to facilitate the comparisons of marine litter data from different regional areas and in various compartments of the marine environment (beach, seafloor, sea-surface etc.) a standard list of litter items should be used as a basis in all assessment protocols.

A master list of all litter items for use in litter monitoring programmes in the European marine environment was produced on the basis of this comparison by MSFD GES Technical Subgroup on Marine Litter (TSG10). The recommended system comprises a two level hierarchy that identifies items firstly by material composition and then by function. It should be noted that the classification system can be adapted for use in surveys where more detailed litter classifications are currently applied. Where litter is observed remotely, for example in some benthic or floating litter surveys, the classification needs to be simpler because it is often impossible to distinguish items based on material composition. In such cases a less resolved classification system is recommended. A higher resolution in litter classification will provide the best opportunity to analyse and interpret data, although a fewer number of classes is likely to result in a lower error rate and therefore provide more consistency in data collection as well as making it easier to train and support survey staff and volunteers.

For each included litter item, supplementary information, if known, is supplied at different levels :

1. Composition of the material e.g. plastic, wood, metal etc.
2. Function of the material e.g. packaging, user items etc.
3. Possible sources of the material
4. Potential of the material to harm

This simple allocation system to a given use, source or potential for harm was made by the TSG10 authors in consultation with a number of experienced European marine litter experts as part of recommendations for standardization of litter categories across indicators. The allocation will, however, vary at a regional and possibly local scale and should be amended to fit into regional or local monitoring programmes (EUR 25009 EN-2011).



This project has received funding from the European Union's Seventh Framework Programme (FP7 2007-2013) under grant agreement n° 289042.



The main categories of litter as defined by TSG10 are:

1	Artificial polymer materials	
2	Metals	
3	Rubber	
4	Cloth/textile	
5	Paper/Cardboard	
6	Processed/worked wood	
7	Glass/ceramics	
8	Miscellaneous	

Figure 9: The main “universal” litter categories (Pictures ©Thomas Maes)



6.2 Quantification of litter

Irrespective of how litter is classified, there is a need to develop a system for quantification in order to provide a basis for comparison between surveys. Ideally, in situations where litter items are collected, both counts and weights should be recorded for all litter classes. TSG10 recommends counting items for all types of marine litter monitoring. Alternatively, it is recommended that the litter is weighed (and the quantity reported as kg). Recording both counts and weights allows for the broadest integration of data and avoids the obvious pitfalls with either type of measurement on its own. If litter is not collected (and particularly for remote observations), then the amount of litter in each class should be quantified by counting items (Cheshire et al., 2009; EUR 25009 EN-2011).



<i>Weights of litter within categories</i>	<i>Counts of litter items within categories</i>
<p>Weights of litter by categories are relatively easy to obtain and provide a very quick method for quantifying large numbers of items that have been collected during a survey. Furthermore, by aggregating items within a class and measuring the weight it is possible to rapidly deal with broken or fragmented material (e.g. glass bottles or plastic bags). In some cases (e.g. cloth or fishing net) the weight will be affected by whether the material is wet or dry, by the density of the material (e.g. plastics and metals) being such differences a source of error for statistical. However, while a simple measurement of weight quantifies how much material is present, it is very difficult to relate this to management or the assessment of downstream risks unless you know what that weight comprises in terms of individual items. Similarly, not all types of litter can be weighed, for example heavily fouled fishing nets or baulks of timber may weigh many tonnes. Practically these cannot be weighed unless the survey team has access to specialist equipment that may not be routinely available.</p>	<p>Counts are relatively easy to make and they do not require any specialised equipment. In relation to litter items such as plastic drink bottles or plastic bags, counts provide a quantitative indicator of relative importance. For remotely observed litter, counts within types are the only available approach. Problems arise, however, when there are litter items within the same class that may differ substantially in terms of size. In such cases counts are much less useful than a measurement of weight. Similarly counts are of very little use for quantifying heavily fragmented litter items.</p>
	

Figure 10: The weight vs count issue as described by Cheshire et al, 2009.



This project has received funding from the European Union's Seventh Framework Programme (FP7 2007-2013) under grant agreement n° 289042.



6.3 Basic types of marine litter surveys:

Regardless of the underpinning motivation, marine litter investigations will generally fall into one of the following basic types:

- 1) Beach litter surveys
- 2) Benthic litter surveys, which include:
 - a. Observations made by divers, submersibles or camera tows.
 - b. Collection of litter via benthic trawls.
- 3) Floating litter surveys, which include:
 - a. Observations made from ship or aerial based platforms (visual/camera).
 - b. Collection of litter via surface trawls.
- 4) Biota surveys of ingested litter, which include:
 - a. Birds
 - b. Turtles
 - c. Fish
 - d. Other
- 5) Surveys of microlitter in:
 - a. Sediments (Beach/Seafloor)
 - b. Water (Surface/Suspended)
 - c. Biota

Links to more detailed information can be found in the Annex.

According to TSG10, the requirements to successfully implement Descriptor 10 of the MSFD depend upon available monitoring techniques of demonstrated quality, which will be able to deliver reliable data at affordable costs. Besides already available monitoring methods, novel methods and automated monitoring devices will play a complementary role in the implementation of the MSFD Descriptor 10 in order to improve the quality of the monitoring results. In their report of last year, the TSG 10 group prepared 15 tool sheets (EUR 25009 EN – 2011) describing different marine litter methodologies for potential use. These tool sheets collect the main information about the methodologies, such as scope, matrices and size ranges. They refer to existing guidelines and detailed descriptions if available and also indicate the maturity of the identified tool, including eventual shortcomings. Further developments in marine litter monitoring are ongoing and will take a more definitive shape in the coming years. Hence it will be important to follow up progress of European and regional marine litter expert groups tasked with the improvement of our understanding of this relatively new problem in our marine environment.

6.4 The Marine Strategic Framework Directive TSG10 and its upcoming report on monitoring guidelines (Summer 2013)

In May 2010, The European Marine Directors agreed to establish two technical subgroups under the WG GES for further development of the descriptors noise and litter, as additional scientific and technical progress was still required to support the further development of the criteria related to those descriptors. The work of the technical subgroup on litter and noise will be reported to the Working Group on Good Environmental Status where all relevant actors (Member States, neighbouring countries, international organisations such as regional sea conventions and marine scientific organisations, stakeholder organisations) can provide structured feedback. This is the main forum where the outcomes of the subgroups' work are addressed. The technical subgroup provides a common platform for addressing how to develop objectives (characteristics of GES), environmental targets and associated indicators in relation to marine litter. This common reflection can then be taken further within each marine region and subregion (where possible in the context of regional sea conventions) and at national level.

By 2014, European member states need to implement a monitoring programme for the assessment of marine litter to meet the 2014 deadline under the Marine Strategy Framework Directive (MSFD). Member states will have to develop a standardised monitoring programme, with quantification methods for beach, benthic, water biota litter, and microparticle monitoring, capable of defining pressures and accumulation areas in order to



This project has received funding from the European Union's Seventh Framework Programme (FP7 2007-2013) under grant agreement n° 289042.



prove movement towards GES. In order to achieve this a unified system for coordinating and / or managing litter assessments is being developed by a European expert group (TSG10). The TSG10 report describes general and practical issues associated with monitoring of marine litter. This includes detailed advice on setting up monitoring approaches/strategies to be used for monitoring planning, taking into account knowledge development and costs of monitoring. It does not include advice on target setting, assessment, scaling and aggregation. This will be prepared at a later stage. In summer 2013 will be published a TSG10 report on monitoring guidelines "Monitoring Guidance for Marine Litter in European Seas".

BEACH SURVEYS



Beach surveys of accumulated marine litter are the most common means of estimating loads in the sea (UNEP/IOC, 2009). Litter monitoring on the coasts of the European seas has developed from a number of campaigns of mostly non-governmental organizations. Most existing protocols that have been used on European coasts have evolved from volunteer programmes and are based on simple counts of the number, in some cases also the measurement of the weight or volume, of litter items found on a given length of beach or water line. While volunteers were effective, efficiencies could be enhanced through integration of the sampling within local resource management programmes. Volunteers need to be properly trained with hands-on training exercises, supportive training materials and programme manuals that detail responsibilities and procedures. Local coordination and management is needed to ensure that volunteers are available when needed and monitoring schedules are followed. This could include support from national parks, resource managers, fisheries and tourism managers as well as

non-government organizations (Sheavly, 2007).

The OSPAR Pilot Project on Monitoring Marine Beach Litter (which formed a basis for the OSPAR Assessment) was the first region-wide project in Europe to develop a standard methodology for monitoring marine litter found on beaches. In the OSPAR Pilot Project on Monitoring Marine Beach Litter, the sources and quantitative trends in marine litter were identified on the beaches of nine OSPAR Contracting Parties (Belgium, Denmark, France, Germany, The Netherlands, Portugal, Spain, Sweden and the United Kingdom). The project's final report is based on a statistical analysis of marine litter from 609 surveys, using a common, standardized survey protocol on 100 metre stretches of 51 regular reference beaches monitored during the pilot project period (2001–2006), supplemented by 335 surveys of 1 kilometre stretches on 31 regular reference beaches during the same period. Additional surveys were carried out during 2006 on four beaches in France. Using specific marine litter items as indicators, the statistical analyses of the beach data identified five main sources: fishing (including aquaculture), sanitary waste/sewage-related waste, operational waste from shipping (including offshore activities), galley waste (non-operational waste from shipping, fisheries and offshore activities) and tourism and recreational activities. Beach surveys, such as the OSPAR ones, provide important information but not necessarily the full picture of the total load of marine litter in the coastal and marine environment. However, due to its region-wide scope, the methodology and findings of the Pilot Project have provided a major step forward in the analysis and better understanding of the sources and trends of marine litter in North-West Europe.

A minimum set of requirements for beach litter monitoring within the MSFD are recommended, which are based on the OSPAR, UNEP and NOAA guidelines.

Amounts washed ashore can be relatively easily assessed during surveys carried out by non-scientists using unsophisticated equipment. Coastal surveys are thus a cost-effective way of obtaining large amounts of information.

Summary of the OSPAR monitoring method for marine litter on beaches

- Select which marine litter items to include in a survey protocol/survey protocols, i.e., which items and number of items to count and register in surveys.
- Establish standard rules regarding the removal or marking of all marine litter items after counting and registration.



This project has received funding from the European Union's Seventh Framework Programme (FP7 2007-2013) under grant agreement n° 289042.



- Establish set criteria for the selection of beaches for regular monitoring.
- Devise a universal form for the collection of data from each beach.
- Identify and select the beaches to be monitored, allocating each beach a reference number, and completing the documentation.
- Establish a standard length of survey section(s) on each beach.
- Mark this/these section(s), using permanent reference points.
- Establish annual survey periods.
- Select a data host. Set up a common, internet-based database.
- Carry out the surveys, using the agreed protocol in accordance with other agreed procedures.
- Establish a system to allow surveyors to input their gathered beach data to the database (transfer registrations and observations from survey protocols to the database) after each survey.

SEABED SURVEYS



At the moment no European Member State has implemented a coordinated national or regional monitoring programme for litter on the seabed within Europe although some monitoring experiments have been performed. The most common approaches to evaluate seafloor litter distributions are using opportunistic sampling. This type of sampling mostly relates to regular fisheries surveys (marine reserve, offshore platforms, etc.) and programs on biodiversity, since methods for determining seafloor litter distributions, trawling, diving and video photography, are similar to those used for benthic and biodiversity assessments. Submersibles and ROVs are possible approaches for deep-sea areas although this requires considerable means. Monitoring programmes for demersal fish

stocks, undertaken as part of the International Bottom Trawl Surveys, operate at large regional scale and provide data using an harmonized protocol which may provide consistent support for monitoring litter at the European scale on a regular basis and within the MSFD framework (EUR 25009 EN – 2011).

The most commonly used method to estimate marine litter density in shallow coastal areas is to conduct underwater visual surveys with SCUBA along line transects, although snorkelling has also been applied for very shallow waters (usually < 10 m depth) and for larger forms of marine litter (nets/gear). This approach is particularly efficient in areas with low litter densities, clear waters, and/or high sea bottom complexity (e.g. rocky reefs, sea grass beds). Field protocols for line transect surveys of litter on the seabed are exactly the same as those for benthic sessile fauna, described in detail in Katsanevakis (2007).



Collection of data on litter on the continental plate (0-200m) was started in the 1990s in both the NE Atlantic (within IBTS program) and the Mediterranean Sea (within MEDITS program) but on an experimental basis. The International Bottom Trawl Surveys Working Group (ICES/ IBTS WG) has recently developed a unique protocol for marine litter assessments using trawling programmes, which was taken up by the International Council for the Exploration of the Sea in the IBTS programme in the NE Atlantic. This protocol harmonizes the procedures for collecting and reporting marine litter data which is collected on the back of existing fish stock surveys. It has been discussed within the GES TG group and modified in order to provide an accurate methodology applicable for MSFD monitoring (facilitating the evaluation of sources, trends, data analysis, etc.).

Only some areas/countries are concerned with deep-sea floor along the European coasts including submarine canyons, seamounts, cold seeps, open slopes and deep basins, such as present in Norway, UK, Ireland, France, Spain, Portugal, Italy, and Greece. Monitoring in those deep-sea areas is largely restricted by sampling difficulties and cost. Litter that reaches the seabed may already have been transported considerable distances, only sinking when weighed down by fouling. The consequence is an accumulation in bays and canyons, often around large cities, rather than at open sea. These densities are a consequence of residual ocean circulation patterns and



This project has received funding from the European Union's Seventh Framework Programme (FP7 2007-2013) under grant agreement n° 289042.



more locally to the morphology of the sea bed (around rocks and/or in depressions or channels) and the extension of deep submarine extensions of coastal rivers. For monitoring, the use of trawls in deep-sea areas is restricted to flat and smooth bottoms. For slopes and rocky bottoms, more specialised equipment is necessary. ROVs which are less complicated than submersibles and generally cheaper are recommended for litter surveys.

WATER COLUMN



© Thomas Maes

The TSG10 report compiles the existing protocols for the monitoring of floating marine meso- and macro litter. It is mainly focussing on a visual observation methodology. It analyses eventual shortcomings of the existing approaches in view of their application to monitoring under the MSFD.

The harmonised protocols ensure data comparability between different visual observation campaigns across regions. The report also addresses the topic of data quality assurance and control for trend analysis and elaborates the possibility of using monitoring data from platforms of opportunity. The here-discussed monitoring of floating litter includes the objects in the water column close to the surface. Litter in the deeper water column is currently not recommended for routine monitoring and should be the subject of research efforts. The report contains a discussion regarding the monitoring of meso/macro litter by tow nets.

BIOTA

The improvement of knowledge concerning impacts on marine life (affected species, species used as indicators, the normalisation of methods and the determination of thresholds) is needed. As no single species can provide full coverage over all Europe's marine sectors, a range of species is needed to monitor ingested litter. Some spatial overlap between regionally restricted monitoring species is desirable to link pollution measurements in the different areas.

On the basis of available information and expertise, the TSG10 report currently focus on the development of monitoring protocols from existing tool sheets for seabirds and sea turtles and on a proposal for a MSFD marine litter monitoring tool sheet on fish ingestion. The approach taken hereby consists of the application of the same categorization of marine litter for all ingestion studies of vertebrates and potentially also invertebrates. The used standard categories follow the existing fulmar methodology, in which a number of plastic categories is counted, and weighted as a unit. In the longer run monitoring options and guidelines for marine mammal ingestion based on the findings from the 2011 report by the group will also be looked at. Ingestion protocols for invertebrates such as crustaceans, shellfish, worm or zooplankton are not included in this report. In addition to the ingestion protocols guidelines are under development for litter in seabird nest structures and entanglement of litter in nest structures. In addition, an evaluation of some monitoring elements such as entanglement rates of marine mammals are suitable for further development.



© J.A. van Franeker

MICROLITTER

Most studies have focused on the sea surface, in the water column, in sediment and in biota. As with the potential impacts the appropriateness of sampling techniques varies according to size category. The 2011 report highlighted the following in relation to microlitter monitoring: "There is a need to standardize sampling approaches in order to monitor the abundance of microplastic for MSFD. For samples from sea surface, water column, sediment and biota, this needs to consider both the sampling design in terms of number and size of replicates, spatial area and frequency of coverage as well as the methodological approach; type of net or core and method of identification used. Given that this is an emerging area with numerous recent studies it is not reasonable to prescribe set methodologies at this time and the development of standard approaches and protocols should be seen as a goal over the next 4 years".



This project has received funding from the European Union's Seventh Framework Programme (FP7 2007-2013) under grant agreement n° 289042.



Nevertheless, the TSG10 report presents a review of existing approaches considering sampling design, methods of sample collection and identification of microparticles. The main objective of the report is to make informed recommendations for standard monitoring protocols for the identification and quantification of microplastics in marine environments. Where possible, basic criteria and approaches are recommended to ensure that future quantitative estimates are comparable, providing standardized data of microplastics in the marine environment.



This project has received funding from the European Union's Seventh Framework Programme (FP7 2007-2013) under grant agreement n° 289042.



ANNEX1_LINKS TO RELEVANT INFORMATION

Guidelines:	
TSG10	http://publications.jrc.ec.europa.eu/repository/bitstream/111111111/22826/2/msfd_ges_tsg_marine_litter_report_eur_25009_en_online_version.pdf
TG10	http://ec.europa.eu/environment/marine/pdf/9-Task-Group-10.pdf
UNEP/IOC	http://www.unep.org/regionalseas/marinelitter/publications/docs/Marine_Litter_Survey_and_Monitoring_Guidelines.pdf
ICC	http://www.oceanconservancy.org/
NOAA	http://marinedebris.noaa.gov http://marinedebris.noaa.gov/tsunamidebris/pdf/shorelinefieldguide.pdf
Regional Assessments	
UNEP/MAP	http://195.97.36.231/acrobatfiles/09WG334_Inf5_eng.pdf
UNEP/Black Sea	http://www.blacksea-commission.org/_publ-ML.asp
UNEP/Baltic	http://www.helcom.fi/publications/other_publications/en_GB/
OSPAR/KIMO	http://qsr2010.ospar.org/media/assessments/p00386_Marine_Litter_in_the_North-East_Atlantic_with_addendum.pdf
Accepted protocols	
OSPAR Beach Litter Monitoring	http://www.ospar.org/documents/dbase/decrecs/agreements/10-02e_beachlitter%20guideline_english%20only.pdf
OSPAR EcoQO Plastic in Fulmars	http://www.ospar.org/documents/dbase/publications/p00355_ecoqo%20plastics%20in%20seabird%20stomachs.pdf
Relevant information:	
The Honolulu Strategy	http://5imdc.wordpress.com/about/honolulustrategy/
The Message from Berlin	http://www.marine-litter-conference-berlin.info/userfiles/file/Message%20from%20Berlin.pdf
Rio+20 - The Future We Want	http://www.uncsd2012.org/content/documents/727The%20Future%20We%20Want%2019%20June%201230pm.pdf
The U.N General Assembly (UNGA) 60th Session Resolutions	http://www.un.org/depts/dhl/resguide/r60.htm
The Marine Strategy Framework Directive	http://ec.europa.eu/environment/water/marine/directive_en.htm