UNITED NATIONS
ENVIRONMENT PROGRAMME
MEDITERRANEAN ACTION PLAN

Meeting of the Ecosystem Approach Correspondence Group on Marine Litter Monitoring

Madrid, Spain, 28 February – 2 March 2017

Agenda item 4: Guidance Factsheets on Marine Litter Monitoring (EO10)

IMAP Indicator Guidance Factsheets on Marine Litter

Table of Contents

Introduction

1.   The 19th Meeting of Contracting Parties (COP 19), held in February 2016, adopted the Integrated Monitoring and Assessment Programme (IMAP) of the Mediterranean Sea and Coast and Related Assessment Criteria. In its Decision IG. 22/7, a specific list of good environmental status common indicators and targets and principles of an integrated Mediterranean Monitoring and Assessment Programme, next to a clear timeline for the implementation of this Programme were detailed. IMAP, through Decision IG.22/7 lays down the principles for an integrated monitoring, which will, for the first time, monitor biodiversity and non-indigenous species, pollution and marine litter, coast and hydrography in an integrated manner. The IMAP aims to facilitate the implementation of article 12 of the Barcelona Convention and several monitoring related provisions under different protocols with the main objective to assess GES. Its backbone are the 11 Ecological Objectives and their 27 common indicators as presented in the decision.

2.   The UNEP/MAP Programme of Work (PoW) adopted at COP 19, includes the Output 1.4.3 for *the Implementation of IMAP (the EcAp-based integrated monitoring and assessment programme) coordinated, including GES common indicators fact sheets, and supported by a data information center to be integrated into Info/MAP platform.*

3.   Therefore, the draft guidance factsheets within each Common Indicator have been developed for coherent monitoring, as well as their targets defined and agreed in order to deliver the achievement of Good Environmental Status (GES), In this context, this document outlines the three Indicator Guidance Factsheets for the Ecological Objectives 10 (Marine Litter) as follows:

- Common Indicator 22: Trends in the amount of litter washed ashore and/or deposited on coastlines (EO10);
- Common Indicator 23: Trends in the amount of litter in the water column including microplastics and on the seafloor (EO10);
- Candidate Indicator 24: Trends in the amount of litter ingested by or entangling marine organisms focusing on selected mammals, marine birds, and marine turtles (EO10)

4.   The main purpose of this revised Indicator Guidance Factsheets is to provide concrete guidance and references to Contracting Parties to design and support implementation of their revised national monitoring programme towards the overall goal of implementing the Ecosystem Approach (EcAp) in the Mediterranean Sea and achieving GES.

5.   The structure of a Common Indicator Factsheets can be summarized looking at the different organization levels of the developed factsheet templates. A common set of relevant policy and science-based information is required for each Indicator (ie. Indicator Title, Definition, Rational, Policy Context and Targets, Indicator analysis methods and Methodology for monitoring (temporal and spatial scope), Contacts and Document Registration). In each, detailed definitions, methodologies, references, gaps, uncertainties, data analysis approaches, basis for aggregation (if applies) and outputs complete the guidance factsheets (see scheme below).

6.   The CORMON meeting on Marine Litter, to be held in Madrid on the 28 February and 1 March 2017, will review these Marine Litter Factsheets and provide comments and suggestions for their revision and finalization for submission to the MED POL Focal Points meeting in May 2017..

ACRONYMS AND ABBREVIATIONS

EEA	European Environment Agency
EU	European Union
GES	Good Environmental Status
HELMEPA	Hellenic Marine Environnent Protection Association
IMAP	Integrated Monitoring and Assessment Programme of the Mediterranean Sea and Coast
JRC	Joint Research Centre of the European Commission
MEDASSET	Mediterranean Association to Save the Sea Turtles
MED POL	UNEP/MAP Programme for the Assessment and Control of Marine Pollution in the Mediterranean
MEDITS	The International Bottom Trawl Survey in the Mediterranean
MOOC	Massive Open Online Course
MSFD	Marine Strategy Framework Directive
NGO	Non Governmental Organization
NOAA	National Oceanic and Atmospheric Administration
TG ML	Technical Group on Marine Litter of the EC MSFD
UN	United Nations

Scheme of IMAP Factsheet Template:

Indicator Title			
Relevant GES definition	**Related Operational Objective**	**Proposed Target(s)**	**IMAP Reference No and definition**
Rationale			
Justification for indicator selection			**Scientific rationale and marine policy context (including relevant references)**
Scientific References			
Policy Context and targets			
Policy context description			
Targets			
Policy documents			
Indicator analysis methods			
Indicator Definition			
Methodology for indicator calculation			
Indicator units			
List of Guidance documents and protocols available			**Agreed scientific methodologies in use, including detailed monitoring requirements**
Data Confidence and uncertainties			
Methodology for monitoring, temporal and spatial scope			
Available Methodologies for Monitoring and Monitoring Protocols			
Available data sources			
Spatial scope guidance and selection of monitoring stations			
Temporal Scope guidance			
Data analysis and assessment outputs			**Data reporting, analysis and aggregation (outpout)**
Statistical analysis and basis for aggregation			
Expected assessments outputs			
Known gaps and uncertainties in the Mediterranean			
Contacts and version Date			
Key contacts within UNEP for further information			**Document Registration**
Version No	**Date**	**Author**	

Common indicator 22: Trends in the amount of litter washed ashore and/or deposited on coastlines (including analysis of its composition, spatial distribution and, where possible, source).

	Related Ecological Objective: (EO 10) Marine and coastal litter do not adversely affect the coastal and marine environment	
Indicator Title	*Common indicator 22: Trends in the amount of litter washed ashore and/or deposited on coastlines (including analysis of its composition, spatial distribution and, where possible, source).*	
Relevant GES definition	**Related Operational Objective**	**Target(s)**
Number/amount of marine litter items on the coastline do not have negative impact on human health, marine life and ecosystem services.=	10.1 The impacts related to properties and quantities of marine litter in the marine environment and coastal environment are minimized	Decreasing trend in the number of/amount of marine litter (items) deposited on the coast.
Rationale		
Scientific References		

- Cheshire, A. C., Adler, E., Barbière, J., Cohen, Y., Evans, S., Jarayabhand, S., Jeftic, 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., Westphalen, G., 2009. UNEP/IOC Guidelines on Survey and Monitoring of Marine Litter. UNEP Regional Seas Reports and Studies 186 (IOC Technical Series No. 83): 120.
- Opfer, S., Arthur, C. and Lippiatt, S., 2012. NOAA Marine Debris Shoreline Survey Field Guide. National Oceanic and Atmospheric Administration.
- JRC, 2011. Marine Litter Technical Recommendations for the Implementation of MSFD Requirements. European Commission, Joint Research Centre, Institute for Environment and Sustainability EUR 25009 EN, pp. 66. doi: 10.2788/92438.
- JRC, 2013. Guidance on Monitoring of Marine Litter in European Seas. JRC Scientific and Policy Reports EUR 26113 EN, pp. 126. doi: 10.2788/99475.

Policy Context and targets (other than IMAP)

Policy context description

The UN Environment / Mediterranean Action Plan Barcelona Convention Regional Plan on Marine Litter Management in the Mediterranean Region is the first ever legally binding regional plan adopted by a Regional Sea Convention (Decision IG. 21/7) that addresses marine litter management in regional level in a coherent manner and sets out legally binding measures at regional and national level, and implementation timetables. The main objective of the Regional Plan on Marine Litter Management in the Mediterranean is to prevent and reduce marine litter generation and its impact on marine and coastal environment in order to achieve good environmental status (GES) as per the relevant Mediterranean ecological objectives and ecosystem approach based Marine Litter related targets adopted by UN Environment / Mediterranean Action Plan in 2012 and 2013 during the 17th and 18th Meeting of the Contracting Parties of the Barcelona Convention consecutively. Moreover, through its Articles: 11 "Assessment of Marine Litter in the Mediterranean" and 12 "Mediterranean Marine Litter Monitoring Programme", the Regional Plan on Marine Litter includes a series of specific provisions for the countries for monitoring and assessment of marine litter i.e. assess the state of marine litter, the impact to marine and coastal environment and human health, the socio-economic aspects of marine litter management, the development of marine litter data banks, the development of national monitoring programmes on marine litter etc.

The EU MSFD (2008/56/EC) requires European Member States to develop strategies that should lead to programmes of measures to achieve or maintain GES in European Seas. MSFD sets the framework for Member States to achieve by 2020 GES for their marine waters, considering 11

	Related Ecological Objective: (EO 10) Marine and coastal litter do not adversely affect the coastal and marine environment
Indicator Title	*Common indicator 22: Trends in the amount of litter washed ashore and/or deposited on coastlines (including analysis of its composition, spatial distribution and, where possible, source).*

descriptors. Descriptor 10 focuses on marine litter, stating that GES is achieved only when "Properties and quantities of marine litter do not cause harm to the coastal and marine environment".

Indicator/Targets

UN Environment / Mediterranean Action Plan Decision IG.21/3 of the 18th Meeting of the Contracting Parties of the Barcelona Convention on the Ecosystem Approach including adopting definition of GES and targets proposes as target for Indicator 10.1.1: Decreasing trend in the number of/amounts of marine litter (items) deposited on the coast.

Moreover, in the framework of the UN Environment / Mediterranean Action Plan Barcelona Convention, Regional Plan on Marine Litter Management in the Mediterranean (Decision IG.21/7 - 18th Meeting of the Contracting Parties), a series of Marine Litter Baseline Values and Environmental Targets have been adopted by the 19th Meeting of the Contracting Parties) (Decision IG.22/10):

Baseline Values for Beach Marine Litter:
- Minimum value: 11 items/100m
- Maximum value: 3600 items/100m
- Mean value: 920 items/100m
- Proposed Baseline: 450-1400 items/100m

Environmental Targets for Beach Marine Litter:
- Types of Target: % of decrease
- Minimum: Significant
- Maximum: 30%
- Reduction Targets: 20% by 2024

Indicator analysis methods

Indicator Definition

GES Definition: Number/amount of marine litter items on the coastline do not have negative impacts on human health, marine life and ecosystem services. Coastline is defined as one or more transects of 100m length each parallel to the seashore from the strandline till the back of the beach (dunes, natural or manmade destruction).

Methodology for indicator calculation

All items found on the sampling unit (i.e. one or two 100m transects) should be entered on survey forms. On the survey forms, each item is given a unique identification number. Data should ideally be entered on the survey form while picking up the litter. Collecting the litter first and identifying it later may alter numbers as collected litter tends to get more entangled or broken.

A standard list of marine litter items should be used including all possible marine litter items. Several relevant lists exist. The UN Environment /Mediterranean Action Plan, Mediterranean Pollution Assessment and Control Programme (MED POL) Masterlist is part of the Integrated Monitoring and Assessment Programme (IMAP) Guidance document (UNEP(DEPI)/MED_IG.22/Inf.7 – Annex VII[1]). A master list of litter categories and items has been also developed by EU MSFD TGML. This master list includes a list of categories and items to

---

[1] https://wedocs.unep.org/rest/bitstreams/8456/retrieve

	Related Ecological Objective: (EO 10) Marine and coastal litter do not adversely affect the coastal and marine environment
Indicator Title	*Common indicator 22: Trends in the amount of litter washed ashore and/or deposited on coastlines (including analysis of its composition, spatial distribution and, where possible, source).*

be recorded during beach litter surveys. A reduced list for the Mediterranean, MSFD and OSPAR compatible, that includes the most frequent items found in Mediterranean beaches may be considered and more useful and practical for the field work. This will also enable a coordinated and harmonized monitoring when operated by NGOs.

It has been strongly recommended to produce regional photo guides including pictures of all litter items on the regional survey protocol. This will assist in the correct identification and allocation of recorded items.

Attentions should be also given on size limits and classes of the surveyed marine litter items. There are no upper size limits to litter recorded on beaches. A lower limit of 0.5 cm in the longest dimension is recommended for litter items monitored during beach surveys.

Indicator units

Counts of items per sampling unit are recommended as the standard unit of litter to be assessed on the coastline.

A sampling unit is a fixed section of beach covering the whole area between the water edges (where possible and safe) or from the strandline to the back of the beach (IMAP Integrated Monitoring and Assessment Guidance document1).
- At least 1 section of 100m on the same beach, optimum 2 sections, are recommended for monitoring purposes on lightly to moderately littered beaches;
- At least 2 sections of 100 m for heavily littered beaches (exceptionally 50m section with a normalization factor of up to 100m to ensure coherence).

List of Guidance documents and protocols available

- UN Environment / Intergovernmental Oceanographic Commission, Guidelines on Survey and Monitoring of Marine Litter (2009).
- UN Environment /Mediterranean Action Plan, Integrated Monitoring and Assessment Programme Guidance document (2016) (UNEP(DEPI)/MED_IG.22/Inf.7)
- EU MSFD TGML, Guidance on Monitoring of Marine Litter in European Seas (2013).
- DeFishGear project, Methodology for Monitoring Marine Litter on Beaches Macro-debris (<2.5cm) (2015).

Data Confidence and uncertainties

Most beach marine litter surveys are organized by NGOs with a focus on cleaning. Moreover, small fragments measuring less than 2.5 cm are often buried and may not be targeted by clean-up campaigns or monitoring surveys. Stranding fluxes are also difficult to assess. Moreover, the majority of studies performed show a high variability in the density of litter depending on the use or characteristics of each beach. More work has also to be done on informing volunteer groups about the necessity to submit standardized research data for statistical purposes. In that respect clean-up programmes shall increase public knowledge of the scientific relevance of information and information sharing.

Quality Assessment and Quality Control for beach marine litter data is considered of primary importance. Based on UN Environment Guidelines (Cheshire et al., 2009), any long-term marine litter assessment programme will require a specific and focussed effort to recruit and train field staff and volunteers. Consistent, high quality training and standard data reporting are essential to ensure data quality and needs to explicitly include the development of operational (field based) skills.

	Related Ecological Objective: (EO 10) Marine and coastal litter do not adversely affect the coastal and marine environment
Indicator Title	*Common indicator 22: Trends in the amount of litter washed ashore and/or deposited on coastlines (including analysis of its composition, spatial distribution and, where possible, source).*

Standard data reporting sheets (i.e. IMAP Reporting Sheets) including a standardized list of marine litter items and also additional information (weather conditions, etc) commonly used at regional level should be promoted in order to maximize homogeneity on the collected data, make comparison possible, come up with most commonly observed items at regional and sub-regional level and thus assess the problem at regional level. Moreover, all the available training material like the UN Environment Massive Open Online Course (MOOC[2]) should be used to train beach marine litter surveyors on surveying, monitoring and on general aspects of marine litter. Staff education programmes should incorporate specific information on the results and outcomes from the work so that staff and volunteers can understand the context of the litter assessment programme.

Quality assurance and quality control should be primarily targeted at education of the field teams to ensure that litter collection and characterization is consistent across surveys. Investment in communication and the training of the country/regional and local survey coordinators and managers is thus critical to survey integrity.

The quality assurance protocol of Ocean Conservancy's National Marine Debris Monitoring Program (USA) required a percentage of all locations to be independently re-surveyed immediately following the scheduled assessment of litter (Sheavly, 2007). The collected litter from the follow-up survey could then be added to that of the main collection and could be used to provide an estimate of the error level associated with the survey.

Methodology for monitoring, temporal and spatial scope

Available Methodologies for Monitoring and Monitoring Protocols

The selection of survey sites should be based on the following criteria:
- A minimum length of 100m;
- Clear access to the sea (not blocked by breakwaters or jetties) such that marine litter is not screened by anthropogenic structures;
- Accessible to survey teams year round, although some consideration needs to be;
- Ideally the site should not be subject to any other litter collection activities, although it is recognized that in many parts of Europe large scale maintenance cleaning is carried out periodically; in such cases the timing of non-survey related beach cleaning must be known such that litter flux rates (the amount of litter accumulation per unit time) can be determined.
- Survey activities should be conducted so as not to impact on any endangered or protected species such as sea turtles, sea birds or shore birds, marine mammals or sensitive beach vegetation; in many cases this would exclude national parks but this may vary depending on local management arrangements.

Within the above constraints, the location of sampling sites within each zone should be stratified such that samples are obtained from beaches subject to different litter exposures, including:
- Urban coasts may better reflect the contribution of land-based inputs;
- Rural coasts may better reflect background values for litter pollution levels
- Coasts close to major rivers, if downstream from the prevailing drift, may better reflect the contribution of riverine input to coastal litter pollution.

At least two surveys per year in spring and autumn are recommended and ideally 4 surveys in spring, summer, autumn and winter. However, because of the large seasonal variation in amounts of

---

[2] http://www.unep.org/gpa/gpml/MOOC.asp

	Related Ecological Objective: (EO 10) Marine and coastal litter do not adversely affect the coastal and marine environment
Indicator Title	*Common indicator 22: Trends in the amount of litter washed ashore and/or deposited on coastlines (including analysis of its composition, spatial distribution and, where possible, source).*

litter washed ashore, initially a higher frequency of surveys may be necessary in order to identify significant seasonal patterns, which can then be considered when treating raw data for long-term trend analyses. Preferably, the surveys for all participating beaches in a given region should be carried out within the shortest timeframe possible within a survey period. Coordinators within these regions should try and coordinate the survey dates between beaches. Furthermore a given beach should be surveyed on roughly the same day each year if possible.

It is very important to document and characterise the survey sites. As surveys should be repeated on exactly the same site the coordinates of the site should be documented. Permanent reference points must be used to ensure that exactly the same site will be monitored for all surveys. The start and end points of each sampling unit can be identified by different methods. For example numbered beach poles could be installed at the site or easily identifiable landmarks could be used. Coordinates obtained by GPS are useful for identifying the reference beaches especially where easily identifiable landmarks are lacking.

Counts of items are recommended as the standard unit of litter to be assessed on the coastline. Once a beach is chosen sampling units can be identified. A sampling unit is a fixed section of beach covering the whole area between the water edges (where possible and safe) or from the strandline to the back of the beach:
- At least 1 section of 100m on the same beach, optimum 2 sections, are recommended for monitoring purposes on lightly to moderately littered beaches
- At least 2 sections of 100 m for heavily littered beaches (exceptionally 50m section with a normalisation factor of up to 100m to ensure coherence)

All items found on the sampling unit should be entered on survey forms. On the survey forms, each item is given a unique identification number. Data should ideally be entered on the survey form while picking up the litter. Collecting the litter first and identifying it later may alter numbers as collected litter tends to get more entangled or broken. Unknown litter or items that are not on the survey form should be noted in an appropriate "other item box". A short description of the item should then be included on the survey form. If possible, digital photos should be taken of unknown items so that they can be identified later and, if necessary, be added to the survey form. Unknown litter or items that are not on the survey form should be noted in an appropriate "other item box". A short description of the item should then be included on the survey form. If possible, digital photos should be taken of unknown items so that they can be identified later and, if necessary, be added to the survey form.
There are no upper size limits to litter recorded on beaches. A lower limit of 0.5 cm in the longest dimension is recommended for litter items monitored during beach surveys. This would ensure the inclusion of caps & lids and cigarette butts in any counts.

Removal of litter should be carried out at the same time as monitoring the litter. Coupling removal with monitoring ensures better accuracy of reporting and enables comparison of litter accumulation over time; It also has the added advantage of leaving a clean beach. It is important to note that only the 100m ref section(s) need to be monitored and cleaned. Further areas of a beach can be cleaned without monitoring if surveyors/volunteers wish to do so. The litter collected should be disposed of properly. Regional or national regulations and arrangements should be followed. If these do not exist local municipalities should be informed. Larger items that cannot be removed (safely) by the surveyors should be marked, with for example paint spray (for marking trees) so they will not be counted again at the next survey.

	Related Ecological Objective: (EO 10) Marine and coastal litter do not adversely affect the coastal and marine environment
Indicator Title	*Common indicator 22: Trends in the amount of litter washed ashore and/or deposited on coastlines (including analysis of its composition, spatial distribution and, where possible, source).*

Available data sources

- DeFishGear Project: http://www.defishgear.net/
- European Environment Agency (EEA) Marine LitterWatch (MLW) Smartphone Application: http://www.eea.europa.eu/themes/coast_sea/marine-litterwatch
- Hellenic Marine Environment Protection Association (HELMEPA): http://www.helmepa.gr/en/home.php
- Legambiente International: http://international.legambiente.it/
- Ocean Conservancy, International Coastal Clean-up (ICC): http://www.oceanconservancy.org/our-work/international-coastal-cleanup/?referrer=https://www.google.gr/
- Surfers Against Sewage: https://www.sas.org.uk/
- Surfrider Foundation Europe: https://www.surfrider.org/

Spatial scope guidance and selection of monitoring stations

Ideally the selected sites should represent litter abundance and composition for a given region. Not any given coastal site may be appropriate, as they may be limited in terms of accessibility, suitability to sampling (sand or rocks/boulders) and beach cleaning activities. If possible the same criteria as the ones considered during the selection of the survey sites should be applied.
The location of sampling sites should be selected in such a way that samples are obtained from beaches subject to different litter exposures, including:
- Urban coasts may better reflect the contribution of land-based inputs;
- Rural coasts may better reflect background values for litter pollution levels \
- Coasts close to major rivers, if downstream from the prevailing drift, may better reflect the contribution of riverine input to coastal litter pollution.

The EU MSFD TGML in its Guidance documents (2013) recommends:
- At least 2 sections of 100m on the same beach for monitoring purposes on lightly to moderately littered beaches;
- At least 2 sections of 50 m for heavily littered beaches.

Temporal Scope guidance

At least two surveys per year in spring and autumn are recommended and ideally 4 surveys in spring, summer, autumn and winter. However, because of the large seasonal variation in amounts of litter washed ashore, initially a higher frequency of surveys may be necessary in order to identify significant seasonal patterns, which can then be considered when treating raw data for long-term trend analyses.

Preferably, the surveys for all participating beaches in a given region should be carried out within the shortest timeframe possible within a survey period. Coordinators within these regions should try and coordinate the survey dates between beaches. Furthermore a given beach should be surveyed on roughly the same day each year if possible.

It should be kept in mind that circumstances may lead to inaccessible and unsafe situations for surveyors: heavy winds, slippery rocks and hazards such as rain, snow or ice, etc. The safety of the surveyors must always come first. Dangerous or suspicious looking items, such as ammunition,

	Related Ecological Objective: (EO 10) Marine and coastal litter do not adversely affect the coastal and marine environment
Indicator Title	*Common indicator 22: Trends in the amount of litter washed ashore and/or deposited on coastlines (including analysis of its composition, spatial distribution and, where possible, source).*

chemicals and medicine should not be removed. Inform the police or authorities responsible. If working on remote beaches it is recommended to work with a minimum of two people.

Data analysis and assessment outputs

Statistical analysis and basis for aggregation

Basic analysis involves spreadsheet development, aggregations per category and type of marine litter items, mean values and corresponding standard deviation. Since we yet do not have long-term data, at the moment there is no statistical method recommended. Moreover, at present there is no agreed statistical method for recommending a minimum number of sites that may be representative for a certain length of coast. This depends greatly on the purpose of the monitoring, on the geomorphology of the coast and how many sites that meet the criteria described above are available. The representativeness of survey sites should be assessed in pilot studies, where initially a large numbers of beaches are surveyed. Subsequently, selection of representative beaches from these sites should be made on the basis of a statistical analysis.

Expected assessments outputs

- Abundance of beach marine litter with detailed information on densities (items/100m transect), different types of material and/or use;
- Temporal and spatial distribution;
- Stranding fluxes;
- Identify sources;
- Top-ten item list in regional and national level.

Known gaps and uncertainties in the Mediterranean

The lack of harmonized monitoring methods and the use of a common list of marine litter items found on beaches leads in several data uncertainties mainly attributed to the lack of comparison among sub-regions and also to give a complete view at basin scale. Comparison is difficult if different methods, different spatial and temporal scales, different size scales of litter items and different lists or categorisation of litter items recorded on beaches are used. Moreover, data collection and data management are considered crucial towards minimizing data uncertainties. Data collation should be undertaken through dedicated database management systems, preferably in regional level, under the control and direction of the local data managers. The EU MSFD TGML Guidance Document (2013), highlights that the existence of such databases would ensure a high level of consistency within each region as well as create a hierarchy of quality assurance on data acquisition. Such a database should be developed and maintained for the Mediterranean.

Contacts and version Date: *UNEP/MAP 16 January 2017*

Key contacts within UN Environment for further information

- Mr Christos Ioakeimidis, Marine Litter MED Project Expert, Mediterranean Pollution Assessment and Control Programme (MED POL) (Christos.Ioakeimidis@unep.org)
- Ms Virginie Hart, Programme Officer, UN Environment/Mediterranean Action Plan, Mediterranean Pollution Assessment and Control Programme (MED POL) (Virginie.Hart@unep.org)
- Ms Tatjana Hema, Deputy Coordinator, UN Environment/Mediterranean Action Plan (Tatjana.Hema@unep.org)

Version No	**Date**	**Author**

	Related Ecological Objective: (EO 10) Marine and coastal litter do not adversely affect the coastal and marine environment	
Indicator Title	*Common indicator 22: Trends in the amount of litter washed ashore and/or deposited on coastlines (including analysis of its composition, spatial distribution and, where possible, source).*	
V.1		

Common indicator 23: Trends in the amount of litter in the water column including microplastics and on the seafloor

[A] Seafloor Marine Litter

	Related Ecological Objective: (EO 10) Marine and coastal litter do not adversely affect the coastal and marine environment	
Indicator Title	*Common Indicator 23: Trends in the amount of litter in the water column including microplastics and on the seafloor*	
Relevant GES definition	**Related Operational Objective**	**Target(s)**
Number/amount of marine litter items in the water surface and the seafloor do not have negative impacts on human health, marine life, ecosystem services and do not create risk to navigation	10.1. The impacts related to properties and quantities of marine litter in the marine and coastal environment are minimized	Decreasing trend in the number/amount of marine litter items in the water surface and the seafloor
Rationale		

Justification for indicator selection

The seafloor has been identified as an important sink for marine litter. From the existing information marine litter can be found in varying depths and places, showing considerable spatial variability. Most litter is comprised of high-density materials and hence sinks. Even low-density synthetic polymers such as polyethylene and polypropylene, may sink under the weight of fouling or additives. The Mediterranean Sea is a special case, as its shelves are not extensive and its deep sea environments can be influenced by the presence of coastal canyons. However there are several studies investigating the abundance of marine litter on the seafloor of the Mediterranean Sea (Galil et al., 1995; Galgani et al., 1996, 2000; Ioakeimidis et al., 2014; Pham et al., 2014; Ramirez-Llodra et al., 2013).

The geographical distribution of litter on the seafloor is strongly influenced by hydrodynamics, geomorphology and human factors. Litter that reaches the seafloor may already have been transported considerable distance, only sinking when weighted down by entanglement and fouling by a wide variety of bacteria, algae, animals and fine-grained accumulated sediments, and litter can then sink to the seafloor. The consequence is an accumulation of litter on specific seafloor locations in response to local sources and oceanographic conditions (Galgani et al., 2000; Keller et al., 2010; Watters et al., 2010). Moreover, seafloor litter tends to become trapped in areas of low circulation. Once litter reaches the seafloor, it lies on the seafloor and it may even partly buried in areas of very high sedimentation rate (Ye and Andrady, 1991). Taking also into account the persistence of most of litter materials (i.e. plastics) and thus the fact that many of the recorded marine litter may be present on the seafloor for year or even decades, then the monitoring of seafloor marine litter becomes extremely important.Information regarding the abundance of small plastic particles accumulating in the deep-sea sediments is still very limited as only few studies exist on this field (Van Cauwenberghe et al., 2013; Woodall et al., 2014) and further work should be encouraged.

Scientific References

- Galgani F., Souplet A., Cadiou Y. (1996). Accumulation of debris on the deep floor off the French Mediterranean coast. Marine Ecology Progress Series 142(1-3):225-234.
- Galgani, F., Leaute, J.P., Moguedet, P., Souplet, A., Verin, Y., Carpentier, A., Goraguer, H., Latrouite, D., Andral, B., Cadiou, Y., Mahe, C., Poulard, J.C., Nerisson, P. (2000). Litter on the Sea Floor Along European Coasts. Marine Pollution Bulletin, Vol. 40, No. 6, pp. 516-527.
- Galil, B.S., Golik, A., Turkay, M. (1995). Litter at the Bottom of the Sea: A Sea Bed Survey in the Eastern Mediterranean. Marine Pollution Bulletin, Vol. 30, No. 1, pp. 22-24.

	Related Ecological Objective: (EO 10) Marine and coastal litter do not adversely affect the coastal and marine environment
Indicator Title	*Common Indicator 23: Trends in the amount of litter in the water column including microplastics and on the seafloor*

- Ioakeimidis C, Zeri C, Kaberi H, Galatchi M, Antoniadis K, Streftaris N, Galgani F, Papathanassiou E, Papatheodorou G. A comparative study of marine litter on the seafloor of coastal areas in the Eastern Mediterranean and Black Seas. Mar Pollut Bull. 2014;89:296–304.
- Keller, A.A., Fruh, E.L., Johnson, M.M., Simon, V., McGourty, C., 2010. Distribution and abundance of anthropogenic marine debris along the shelf and slope of the US West Coast. Mar. Pollut. Bull. 60, 692–700.
- Lundqvist, J. (2013) – Monitoring marine debris, Report of university of Gothenburg, Faculty of sciences, 22 pages.
- Pham CK, Ramirez-Llodra E, Alt CHS, Amaro T, Bergmann M, Canals M, Company JB, Davies J, Duineveld G, Galgani F, Howell KL, Huvenne VAI, Isidro E, Jones DOB, Lastras G, Morato T, Gomes-Pereira JN, Purser A, Stewart H, Tojeira I, Tubau X, Van Rooij D, Tyler PA, (2014). Marine litter distribution and density in European Seas, from the shelves to deep basins. PLoS One. 2014;9:e95839..
- Ramirez-Llodra, E., De Mol, B., Company, J. B., Coll, M., Sardà, F. (2013). Effects of natural and anthropogenic processes in the distribution of marine litter in the deep Mediterranean Sea. Progress in Oceanography, Vol. 118, pp. 273–287.
- Van Cauwenberghe, L., Claessens, M., Vandegehuchte, M.B., Mees, J., Janssen, C.R., 2013. Assessment of marine debris on the Belgian Continental Shelf. Mar. Pollut. Bull. 73, 161e169.
- Watters, D.L., Yoklavich, M.M., Love, M.S., Schroeder, D.M., 2010. Assessing marine debris in deep seafloor habitats off California. Mar. Pollut. Bull. 60, 131–138.
- Woodall, L., Sanchez-Vidal, A., Canals, M., Paterson, G., Coppock, R., Sleight, V.,et al. (2014). The deep sea is a major sink for microplastic debris. R. Soc. Open Sci. 1:140317.
- Ye S. and Andrady A.L., 1991. Fouling of floating plastic debris under Biscayne Bay exposure conditions. Mar. Pollut. Bull. 22(12), 608-613.

Policy Context and targets (other than IMAP)

Policy context description

The UN Environment / Mediterranean Action Plan Barcelona Convention Regional Plan on Marine Litter Management in the Mediterranean Region is the first ever legally binding regional plan adopted by a Regional Sea Convention (Decision IG. 21/7) that addresses marine litter management in regional level in a coherent manner and sets out legally binding measures at regional and national level, and implementation timetables. The main objectives of the ML Management Regional Plan are to prevent and reduce marine litter generation and its impact on marine and coastal environment in order to achieve good environmental status (GES) as per the relevant Mediterranean ecological objectives and ecosystem approach based Marine Litter related targets adopted by UN Environment / Mediterranean Action Plan in 2012 and 2013 during the 17th and 18th Meeting of the Contracting Parties of the Barcelona Convention consecutively. Moreover, through its Articles 11 "Assessment of marine litter in the Mediterranean" and 12 "Mediterranean Marine Litter Monitoring Programme", the Regional Plan on Marine Litter includes a series of specific provisions for the countries for monitoring and assessment of marine litter i.e. assess the state of marine litter, the impact to marine and coastal environment and human health, the socio-economic aspects of marine litter management, the development of marine litter data banks, the development of national monitoring programmes on marine litter etc.

The EU Marine Strategy Framework Directive (MSFD) (2008/56/EC) requires European Member States to develop strategies that should lead to programmes of measures to achieve or maintain Good Environmental Status (GES) in European Seas. MSFD sets the framework for Member States to achieve by 2020 GES for their marine waters, considering 11 descriptors. Descriptor 10 focuses

	Related Ecological Objective: (EO 10) Marine and coastal litter do not adversely affect the coastal and marine environment
Indicator Title	*Common Indicator 23: Trends in the amount of litter in the water column including microplastics and on the seafloor*

on marine litter, stating that GES is achieved only when "Properties and quantities of marine litter do not cause harm to the coastal and marine environment".

Indicator/Targets

UN Environment / Mediterranean Action Plan Decision IG.21/3 adopted by the 18th Meeting of the Contracting Parties of the Barcelona Convention on the Ecosystem Approach including adopting definition of GES and targets proposes as target for Indicator 10.1.2: Decreasing trend in the number of/amounts of marine litter items in the water surface and the seafloor.

Moreover, in the framework of the UN Environment / Mediterranean Action Plan Barcelona Convention Regional Plan on Marine Litter Management in the Mediterranean (Decision IG.21/7 - 18th Meeting of the Contracting Parties), a series of Marine Litter Baseline Values and Environmental Targets have been adopted by the 19th Meeting of the Contracting Meeting (Decision IG.22/10):

Baseline Values for Seafloor Marine Litter:
-   Minimum value: 0 items/km^2
-   Maximum value: 4,860,000 items/ km^2
-   Mean value: 340,000 items/ km^2
-   Proposed Baseline: 200,000 – 500,000 items/ km^2

Environmental Targets for Seafloor Marine Litter:
-   Types of Target: % of decrease
-   Minimum: Stable
-   Maximum: 10% in 5 years
-   Reduction Targets: Statistically Significant (15% in 15 years is possible)

Policy documents

-   UN Environment / Mediterranean Action Plan, Regional Plan on Marine Litter Management in the Mediterranean, Decision IG.21/7 (2013)[3].
-   UN Environment / Mediterranean Action Plan, Integrated Monitoring and Assessment Programme of the Mediterranean Sea and Coast and Related Assessment Criteria, Decision IG 22/7 (2016)[4].
-   UN Environment, Marine Litter Legislation Toolkit for Policymakers (2016)[5].
-   European Commission, Marine Strategy Framework Directive, Directive 2008/56/EC (2008)[6].
-   European Commission, Decision on criteria and methodological standards on good environmental status of marine waters (2010)[7].

Indicator analysis methods

Indicator Definition

GES Definition: Number/amount of marine litter items in the water surface and the seafloor do not have negative impacts on human health, marine life, ecosystem services and do not create risk to navigation.

---

[3] https://wedocs.unep.org/rest/bitstreams/8222/retrieve (ENG)/ https://wedocs.unep.org/rest/bitstreams/8223/retrieve (FR)
[4] https://wedocs.unep.org/rest/bitstreams/8385/retrieve
[5] http://www.unep.org/stories/Ecosystems/Marine-Litter-Legislation-A-toolkit-for-Policymakers.asp
[6] http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32008L0056&from=EN
[7] http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32010D0477(01)&from=EN

	Related Ecological Objective: (EO 10) Marine and coastal litter do not adversely affect the coastal and marine environment
Indicator Title	*Common Indicator 23: Trends in the amount of litter in the water column including microplastics and on the seafloor*

Methodology for indicator calculation

General strategies for the investigation of seabed marine litter are similar to those used to assess the abundance and type of benthic species. The most common approaches to evaluate sea-floor litter distributions use opportunistic sampling. This type of sampling is usually coupled with regular fisheries surveys (marine reserve, 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. Monitoring programmes for demersal fish stocks, undertaken as part of the Mediterranean International Bottom Trawl Surveys (MEDITS), operate at large regional scale and provide data using a harmonized protocol, which may provide a consistent support for monitoring litter at Regional scale on a regular basis and within the ECAP requirements.

Shallow sea-floor (<20m):
The most commonly used method to estimate marine litter density in shallow coastal areas is to conduct underwater visual surveys with SCUBA/snorkelling. These surveys are best based on line transect surveys of litter on the sea-floor, which is derived from UN Environment (Cheshire, 2009). The protocol is actually in use for evaluation of benthic fauna. It requires SCUBA equipment and trained observers. Only litter items above 2.5 cm are considered, between 0 and 20 m (to 40 meters with skilled divers).

Individual litter within 4 m of the line (half of the width –Wt - of the line transects) are recorded. For each observed litter item, when possible, the corresponding line segment of occurrence and its perpendicular distance from the line (y_i - for the estimation of detection probability, measured with the use of a 2 m plastic rod), and litter size category (w_i) are recorded. The nature of the bottom/habitat is also recorded. The length of the line transects vary between 20 and 200 m, depending on the depth, the depth gradient, the turbidity, the habitat complexity and the litter density (Katsavenakis, 2009). Results are expressed in litter density (items/m2 or items/ 100 m2). In distance sampling surveys, detectability is used to correct abundance estimations (Katsavenakis, 2009). The standard software for modelling detectability and estimating density/abundance, based on distance sampling surveys, is DISTANCE (Thomas et al., 2006).

Monitoring the Sea-floor (20-800m):
From all the methods assessed, trawling (otter trawl) has been shown to be the most suitable for large scale evaluation and monitoring (Goldberg, 1995, Galgani et al., 1995, 1996, 2000). Nevertheless there are some restrictions in rocky areas and in soft sediments, as the method may be restricted and/or underestimate the quantities present. This approach is however reliable, reproducible, allowing statistical processing and comparison of sites. As recommended by UN Environment (Cheshire, 2009), sites should be selected to ensure that they:

i. Comprise areas with uniform substrate (ideally sand/silt bottom);
ii. Consider areas generating/accumulating litter;
iii. Avoid areas of risk (presence of munitions), sensitive or protected areas;
iv. Do not impact on any endangered or protected species.

Sampling units should be stratified relative to sources (urban, rural, close to riverine inputs) and impacted offshore areas (major currents, shipping lanes, fisheries areas, etc.). General strategies to investigate seabed litter are similar to methodology for benthic ecology and place more emphasis on the abundance and nature of items (e.g. bags, bottles, pieces of plastics) rather than their mass. The occurrence of international bottom trawls surveys such as MEDITS (Mediterranean/Black Sea)

	Related Ecological Objective: (EO 10) Marine and coastal litter do not adversely affect the coastal and marine environment
Indicator Title	*Common Indicator 23: Trends in the amount of litter in the water column including microplastics and on the seafloor*

provide useful and valuable means for monitoring marine litter. These are using common gears depending on region (MEDITS net in the Mediterranean) and provide some harmonized and common conditions of sampling (20 mm mesh, 30-60 min tows, large sampling surface covered) and hydrographical and environmental information (surface & bottom temperature, surface & bottom salinity, surface & bottom current direction & speed, wind direction & speed, swell direction and height).

Indicator units

- Litter on the seafloor shallow coastal waters(0-20m): visually surveyed litter items size above 2.5cm
- Litter on the seafloor 20-800m: items/ha or items/km^2 of litter collected in bottom trawl surveys

List of Guidance documents and protocols available

- UN Environment / Intergovernmental Oceanographic Commission, Guidelines on Survey and Monitoring of Marine Litter" (2009).
- UN Environment / Mediterranean Action Plan, Integrated Monitoring and Assessment Programme Guidance document (2016) (UNEP(DEPI)/MED_IG/22/Inf7).
- EU MSFD TGML, Guidance on Monitoring of Marine Litter in European Seas (2013).
- International bottom trawl survey in the Mediterranean, Instructional Manual, MEDITS Working Group (2013).
- DeFishGear, Methodology for Monitoring Marine Litter on the Seafloor (continental shelf) Bottom Trawl Surveys (2016).

Data Confidence and uncertainties

Several Contracting Parties from UN Environment / Mediterranean Action Plan and its Mediterranean Pollution Assessment and Control Programme (MED POL) have indicated they will use their fish stock surveys for benthic litter monitoring. This is considered to be an adequate approach although quantities of litter might be underestimated, given restrictions in some areas. The adoption of a common protocol will lead to a significant level of standardization among the Contracting Parties countries that apply this type of sampling strategy.

Data on litter in shallow sea-floor are collected through protocols already validated for benthic species. Until now, no quality assurance programme has been considered for litter monitoring on the sea-floor. For MEDITS, sampling data are collected in the DATRAS database and participate in data quality checking for hydrographical and environmental conditions. This process may also support quality insurance for data on litter. Currently, there are on-going discussions on how to organize and harmonize a specific system to collect, validate and organize data through a common platform, enabling the review and validation of data. MEDITS has included litter data to be analysed within a specific sub-group.

Methodology for monitoring, temporal and spatial scope

Available Methodologies for Monitoring and Monitoring Protocols

Monitoring the shallow sea-floor (<20m):
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. They can access, have the skills and the equipment needed to collect, record, and share information about litter they encounter underwater. Many dive clubs and dive shops organize underwater clean-ups, often in partnerships with NGOs or local governments. Many of these events, when managed, can

	Related Ecological Objective: (EO 10) Marine and coastal litter do not adversely affect the coastal and marine environment
Indicator Title	*Common Indicator 23: Trends in the amount of litter in the water column including microplastics and on the seafloor*

be a valuable source of information and possibly be a part of a regular survey, monitoring or even assessment efforts while using volunteers.

For some Contracting Parties use of volunteer divers might be a good opportunity for shallow-water litter monitoring but standardization and conformity with common methodologies and tools such as those proposed by the EU MSFD Technical Group on Marine Litter (TGML) should be achieved. Fixed sites, common frequency and sampling methodology can be easily established by each Contracting Party and training, material distribution etc. can be achieved relatively easily when partner NGOs or research institutions are involved.

Monitoring the Sea-floor (20-800m):
Templates for data recording have been integrated in MEDITS Manuals. Data on litter should be collected on these templates using items categories such as those listed for Sea-floor prepared by TGML. Other elements from the haul operations should be also recorded – See MEDITS for the Mediterranean/Black Sea. Data on litter should be reported as items/ha or items/km^2 before further processing and reporting.

A standardized litter classification system has been defined for monitoring the sea floor by the EU MSFD TGML. The categories were defined in accordance with types of litter found at regional level, enabling common main categories for all regions. The main categories have a hierarchical system including sub categories. It considers 4 main categories of material for the Mediterranean (wood, paper/cardboard, other, unspecific). There are various subcategories for a more detailed description of litter items. Other specific categories may be added by Contracting Parties and additional description of the item may provide added-value, as long as the main categories and sub-categories are maintained. Furthermore, the weight, picture and note of potential attached organisms may further complement the classification of items.

Site information and trawling sampling characteristics such as date, position, type of trawl, speed, distance, sampled area, depth, hydrographical and meteorological conditions should be recorded. Data-sheets should be filled out for each trawl and compiled by survey. If multiple counts (transects/observers) are run at any given site then a new sheet should be used for each trawl shot. After each survey data must be aggregated for analysis and reporting.

Towed video camera for shallow waters (Lundqvist, 2013) or ROVs for deeper areas are simpler and generally cheaper and must be recommended for litter surveys. There are some available protocols where litter is counted on routes and expressed as item/km, especially when using submersibles/ROVs at variable depths above the deep sea floor (Galgani et al., 1996) however technology enables the evaluation of densities trough video-imagery using a standardized approach especially for shallow waters.

Available data sources

- DeFishGear Project: http://www.defishgear.net/
- Hellenic Centre for Marine Research (HCMR): www.hcmr.gr
- Institut français de recherche pour l'exploitation de la mer (IFREMER): http://wwz.ifremer.fr/
- International Bottom Trawl Surveys in the Mediterranean (MEDITS): http://www.sibm.it/SITO%20MEDITS/principaleprogramme.htm
- Laboratory of Marine Geology and Physical Oceanography, Department of Geology, University of Patras: http://www.oceanus.upatras.gr/?q=node/15

	Related Ecological Objective: (EO 10) Marine and coastal litter do not adversely affect the coastal and marine environment
Indicator Title	*Common Indicator 23: Trends in the amount of litter in the water column including microplastics and on the seafloor*

Spatial scope guidance and selection of monitoring stations

Monitoring the shallow sea-floor (<20m):
Surveys are conducted through 2 line transects for each site. Unbiased design-based inference requires allocating the transects randomly in the study area or on a grid of systematically spaced lines randomly superimposed. However, with a model-based approach like density surface modelling (DSM), it is not required that the line transects are located according to a formal and restrictive survey sampling scheme, although good spatial coverage of the study area is desirable. Line transect are defined with a nylon line, marked every 5 meters with resistant paints, that is deployed using a diving reel while SCUBA diving.

Monitoring the Sea-floor (20-800m):
UN Environment (Cheshire, 2009) recommends that at least 20 sampling units will be selected at regional level although a higher level of redundancy (i.e. replication) in sampling units within each region is highly recommended.

Moreover, the protocol of the EU MSFD TGML for sampling and trawling margins (20-800m) has been standardized for each region. For the Mediterranean Region, the protocol is derived from the MEDITS protocol (see the protocol manual, Bertran et al., 2007). The hauls are positioned following a depth stratified sampling scheme with random drawing of the positions within each stratum. The number of positions in each stratum is proportional to the surface of these strata and the hauls are made in the same position from year to year. The following depths (10 – 50; 50 – 100; 100 – 200; 200 – 500; 500 - 800 m) are fixed in all areas as strata limits. The total number of hauls for the Mediterranean Sea is 1385; covering the shelves and slopes from 11 countries in the Mediterranean.

Temporal Scope guidance

Monitoring the shallow sea-floor (<20m):
The minimum sampling frequency for any site should be annually. Ideally it is recommended that locations are surveyed every three months (allowing an interpretation in terms of seasonal changes).

Monitoring the Sea-floor (20-800m):
The haul duration is fixed at 30 minutes on depths less than 200m and at 60 minutes at depths over 200m (defined as the moment when the vertical net opening and door spread are stable), using the same GOC 73 trawl with 20 mm mesh nets (Bertran et al, 2007) and sampling between May and July, at 3 knots between 20 and 800 m depth.

Data analysis and assessment outputs

Statistical analysis and basis for aggregation

Basic statistics may be applied during the analysis and aggregation of the results.

Expected assessments outputs

- Assess marine litter found on the seafloor of the Mediterranean sea at basin scale;
- Assess abundance, density (items/ha or items/km^2), spatial and temporal distribution and types;
- Identify sources to target prevention and reduction measures;
- Map existing information in order to assess marine litter accumulation areas on the seafloor of the Mediterranean Sea

Known gaps and uncertainties in the Mediterranean

	Related Ecological Objective: (EO 10) Marine and coastal litter do not adversely affect the coastal and marine environment
Indicator Title	*Common Indicator 23: Trends in the amount of litter in the water column including microplastics and on the seafloor*

More than 50 studies were conducted worldwide between 2000 and 2015, but until recently very few covered extensive geographical areas or considerable depths. While there is sufficient knowledge on seafloor marine litter for the Northern part of the Mediterranean sea, however more information shall be acquired for the Southern part of the Mediterranean. Moreover, accumulation areas shall be assessed with priority on the convergence zones and deep-sea canyons.

Contacts and version Date: *UNEP/MAP 16 January 2017*

Key contacts within UN Environment for further information

- Mr Christos Ioakeimidis, Marine Litter MED Project Expert, Mediterranean Pollution Assessment and Control Programme (MED POL) (Christos.Ioakeimidis@unep.org)
- Ms Virginie Hart, Programme Officer, UN Environment / Mediterranean Action Plan, Mediterranean Pollution Assessment and Control Programme (MED POL) (Virginie.Hart@unep.org)
- Ms Tatjana Hema, Deputy Coordinator, UN Environment / Mediterranean Action Plan (Tatjana.Hema@unep.org)

Version No	**Date**	**Author**
V.1		

Common indicator 23: Trends in the amount of litter in the water column including microplastics and on the seafloor

[B] Floating Marine Litter

	Related Ecological Objective: (EO 10) Marine and coastal litter do not adversely affect the coastal and marine environment	
Indicator Title	*Common indicator 23: Trends in the amount of litter in the water column including microplastics and on the seafloor*	
Relevant GES definition	**Related Operational Objective**	**Target(s)**
Number/amount of marine litter items in the water surface and the seafloor do not have negative impact on human health, marine life, ecosystem services and do not create risk to navigation	The impacts related to properties and quantities of marine litter in the marine and coastal environment are minimized (10.1)	Decreasing trend in the number/amount of marine litter in the water surface and the seafloor.

Rationale
Justification for indicator selection

The Mediterranean Sea is often referred to as one of the places with the highest concentrations of litter in the world. For floating litter, very high levels of plastic pollution are found, but densities are generally comparable to those being reported from many coastal areas worldwide. Floating marine litter comprises the mobile fraction of debris in the marine environment, as it is less dense than seawater. However, the buoyancy and density of plastics may change during their stay in the sea due to weathering and biofouling (Barnes et al., 2009). Polymers comprise the majority of floating marine debris, with figures reaching up to 100%. Although synthetic polymers are resistant to biological or chemical degradation processes, they can be physically degraded into smaller fragments and hence turn into micro litter, measuring less than 5 mm.

Floating marine litter items of different size (micro- to macro-litter) may be found floating at sea. The transportation of floating litter particles (especially microplastics) can be considered passive, mainly subject to surface currents. Beyond vertical mixing, waves and wind also affect the horizontal transport of microplastics (GESAMP, 2016). A 30-year circulation model using various input scenarios showed the accumulation of floating debris in ocean gyres and closed seas, such as the Mediterranean Sea, made up 7-8% of the total debris expected to accumulate (Lebreton et al., 2012). Locations that are particularly susceptible to litter accumulation are as follows: i) coastal areas; ii) areas close to terrestrial sources (e.g. sewage wastewater, river); iii) depressions in the seabed; and iv) low-energy environments (low currents, weak circulation) (IMO, 2016).

Visual assessment approaches include the use of research vessels, marine mammal surveys, commercial shipping carriers, and dedicated litter observations. Aerial surveys are now being employed for larger items. Although the basic principle of floating debris monitoring through visual observation is very simple, there are few datasets available for the comparable assessment of debris abundance, and monitoring is only performed occasionally.

Scientific References

- Aliani S., Griffa A., A.Molcard (2003) Floating debris in the Ligurian Sea, north-western Mediterranean, Marine Bulletin, 46, 1142-1149.
- Barnes D.K., Galgani F., Thompson R.C., M.Barlaz (2009) Accumulation and fragmentation of plastic debris in global environments. Philosophical Transactions of the Royal Society B 364, 1985–1998. doi:10.1098/rstb.2008.0205.

	Related Ecological Objective: (EO 10) Marine and coastal litter do not adversely affect the coastal and marine environment
Indicator Title	*Common indicator 23: Trends in the amount of litter in the water column including microplastics and on the seafloor*

- Gerigny O., Henry M., Tomasino C., F.Galgani (2011). Déchets en mer et sur le fond. in rapport de l'évaluation initiale, Plan d'action pour le milieu marin - Mediterranée Occidentale, rapport PI Déchets en mer V2 MO, pp. 241-246.
- GESAMP (2016). "Sources, fate and effects of microplastics in the marine environment: part two of a global assessment" (Kershaw, P.J., and Rochman, C.M., eds). (IMO/FAO/UNESCO-IOC/UNIDO/WMO/IAEA/UN/ UNEP/UNDP Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection). Rep. Stud. GESAMP No. 93, 220 p.
- IMO (2016). Marine Litter in Wastes Dumped at Sea. Review of the Current State of Knowledge Regarding under the London Convention and Protocol. International Maritime Organization (IMO).
- Lebreton L., Greer S., J.Borrero (2012) Numerical modelling of floating debris in the world's oceans, Marine Pollution Bulletin 64, 653-661.
- Suaria G., Avio C., Lattin G., regoli F., S. Aliani (2015) Neustonic microplastics in the Southern Adriatic Sea. Preliminary results. Micro 2015. Seminar of the Defishgear projct, Abstract book, Piran 4-6 may 2015, p 42.
- Topcu T., G.Ozturk (2013) Origin and abundance of marine litter along sandy beaches of the Turkish Western Black Sea Coast. Mar. Env. Res., 85, 21-28.
- UNEP (2009), Marine Litter A Global Challenge, Nairobi: UNEP. 232 pp.

Policy Context and targets (other than IMAP)

Policy context description

The UN Environment / Mediterranean Action Plan Barcelona Convention Regional Plan on Marine Litter Management in the Mediterranean Region is the first ever legally binding regional plan adopted by a Regional Sea Convention (Decision IG. 21/7) that addresses marine litter management in regional level in a coherent manner and sets out legally binding measures at regional and national level, and implementation timetables. The main objective of the Regional Plan on Marine Litter Management in the Mediterranean is to prevent and reduce marine litter generation and its impact on marine and coastal environment in order to achieve good environmental status (GES) as per the relevant Mediterranean ecological objectives and ecosystem approach based Marine Litter related targets adopted by UN Environment / Mediterranean Action Plan in 2012 and 2013 during the 17th and 18th Meeting of the Contracting Parties of the Barcelona Convention consecutively. Moreover, through its Articles 11 "Assessment of marine litter in the Mediterranean" and 12 "Mediterranean Marine Litter Monitoring Programme", the Regional Plan on Marine Litter includes a series of specific provisions for the countries for monitoring and assessment of marine litter i.e. assess the state of marine litter, the impact to marine and coastal environment and human health, the socio-economic aspects of marine litter management, the development of marine litter data banks, the development of national monitoring programmes on marine litter etc.

The EU Marine Strategy Framework Directive (MSFD) (2008/56/EC) requires European Member States to develop strategies that should lead to programmes of measures to achieve or maintain Good Environmental Status (GES) in European Seas. MSFD sets the framework for Member States to achieve by 2020 GES for their marine waters, considering 11 descriptors; descriptor 10, focuses on marine litter, stating that GES is achieved only when "properties and quantities of marine litter do not cause harm to the coastal and marine environment".

Indicator/Targets

UN Environment / Mediterranean Action Plan Decision IG.21/3 of the 18th Meeting of the Contracting Parties of the Barcelona Convention on the Ecosystem Approach including adopting

	Related Ecological Objective: (EO 10) Marine and coastal litter do not adversely affect the coastal and marine environment
Indicator Title	*Common indicator 23: Trends in the amount of litter in the water column including microplastics and on the seafloor*

definition of GES and targets proposes as target for Indicator 10.1.2: Decreasing trend in the number of/amounts of marine litter items in the water surface and the seafloor.

Moreover, in the framework of the UN Environment / Mediterranean Action Plan Barcelona Convention Regional Plan on Marine Litter Management in the Mediterranean, adopted by the 18th Meeting of the Contracting Parties (Decision IG.21/7), a series of Marine Litter Baseline Values and Environmental Targets have been adopted by the 19th Meeting of the Contracting Parties (Decision IG.22/10):

Baseline Values for Floating Marine Litter:
- Minimum value: 0 items/km^2
- Maximum value: 195 items/ km^2
- Mean value: 3.9 items/ km^2
- Proposed Baseline: 3-5 items/ km^2

Environmental Targets for Floating Marine Litter:
- Types of Target: % of decrease
- Minimum: -
- Maximum: -
- Reduction Targets: Statistically Significant

Baseline Values for Floating Microplastics:
- Minimum value: - items/km^2
- Maximum value: 4,860,000 items/ km^2
- Mean value: 340,000 items/ km^2
- Proposed Baseline: 200,000 – 500,000 items/ km^2

Environmental Targets for Floating Microplastics:
- Types of Target: % of decrease
- Minimum: -
- Maximum: -
- Reduction Targets: Statistically Significant

Policy documents

- UN Environment / Mediterranean Action Plan, Regional Plan on Marine Litter Management in the Mediterranean, Decision IG.21/7 (2013)[8].
- UN Environment / Mediterranean Action Plan, Integrated Monitoring and Assessment Programme of the Mediterranean Sea and Coast and Related Assessment Criteria, Decision IG.22/7 (2016)[9].
- UN Environment, Marine Litter Legislation Toolkit for Policymakers (2016)[10].
- European Commission, Marine Strategy Framework Directive, Directive 2008/56/EC (2008)[11].
- European Commission, Decision on criteria and methodological standards on good environmental status of marine waters (2010)[12].

---

[8] https://wedocs.unep.org/rest/bitstreams/8222/retrieve (ENG) / https://wedocs.unep.org/rest/bitstreams/8223/retrieve (FR)
[9] https://wedocs.unep.org/rest/bitstreams/8385/retrieve
[10] http://www.unep.org/stories/Ecosystems/Marine-Litter-Legislation-A-toolkit-for-Policymakers.asp
[11] http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32008L0056&from=EN
[12] http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32010D0477(01)&from=EN

	Related Ecological Objective: (EO 10) Marine and coastal litter do not adversely affect the coastal and marine environment
Indicator Title	*Common indicator 23: Trends in the amount of litter in the water column including microplastics and on the seafloor*

Indicator analysis methods

Indicator Definition

GES Definition: Number/amount of marine litter items in the water surface and the seafloor do not have negative impacts on human health, marine life, ecosystem services and do not create risk to navigation.

Methodology for indicator calculation

The reporting of monitoring results requires the grouping into categories of material, type and size of litter object. The approach for categories of floating litter is linked with the development of a "master list" with the categories (Artificial Polymer Materials, Rubber, Cloth/Textile, Paper/Cardboard, Processed/Worked Wood, Metal, Glass/Ceramics) for other environmental compartments such as the "master list" prepared by the EU MSFD TGML. This allows cross comparisons. For the practical use during the monitoring the list has to be arranged by object occurrence frequency so that the data acquisition can be done in the required short time. As floating litter items will be observed but not collected, the size is the only indicative parameter of the amount of plastic material that it contains. The size of an object is defined here as its largest dimension, width or length, as visible during the observation.

The lower size limit for the observations is determined by the observation conditions. A lower size limit that appears to be reasonable for observation from "ships-of-opportunity" and is in line with the size for beach litter surveys is probably the 2.5 cm. This denotes that observations not achieving this minimum size limit cannot be recommended. For reporting purposes size range classes must be introduced as visual observation will not permit the correct measuring of object sizes. Only the estimation of size classes is feasible. The size determination/reporting scheme should enclose the following classes: 2.5 – 5 cm, 5 - 10 cm, 10 – 20 cm, 20 – 30 cm, 30 – 50 cm. While also wider size range classes (e.g. 2.5–10cm, 10–30cm, 30–50 cm) could be utilized, it will be important that a common approach is used, as the data will be combined in common data bases. The upper size limit will have to be determined by statistical calculations regarding the density of the object occurrence in comparison to transect width, length and frequency. In coherence with the beach litter surveys an upper limit of 50 cm is here provisionally proposed. It has to be evaluated in experiments and from initial data sets if items larger than 50 cm should be reported, as their relevance in the statistical evaluation of data from short and narrow coastal transects might be questionable.

Indicator units

For floating marine litter the unit of reporting will be items of floating litter, 2.5 to 50 cm per km². The data will be available for the different categories and size classes.

List of Guidance documents and protocols available

- UN Environment / Intergovernmental Oceanographic Commission, Guidelines on Survey and Monitoring of Marine Litter (2009).
- UN Environment / Mediterranean Action Plan, Integrated Monitoring and Assessment Programme Guidance document (2016) (UNEP(DEPI)/MED_IG.22/Inf.7).
- EU MSFD TGML, Guidance on Monitoring of Marine Litter in European Seas (2013).
- DeFishGear project "Methodology for Monitoring Marine Litter on the Sea Surface Visual observation" (2015).

Data Confidence and uncertainties

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

	Related Ecological Objective: (EO 10) Marine and coastal litter do not adversely affect the coastal and marine environment
Indicator Title	*Common indicator 23: Trends in the amount of litter in the water column including microplastics and on the seafloor*

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

The widespread acquisition of monitoring data will need some kind of inter-comparison or calibration in order to ensure comparability of data between different areas and over time, for trend assessments. Approaches for this should be developed and implemented. This can be hands (eyes)–on training courses with comparisons of observations. Such events should be organized at Regional level with further implementation at national scale. A methodology for calibrating observation quality by artificial targets may be devised through research efforts.

Methodology for monitoring, temporal and spatial scope

Available Methodologies for Monitoring and Monitoring Protocols

A harmonized approach for the quantification of floating marine litter by ship-based observers has been developed by the EC MSFD Technical Group on Marine Litter (TGML). It has the scope to harmonize the monitoring of floating marine litter:

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

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

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

The ideal location for observation will often be in the bow area of the ships. If that area is not accessible, the observation point should be selected so that the target size range can be observed, eventually reducing the observation corridor, as ship induced waves might interfere with the observations. An inclinometer can be used to measure distances at sea (Doyle, 2007).

The protocol will have to go through an experimental implementation phase during which it is applied in different sea regions by different institutions, its practicality is tested and feedback for definition of observation parameters is provided.

	Related Ecological Objective: (EO 10) Marine and coastal litter do not adversely affect the coastal and marine environment
Indicator Title	*Common indicator 23: Trends in the amount of litter in the water column including microplastics and on the seafloor*

The observation, quantification and identification of floating litter items must be made by a dedicated observer who does not have other duties contemporaneously. Observation for small items and surveying intensively the sea surface leads to fatigue and consequently to observation errors. The transect lengths should therefore be selected in a way that observation times are not too long. Times of 1 h for one observer could be reasonable, corresponding to a length of a few kilometres.

Available data sources

- DeFishGear Project: http://www.defishgear.net/
- Hellenic Marine Environment Protection Association (HELMEPA): http://www.helmepa.gr/en/home.php\

Spatial scope guidance and selection of monitoring stations

The monitoring of floating marine litter by human observers is a methodology indicated for short transects in selected areas. In a region with little or no information about floating marine litter abundance it might be advisable to start by surveys in different areas in order to understand the variability of litter distribution. The selected areas should include expected low density areas (e.g. open sea) as well as expected high density areas (e.g. close to ports). This will help to obtain maximum/minimum conditions and train the observers. Other selected areas (e.g. in estuaries), in the vicinity of cities, in local areas of touristic or commercial traffic, incoming currents from neighbouring areas or outgoing currents should be considered. Based on the experience obtained in this initial phase, a routing programme including areas of interest should then be established.

Temporal Scope guidance

The observation of floating marine litter is much depending on the observation conditions, in particular on the sea state and wind speed. The organization of monitoring must be flexible enough to take this into account and to re-schedule observations in order to meet appropriate conditions. Ideally the observation should be performed after a minimum duration of calm sea, so that there is no bias by litter objects which have been mixed into the water column by recent storms or heavy sea.
The initial, investigative monitoring should be performed with a higher frequency in order to understand the variability of litter quantities in time. Even burst sampling, i.e. high sampling frequency over short period, might be appropriate in order to understand the variability of floating marine litter occurrence.

For trend monitoring the timing will depend on the assumed sources of the litter, this can be e.g. monitoring an estuary after a rain period in the river basin, monitoring a touristic area after a holiday period. The timing of the surveys will also depend on the schedule of the observation platforms. Regular patrols of coast guard ships, ferry tracks or touristic trips may offer frequent opportunities which thus also allow the use during the needed calm weather conditions.

Data analysis and assessment outputs

Statistical analysis and basis for aggregation

No specific statistical tool is required for the analysis of the observed floating marine litter items. However, it is not uncommon that floating marine litter items appear grouped, either because they have been released together or because they accumulate on oceanographic fronts. The reporting system should acknowledge this and foresee a way to report such groups. The occurrence of such accumulation areas needs to be considered when evaluating the data. Along with the litter occurrence data, a series of metadata should be recorded, including geo-referencing (coordinates)

	Related Ecological Objective: (EO 10) Marine and coastal litter do not adversely affect the coastal and marine environment
Indicator Title	*Common indicator 23: Trends in the amount of litter in the water column including microplastics and on the seafloor*

and wind speed (m/s). This accompanying data shall allow the evaluation of the data in the correct context.

Expected assessments outputs

- Assess accumulation zones for floating marine litter items;
- Assess abundance, density and types of floating marine litter items in a more precise way;
- Information on the degradation process;
- Comparison with marine litter found in other sea compartments.
-

Known gaps and uncertainties in the Mediterranean

Only a few studies have been published on the abundance of floating macro and mega debris in Mediterranean waters (Aliani et al., 2003; UNEP, 2009; Topcu et al., 2010, Gerigny et al., 2011, Suaria and Aliani, 2015), and the reported quantities measuring over 2 cm range widely from 0 to over 600 items per square kilometer. So the abundance of floating marine litter in the Mediterranean Sea cannot be estimated with accuracy. Moreover we still have no information on the accumulation zones for floating marine litter items.

Contacts and version Date: *UNEP/MAP 16 January 2017*

Key contacts within UN Environment for further information

- Mr Christos Ioakeimidis, Marine Litter MED Project Expert, Mediterranean Pollution Assessment and Control Programme (MED POL) (Christos.Ioakeimidis@unep.org)
- Ms Virginie Hart, Programme Officer, UN Environment / Mediterranean Action Plan, Mediterranean Pollution Assessment and Control Programme (MED POL) (Virginie.Hart@unep.org)
- Ms Tatjana Hema, Deputy Coordinator, UN Environment / Mediterranean Action Plan (Tatjana.Hema@unep.org)

Version No	Date	Author
V.1		

Candidate Common indicator 24: Trends in the amount of litter ingested by or entangling marine organisms, especially mammals, marine birds and turtles

	Related Ecological Objective: (EO 10) Marine and coastal litter do not adversely affect the coastal and marine environment	
Indicator Title	*Candidate Common indicator 24: Trends in the amount of litter ingested by or entangling marine organisms, especially mammals, marine birds and turtles*	
Relevant GES definition	**Related Operational Objective**	**Target(s)**
	Impacts of litter on marine life are controlled to the maximum extent practicable (10.2)	Decreasing trend in the cases of entanglement or/and a decreasing trend in the stomach content of the sentinel species.
Rationale		

Justification for indicator selection

As marine litter affects different ecological compartments, the study of its impact on marine biota of all trophic levels on the same temporal and spatial scale is of increasing importance. More than 800 marine and coastal species are affected by marine debris through ingestion, entanglement, ghost-fishing and dispersal by rafting as well as habitat effects. More than 500 marine and coastal species are affected by ingestion of, or entanglement in, marine debris, which includes the effects of ghost fishing. The number of seabird and marine mammal species affected by marine debris ingestion or entanglement is steadily rising. Moreover, microplastics are present in all marine habitats and from the ocean surface to the seabed, and are available to every level of the food web, from primary producers to higher trophic levels (GESAMP, 2015). Microplastics are also providing a new habitat in the oceans for microbial communities, although the effects on ocean ecosystems and processes are not yet understood (CBD, 2016).

With regard to biodiversity, it is essential to focus research on sensitive species such as turtles, marine mammals, seabirds, and filter feeders, invertebrates or fish that may be ingest micro plastics. Protocols also have to be developed in order to assess early warning effects on key species and key habitats (Deudero & Alomar, in CIESM, 2014). The effect of marine litter on marine populations is difficult to quantify, as an unknown number of marine animals die at sea and may quickly sink or be consumed by predators, eliminating them from potential detection. New methods for the unbiased estimation of mortality rates and the effects on the population dynamics of many affected species are urgently needed.

In the North Sea, an indicator is available, which expresses the impact of marine litter (OSPAR EcoQO). It measures ingested litter in Northern Fulmar and it is used to assess temporal trends, regional differences and compliance with a set target for acceptable ecological quality in the North Sea area (Van Franeker et al., 2011). A combined protocol is also proposed by the EU Marine Strategy Framework Directive (MSFD) Technical Group on Marine Litter (TGML) which can be used for seabirds in general. However alternative tools are needed for the Mediterranean Sea.

On the basis of available information and expertise, a monitoring protocol for marine litter in sea turtles with focus on relevant parameters for application in the Mediterranean Sea is proposed by the EU MSFD TGML. The loggerhead sea turtle (*Caretta caretta*) is the most abundant chelonian in the Mediterranean (Camedda et al., 2014; Casale and Margaritoulis, 2010) and may ingest plastic bags mistaken for jellyfishes (Mrosovsky et al., 2009) when they feed in neritic and offshore habitats. This is a very sensitive species to marine litter and one of the most studied. Despite the fact that the loggerhead is able to ingest any kind of waste, plastic items seem to be more significant than other kinds of marine litter. Different studies in the Mediterranean Sea (Lazar and Gracan, 2011; Campani et al., 2013, Camedda et al., 2014), as well as for other seas and oceans, demonstrated that plastic is the most frequently ingested anthropogenic debris. There is no difference in litter found in stranded sea turtles when compared with those excreted by hospitalized

	Related Ecological Objective: (EO 10) Marine and coastal litter do not adversely affect the coastal and marine environment
Indicator Title	*Candidate Common indicator 24: Trends in the amount of litter ingested by or entangling marine organisms, especially mammals, marine birds and turtles*

ones (Cameda et al., 2014), with analyses showing homogeneity in relation of the total abundance, weight, and composition among alive and dead individuals.

Entanglement in beached animals, entanglement in live animals (others than in relation to seabird nests), ingestion of litter by marine mammals, ingestion of litter by marine invertebrates and research on food chain transfer are reflected in the final report of the EU MSFD TGML. However only ingestion of and entanglement in marine litter by marine mammals are considered by the EU MSFD TGML for further development whereas the other aspects are crucial issues for research but not suitable to be recommended for wide monitoring application at this stage.

Scientific References

- Camedda A., Marra S., Matiddi M., Massaro G., Coppa S., Perilli A., Ruiu A., Briguglio P., G.De Lucia (2014). Interaction between loggerhead sea turtles (Caretta caretta) and marine litter in Sardinia (Western Mediterranean Sea). Marine Environmental Research, 100, 25-32.
- Campani T., Baini M., Giannetti M., Cancelli F., Mancusi C., Serena F., Marsili L., Casini S., M.C. Fossi (2013) Presence of plastic debris in loggerhead turtle stranded along the Tuscany coasts of the Pelagos Sanctuary for Mediterranean Marine Mammals (Italy). Mar. Pollut. Bull. 74, 225-230.
- Casale P., D.Margaritoulis (2010) Sea Turtles in the Mediterranean: Distribution, Threats and Conservation Priorities. IUCN: Gland, Switzerland. 304 pages.
- CBD (2016). Marine Debris: Understanding, Preventing and Mitigating the Significant Adverse Impacts on Marine and Coastal Biodiversity. Technical Series No.83. Secretariat of the Convention on Biological Diversity, Montreal, 78 pages.
- Deudero S., C. Alomar (2014) Revising interactions of plastics with marine biota: evidence from the Mediterranean. CIESM worshoP "Marine Litter in the Mediterranean an Black Seas". CIESM ed., Tirana, Albania, 18 - 21 June 2014, 79-86 (http://www.ciesm.org/online/monographs/).
- GESAMP (2015). "Sources, fate and effects of microplastics in the marine environment: a global assessment" (Kershaw, P. J., ed.). (IMO/FAO/UNESCO-IOC/UNIDO/WMO/IAEA/UN/UNEP/UNDP Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection). Rep. Stud. GESAMP No. 90, 96 p.
- Lazar B., R.Gracan (2011) Ingestion of marine debris by loggerhead sea turtle, Caretta caretta in the Adriatic Sea. Mar. Pollut. Bull. 62, 43-47.
- Mrosovsky N., Ryan G.D., A.James (2009) Leatherback turtles: the menace of plastic. Mar. Pollut. Bull. 58, 287-289.
- Van Franeker J.A., Blaize C., Danielsen J., Fairclough K., Gollan J., Guse N., Hansen P.L., Heubeck M., Jensen J.-K., Le Guillou G., Olsen B., Olsen K.O., Pedersen J., Stienen E.W.M., Turner D.M. (2011). Monitoring plastic ingestion by the northern fulmar Fulmarus glacialis in the North Sea. Environ. Pollut., 159 (2011), pp. 2609–2615

Policy Context and targets (other than IMAP)

Policy context description

The UN Environment / Mediterranean Action Plan Barcelona Convention Regional Plan on Marine Litter Management in the Mediterranean Region is the first ever legally binding regional plan adopted by a Regional Sea Convention (Decision IG. 21/7) that addresses marine litter management in regional level in a coherent manner and sets out legally binding measures at regional and national level, and implementation timetables. The main objectives of the ML Management Regional Plan are to prevent and reduce marine litter generation and its impact on marine and coastal environment in order to achieve good environmental status (GES) as per the relevant Mediterranean ecological objectives and ecosystem approach based Marine Litter related targets

	Related Ecological Objective: (EO 10) Marine and coastal litter do not adversely affect the coastal and marine environment
Indicator Title	*Candidate Common indicator 24: Trends in the amount of litter ingested by or entangling marine organisms, especially mammals, marine birds and turtles*

adopted by UN Environment / Mediterranean Action Plan in 2012 and 2013 during the 17th and 18th Meeting of the Contracting Parties of the Barcelona Convention consecutively.

The EU MSFD (2008/56/EC) requires European Member States to develop strategies that should lead to programmes of measures to achieve or maintain Good Environmental Status (GES) in European Seas. MSFD sets the framework for Member States to achieve by 2020 GES for their marine waters, considering 11 descriptors. Descriptor 10 focuses on marine litter, stating that GES is achieved only when "Properties and quantities of marine litter do not cause harm to the coastal and marine environment".

Indicator/Targets

UN Environment / Mediterranean Action Plan Decision IG.21/3 of the 18th Meeting of the Contracting Parties of the Barcelona Convention on the Ecosystem Approach including adopting definition of GES and targets proposes as target for Indicator 10.2: Decreasing trend in the cases of entanglement or/and a decreasing trend in the stomach content of the sentinel species.

Moreover, in the framework of the UN Environment / Mediterranean Action Plan Barcelona Convention Regional Plan on Marine Litter Management in the Mediterranean, adopted by the 18th Meeting of the Contracting Parties (Decision IG.21/7), a series of Marine Litter Baseline Values and Environmental Targets have been adopted by the 19th Meeting of the Contracting Parties (Decision IG.22/10):

Baseline Values for Affected Sea Turtles (%):
- Minimum value: 14%
- Maximum value: 92.5%
- Mean value: 45.9%
- Proposed Baseline: 40-60%

Environmental Targets for Affected Sea Turtles (%):
- Types of Target: % of decrease in the rate of affected animals
- Minimum: -
- Maximum: -
- Reduction Targets: Statistically Significant

Baseline Values for Ingested Marine Litter (gr):
- Minimum value: 0 gr
- Maximum value: 14 gr
- Mean value: 1.37 gr
- Proposed Baseline: 1-3 gr

Environmental Targets for Ingested Marine Litter (gr):
- Types of Target: % decrease in quantity of ingested weight (gr)
- Minimum: -
- Maximum: -
- Reduction Targets: Statistically Significant

Policy documents
- UN Environment / Mediterranean Action Plan, Regional Plan on Marine Litter Management in the Mediterranean, Decision IG.21/7 (2013)[13].

---

[13] https://wedocs.unep.org/rest/bitstreams/8222/retrieve (ENG) / https://wedocs.unep.org/rest/bitstreams/8223/retrieve (FR)

	Related Ecological Objective: (EO 10) Marine and coastal litter do not adversely affect the coastal and marine environment
Indicator Title	*Candidate Common indicator 24: Trends in the amount of litter ingested by or entangling marine organisms, especially mammals, marine birds and turtles*

- UN Environment / Mediterranean Action Plan, Integrated Monitoring and Assessment Programme of the Mediterranean Sea and Coast and Related Assessment Criteria, Decision IG.22/7 (2016)[14].
- UN Environment, Marine Litter Legislation Toolkit for Policymakers (2016)[15].
- European Commission, Marine Strategy Framework Directive, Directive 2008/56/EC (2008)[16].
- European Commission, Decision on criteria and methodological standards on good environmental status of marine waters (2010)[17].

Indicator analysis methods	
Indicator Definition	

Methodology for indicator calculation

Seabirds:
The methodology of the tool proposed by the EU MSFD TGML follows the OSPAR Ecological Quality Objective (EcoQO) methods for monitoring litter particles in stomachs of northern fulmars (*Fulmarus glacialis*). The stomach contents of birds beached or otherwise found dead are used to measure trends and regional differences in marine litter. Background information and the technical requirements are described in detail in documents related to the fulmar EcoQO methodology. A pilot study evaluating methods and potential sources of bias was conducted by Van Franeker & Meijboom (2002). Bird dissection procedures including characters for age, sex, cause of death etc. have been specified in Van Franeker (2004). Further OSPAR EcoQO details were given in OSPAR (2008, 2010a, b) and in Van Franeker et al., (2011a, 2011b).

Sea Turtles:
The stomach contents of stranded Loggerhead sea turtles Caretta caretta (Linnaeus, 1758) are used to measure trends and regional differences in marine litter. A recent pilot study evaluating methods and potential sources of bias was conducted during 2012 by ISPRA, CNR-IAMC Oristano, Stazione Zoologica Napoli; University of Siena, University of Padova, ArpaToscana. Caretta caretta feeds in the water column and at the seafloor. Therefore these two marine compartments are addressed when quantifying litter in the stomachs of stranded Loggerhead sea turtles.

Entanglement rates among beached animals:
Direct harm or death is more easily observed and thus more frequently reported for entanglement than for ingestion of litter. This applies to all sorts of organisms, marine mammals, birds, turtles, fishes, crustaceans etc. It is, however, difficult from simply looking at the outside appearance of an animal to identify whether a particular individual has died because of entanglement in litter rather than from other causes, mainly entanglement in active fishery gear (by-catch). Nevertheless it is possible to differentiate between animals that have died quickly due to entanglement and sudden death in active fishing gear and those suffering a long drawn out death after entanglement in pieces of nets, string or other litter items, because entangled birds, which have been entangled for a time before death are emaciated.

Proportions of sea birds found dead with actual remains of litter attached as evidence for the cause of mortality are extremely low. The possible use of entangled beached birds as an indication of mortality due to litter will be further investigated by the EU MSFD TGML.

---

[14] https://wedocs.unep.org/rest/bitstreams/8385/retrieve
[15] http://www.unep.org/stories/Ecosystems/Marine-Litter-Legislation-A-toolkit-for-Policymakers.asp
[16] http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32008L0056&from=EN
[17] http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32010D0477(01)&from=EN

	Related Ecological Objective: (EO 10) Marine and coastal litter do not adversely affect the coastal and marine environment
Indicator Title	*Candidate Common indicator 24: Trends in the amount of litter ingested by or entangling marine organisms, especially mammals, marine birds and turtles*

In marine mammals, numbers of beached animals and especially cetaceans are often high and many have body marks suggesting entanglement, although remains of ropes or nets on the corpses are mostly rare. Given that in a number of places well working stranding networks are already in place, dead marine mammals should, whenever possible, become subject to pathologic investigations which need to include an assessment for the cause of disease and death and the relevance of marine litter in this connection.

This issue will be further investigated and the development of a dedicated monitoring protocol for the entanglement of marine mammals in marine litter will be considered in the next report of the EU MSFD TGML.

Ingestion of litter by marine mammals and entanglement:
Ingestion of litter by a wide range of whales and dolphins is known. Although known rates of incidences of ingested litter are generally low to justify a standard ECAP monitoring recommendation at this point, it can also be argued that the number of pathologically studied animals is low as well. Dead marine mammals should, whenever possible, become subject to pathologic investigations which need to include an assessment for the cause of disease and death and the relevance of ingested marine macro- and microlitter in this connection.

The development of a monitoring protocol for the ingestion of marine litter in the different size categories by marine mammals will therefore be considered in the next report of the TSG ML. Opportunistic monitoring of marine mammals is envisaged under the population demographic characteristics component of the EcAp biodiversity common indicators.\

Indicator units

- For sea turtles: Abundance by mass (weight in grams, accurate to 3th decimal) is the main information useful for the monitoring programme.

List of Guidance documents and protocols available

- UN Environment / Intergovernmental Oceanographic Commission, Guidelines on Survey and Monitoring of Marine Litter (2009).
- UN Environment / Mediterranean Action Plan, Integrated Monitoring and Assessment Programme Guidance document (2016) (UNEP(DEPI)/mED_IG.22/Inf.7).
- EU MSFD TGML, Guidance on Monitoring of Marine Litter in European Seas (2013).

Data Confidence and uncertainties

Seabirds:
The methodology referred to in this tool is based on an agreed OSPAR methodology which has been developed over a number of years with ICES and OSPAR and which has received full quality assurance by publication in peer reviewed scientific literature (Van Franeker et al., 2011a). The EcoQO methodology has been fully tested an implemented on Northern Fulmars Fulmarus glacialis, including those from Canadian Arctic and northern Pacific areas. All methodological details can be applied to other tubenosed seabirds (Procellariiformes) with no or very minor modifications. Trial studies are being conducted using shearwaters from the more southern parts of the north Atlantic and Mediterranean. In other seabird families, methods may have to be adapted as stomach morphology, foraging ecology, and regurgitation of indigestible stomach contents differ and can affect methodological approaches.

	Related Ecological Objective: (EO 10) Marine and coastal litter do not adversely affect the coastal and marine environment
Indicator Title	*Candidate Common indicator 24: Trends in the amount of litter ingested by or entangling marine organisms, especially mammals, marine birds and turtles*

Sea turtles:

There is a lack of quality assurance/quality control (QA/QC) due to lack of long-term monitoring programmes. More publications in peer reviewed scientific literature are required.

Methodology for monitoring, temporal and spatial scope

Available Methodologies for Monitoring and Monitoring Protocols

Seabirds:

Bird corpses are stored frozen until analysis. Standardized dissection methods for Fulmar corpses have been published in a dedicated manual (Van Franeker, 2004) and are internationally calibrated during annual workshops. Stomach content analyses and methods for data processing and presentation of results were described in full detail in Van Franeker & Meijboom (2002) and updated in later reports (van Franeker et al., 2011a, b). At dissections, a full series of data is recorded to determine sex, age, breeding status, likely cause of death, origin, and other issues. Age, the only variable found to influence litter quantities in stomach contents, is largely determined on the basis of development of sexual organs (size and shape) and presence of Bursa of Fabricius (a gland-like organ positioned near the end of the gut which is involved in immunity systems of young birds; it is well developed in chicks, but disappears within the first year of life or shortly after). After dissection, stomachs of birds are opened for analysis. Stomachs of Fulmars have two 'units': initially food is stored and starts to digest in a large glandular stomach (the proventriculus) after which it passes into a small muscular stomach (the gizzard) where harder prey remains can be processed through mechanical grinding. For the purpose of most cost-effective monitoring, the contents of proventriculus and gizzard are combined, but optional separate recordings should be considered where possible.

Stomach, contents are carefully rinsed in a sieve with a 1mm mesh and then transferred to a petri dish for sorting under a binocular microscope. The 1 mm mesh is used because smaller meshes become easily clogged with mucus from the stomach wall and with food-remains. Analyses using smaller meshes were found to be extremely time consuming and particles smaller than 1 mm seemed rare in the stomachs, contributing little to plastic mass.

If oil or chemical types of pollutants are present, these may be sub-sampled and weighed before rinsing the remainder of stomach content. If sticky substances hamper further processing of the litter objects, hot water and detergents are used to rinse the material clean as needed for further sorting and counting under a binocular microscope.

In the Fulmar EcoCO, stomach contents are sorted into categories, and this categorisation is followed for marine biota monitoring ingestion in seabirds, marine turtles and fish. The fulmar categorisation of stomach contents is based on the general 'morphs' of plastics (sheet-like, filament, foamed, fragment, other) or other general rubbish or litter characteristics. This is because in most cases, particles cannot be unambiguously linked to particular objects. But where such is possible, under notes in datasheets, the items should be described and assigned a litter category number using as master list, such as the "Master List" developed by the EU MSFD TGML group. For each litter category/subcategory an assessment is made of:
  i.   Incidence (percentage of investigated stomachs containing litter);
  ii.   Abundance by number (average number of items per individual), and
  iii. abundance by mass (weight in grams, accurate to 4th decimal)

In the fulmar monitoring scheme, stomach contents are rinsed over a sieve with mesh 1 mm prior to further categorisation, counting and weighing. The size range of plastics monitored is thus ≥ 1 mm.

	Related Ecological Objective: (EO 10) Marine and coastal litter do not adversely affect the coastal and marine environment
Indicator Title	*Candidate Common indicator 24: Trends in the amount of litter ingested by or entangling marine organisms, especially mammals, marine birds and turtles*

Unpublished data on particle size details in stomachs of fulmars show that a smaller mesh size would not be of use because smaller items have passed into the gut.

Sea Turtle:

The Loggerhead sea turtle Caretta caretta is a protected species (CITES), therefore only authorized people can handle them. Upon finding the animal, its discovery should be reported to the main authorities and the operation of coordinated with the local authorities (depending on national law). Based on initial observations and if possible still at the place of discovery, some data should be recorded on an "Identification Data" Sheet. The animal should be transported to an authorized service centre for necropsy. In case the body is too decomposed, the integrity of the digestive tract should be assessed before disposal at the licensed contractor. If the necropsy cannot be carried out immediately after recovery, the carcass should be frozen at -16 ° C, in the rehabilitation facility.

Before the necropsy operation, morphometric measurements should be collected and recorded on an appropriate Data Sheet. External examination of the animal should be conducted, including inspecting the oral cavity for possible presence of foreign material. The methodology suggested in the EU MSFD TGML report could be followed to carry out a dissection of the animal to expose the gastrointestinal system (GI). The following sampling procedure of GI contents can be applied to any section of the GI: the section of the GI should be placed in a graduated beaker of adequate size, pre-weighed on electronic balance (accuracy of $\pm$ 1g). The section of GI should be open and the contents emptied into the beaker with the help of a spatula, followed by the record of the net weight and volume of the content. The section of the GI should be observed and any ulcers or any lesions caused by hard plastic items should be recorded.

The contents should be inspected for the presence of any tar, oil, or particularly fragile material that must be removed and treated separately. The liquid portion, mucus and the digested unidentifiable matter should be removed, by washing the contents with freshwater through a filter mesh 1 mm, followed by a rinse of all the material collected by the filter 1mm in 70% alcohol and finally again in freshwater. The retained content should be enclosed in plastic bags or pots, labelled and frozen, not forgetting the sample code and corresponding section of the GI. Finally, the contents can then be sent for analysis. If the contents are stored in liquid fixative, note of the compound and the percentage of dilution should be noted and communicated to the staff in charge of further analysis.

For the analysis of the contents of the GI, the organic component should be separated from any other items or material (marine litter). The fraction of marine litter should be analysed and categorised with the help of a stereo-microscope, following the approach used in the protocol for ingestion in birds (Van Franeker et al., 2005; 2011b; Matiddi et al., 2011) and using a Standard Data-Sheet.

The fraction of marine litter should be dried at room temperature and the organic fraction at 30°C. Both fractions should be weighted, including the different categories of items identified within the marine litter fraction. The volume of the litter found should also me measured, through the variation of water level in a graduated beaker, when the items are immersed without air. If possible, different categories of "food" should also be identified. Otherwise, the dry contents should be kept in labelled bags and sent to an expert taxonomist. An optional methodology for application for sampling litter excreted by live sea-turtles (faecal pellet analysis) in case of finding a specimen alive is recommended by the EU MSFD TGML.

For turtle analyses, stomach contents are sorted into the same categories as for birds. Following the method for seabirds, abundance by mass (weight in grams, accurate to 3th decimal) is the main information useful for the monitoring programme. Other information such as the colour of items, volume of litter, different type of litter, different incidence of litter in oesophagus, intestine and

	Related Ecological Objective: (EO 10) Marine and coastal litter do not adversely affect the coastal and marine environment
Indicator Title	*Candidate Common indicator 24: Trends in the amount of litter ingested by or entangling marine organisms, especially mammals, marine birds and turtles*

stomach, incidence and abundance by number per litter category, are useful for research and impact analysis. The size range should be ≥1 mm (stomach contents are rinsed over 1 mm mesh sieve).

Available data sources

- Mediterranean Association to Save the Sea Turtles (MEDASSET): http://www.medasset.org

Spatial scope guidance and selection of monitoring stations

Seabirds:
Dead birds are collected from beaches or from accidental mortalities such as long-line victims; fledgling road kills etc. (for methodology see Van Franeker, 2004). The tool is applicable to the regions where fulmars occur; for similar seabird species such as any of the family of the tubenoses, the methodology can follow this approach. This could for example be applied to shearwater species occurring in the Mediterranean Sea.

Sea turtles:
Dead sea turtles are collected from beaches or at sea from accidental mortalities such as victims of long-line fishing (by catch) or of boat collisions. The tool is applicable to the Mediterranean Sea region.

Temporal Scope guidance

Seabirds:
Continuous sampling is required. A sample size of 40 birds or more is recommended for a reliable annual average for a particular area. However, also years of low sample size can be used in the analysis of trends as these are based on individual birds and not on annual averages. For reliable conclusions on change or stability in ingested litter quantities, data over periods of 4 to 8 years (depending on the category of litter) is needed.

Sea turtles:
Continuous sampling is required. Minimum sample population size for year and period of sampling must be established for reliable conclusions on change or stability in ingested litter quantities.

Data analysis and assessment outputs

Statistical analysis and basis for aggregation

Seabirds:
Because of potential variations in annual data, it is recommended to describe 'current levels' as the average for all data from the most recent 5-year period, in which the average is the 'population average' which includes individuals that were found to have zero litter in the stomach.
As indicated, EcoQO data presentation for Northern Fulmars is for the combined contents of glandular (proventriculus) and muscular (gizzard) stomachs. Results of age groups are combined except for chicks or fledglings which should be dealt with separately. Potential bias from age structure in samples should be checked regularly.

In the Fulmar EcoQO, statistical significance of trends in ingested litter, i.e. plastics, is based on linear regression of ln-transformed data for the mass of litter (of a chosen category) in individual stomachs against their year of collection. 'Recent' trends are defined as derived from all data over the most recent 10-year period. The Fulmar EcoQO focuses on trend analyses for industrial plastics, user plastics, and their combined total.

	Related Ecological Objective: (EO 10) Marine and coastal litter do not adversely affect the coastal and marine environment
Indicator Title	*Candidate Common indicator 24: Trends in the amount of litter ingested by or entangling marine organisms, especially mammals, marine birds and turtles*

Sea turtles:
Specific long-term monitoring programmes are required in order to assess trends.

Expected assessments outputs

- Develop an Ecological Quality Objective (ECOQ) for the ingestion of litter in indicator species suitable for monitoring (sea turtles) and support implementation of the monitoring of this indicator (capacity building, technology transfer).
- Identify new indicator species for impact (entanglement, ingestion, microplastics, and rafted species) through laboratory and field evaluation, and define thresholds for harm.

Known gaps and uncertainties in the Mediterranean

- A better understanding of entanglement (lethal or sub lethal) under different environmental conditions and of how litter is ingested by marine organisms is necessary;
- For ingestion of litter by sea turtles, the precise definition of target (GES) and the identification of parameters/biological constrains and possible bias sources should be better exploited;
- Work on other "sentinel" species (fishes and invertebrates) should be promoted to provide additional protocols supporting the measurement of impacts;
- New approaches and new metrics to assess entanglement, or ingestion, in marine litter should be developed which may also open new perspectives in the context of monitoring.

Contacts and version Date: *UNEP/MAP 16 January 2017*

Key contacts within UN Environment for further information

- Mr Christos Ioakeimidis, Marine Litter MED Project Expert, Mediterranean Pollution Assessment and Control Programme (MED POL) (Christos.Ioakeimidis@unep.org)
- Ms Virginie Hart, Programme Officer, UN Environment / Mediterranean Action Plan, Mediterranean Pollution Assessment and Control Programme (MED POL) (Virginie.Hart@unep.org)
- Ms Tatjana Hema, Deputy Coordinator, UN Environment / Mediterranean Action Plan (Tatjana.Hema@unep.org)

Version No	**Date**	**Author**
V.1		