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Agenda item 8: Implementation of Decision IG 22/7 on IMAP and Articles 7 and 8 of the LBS Protocol

IMAP Common Indicator Guidance Facts Sheets (Pollution and Marine Litter)

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1. Explanatory Note by the Secretariat

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 centre 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 Therefore, the draft guidance factsheets within each Common Indicator have been developed for coherent monitoring, as well as their targets defined and agreed in order to deliver the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 seven Indicator Guidance Factsheets for the Ecological Objectives 9 (Contaminants), 5 (Eutrophication) and 10 (Marine Litter) as follows:

- Common Indicator 13. Concentration of key nutrients in water column (EO5);
- Common Indicator 14. Chlorophyll *a* concentration in water column (EO5);
- Common Indicator 17. Concentration of key harmful contaminants measured in the relevant matrix (EO9);
- Common Indicator 18. Level of pollution effects of key contaminants where a cause and effect relationship has been established (EO9);
- Common Indicator 19. Occurrence, origin (where possible), and extent of acute pollution events (e.g. slicks from oil, oil products and hazardous substances) and their impact on biota affected by this pollution (EO9);
- Common Indicator 20. Actual levels of contaminants that have been detected and number of contaminants which have exceeded maximum regulatory levels in commonly consumed seafood (EO9);
- Common Indicator 21. Percentage of intestinal enterococci concentration measurements within established standards (EO9);
- 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);
- Common Indicator 23: Trends in the amount of litter in the water column including microplastics and on the seafloor; and
- Candidate Indicator 24: Trends in the amount of litter ingested by or entangling marine organisms, especially mammals, marine birds and turtles

4. This document is based on 40 years of unique work and experience, within the MED POL Programme, as well as a number of initiative and research projects, such as the Horizon 2020 initiative for the depollution of the Mediterranean. Earlier work on indicators includes 36 Indicator Factsheets developed in 2005 by MEDPOL and the development of six indicators for Horizon 2020 in 2014¹.

¹UNEP(DEPI)/MED WG. 399/4. 16 May 2014

5. The main purpose of this revised Indicator Guidance Factsheets is to provide concrete guidance and references to Contracting Parties to 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.

6. 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 on each (ie. Indicator Title, Rational, Policy Context and Targets, Indicator analysis methods and Methodolgy 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).

7. The CORMON meeting on Pollution, held in Marseilles on the 19-21 October, and the CORMON meeting on Marine Litter, held in Madrid on the Madrid, Spain, 28 February – 2 March 2017, reviewed these factsheets and provided comments and suggestions for their revision. This document reflects comments received.

Scheme of IMAP Factsheet Template:

Indicator Title			} IMAP Reference No and definition
Relevant GES definition	Related Operational Objective	Proposed Target(s)	
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			} Agreed scientific methodologies in use, including detailed monitoring requirements
Indicator Definition			
Methodology for indicator calculation			
Indicator units			
List of Guidance documents and protocols available			
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 reporting, analysis and aggregation (output)
Data analysis and assessment outputs			
Statistical analysis and basis for aggregation			
Expected assessments outputs			
Known gaps and uncertainties in the Mediterranean			} Document Registration
Contacts and version Date			
Key contacts within UNEP for further information			
Version No	Date	Author	

2. Common indicators Factsheet

Common Indicator 13 (EO5): Concentration of key nutrients in water column^{2,3}

Indicator Title	13. Concentration of key nutrients in water column (EO5)	
Relevant GES definition	Related Operational Objective	Proposed Target(s)
Concentrations of nutrients in the euphotic layer are in line with prevailing physiographic, geographic and climate conditions	Human introduction of nutrients in the marine environment is not conducive to eutrophication	<ol style="list-style-type: none"> 1. Reference nutrients concentrations according to the local hydrological, chemical and morphological characteristics of the un-impacted marine region. 2. Decreasing trend of nutrients concentrations in water column of human impacted areas, statistically defined. 3. Reduction of BOD emissions from land based sources. 4. Reduction of nutrients emissions from land based sources
Rational		
Justification for indicator selector		
<p>Eutrophication is a process driven by enrichment of water by nutrients, especially compounds of nitrogen and/or phosphorus, leading to: increased growth, primary production and biomass of algae; changes in the balance of nutrients causing changes to the balance of organisms; and water quality degradation. The direct and indirect consequences of eutrophication are undesirable when they degrade ecosystem health and/or the sustainable provision of goods and services, such as algal blooms, dissolved oxygen deficiency, declines in sea-grasses, mortality of benthic organisms and/or fish. Although, these changes may also occur due to natural processes, the management concern begins when they are attributed to anthropogenic sources.</p>		
Scientific References		
<ol style="list-style-type: none"> i. Brzezinski M.A., 1985. The Si:C:N ratio of marine diatoms: interspecific variability and the effect of some environmental variables. <i>Journal of Phycology</i>, Vo. 21, pp. 347–357. ii. Conley D.J., Schelske C.L., Stoermer E. F., 1993. Modification of the biogeochemical cycle of silica with eutrophication. <i>Mar. Ecol. Prog. Ser.</i> 101, 179-192. iii. Devlin, M., Painting, S., Best, M., 2007. Setting nutrient thresholds to support an ecological assessment based on nutrient enrichment, potential primary production and undesirable disturbance. <i>Mar. Poll.</i>, 55., 65-73. iv. Carstensen, J., 2007. Statistical principles for ecological status classification of Water Framework Directive monitoring data. <i>Mar. Poll.</i>, 55, 3-15. 		
Policy Context and targets		

²Note that this builds upon a previous indicator factsheet developed under Horizon 2020. H2020 Indicators Fact Sheets. Regional meeting on PRTR and Pollution indicators, Ankara (Turkey), 16-17 June 2014. (UNEP(DEPI)/MED WG. 399/4)

³MSFD Descriptor 5: Human-induced eutrophication is minimized, especially adverse effects thereof, such as losses in biodiversity, ecosystem degradation, harmful algae blooms and oxygen deficiency in bottom waters.

Indicator Title	13. Concentration of key nutrients in water column (EO5)
<p>Policy context description</p> <p>In the Mediterranean, the UNEP/MAP MED POL Monitoring programme included from its inception the study of eutrophication as part of its seven pilot projects approved by the Contracting Parties at the Barcelona meeting in 1975 (UNEP MAP, 1990a,b). The issue of a consistent monitoring strategy and assessment of eutrophication was first raised at the UNEP/MAP MED POL National Coordinators Meeting in 2001 (Venice, Italy) which recommended to the Secretariat to elaborate a draft programme for monitoring of eutrophication in the Mediterranean coastal waters (UNEP/MAP MED POL, 2003). In spite of a series of assessments reviewing the concept and state of eutrophication, there are important gaps in the capacity to assess the intensity of this phenomenon. Efforts have been devoted to define the concepts to assess the intensity and to extend experience beyond the initial sites in the Adriatic Sea, admittedly, the most eutrophic area in the entire Mediterranean Sea. In the context of the Mediterranean Sea, the Integrated Monitoring and Assessment Programme (UNEP/MAP, 2016) and the European Marine Strategy Framework Directive (2000/56/EC) are the two main policy tools for the eutrophication phenomenon.</p>	
<p>Targets</p> <p>For each considered marine spatial scale (region, sub-region, local water mass, etc.) the nutrient levels should be compared based on base reference levels and trends monitoring until commonly agreed thresholds have been scientifically assessed and agreed upon in the Mediterranean Sea.</p>	
<p>Policy documents</p> <p>General Policy documents</p> <ol style="list-style-type: none"> i. 19th COP to the Barcelona Convention, Athens, Greece, 2016. Decision IG.22/7 - Integrated Monitoring and Assessment Programme (IMAP) of the Mediterranean Sea and Coast and Related Assessment Criteria (UNEP(DEPI)/MED IG.22/28) ii. 19th COP to the Barcelona Convention, Athens, Greece, 2016. Draft Integrated Monitoring and Assessment Guidance (UNEP(DEPI)/MED IG.22/Inf.7) iii. 18th COP to the Barcelona Convention, Istanbul, Turkey, 2013. Decision IG.21/3 - Ecosystems Approach including adopting definitions of Good Environmental Status (GES) and Targets. UNEP(DEPI)/MED IG.21/9 iv. Directive 2008/56/EC of the European Parliament and of the Council of 17 June 2008 establishing a framework for community action in the field of marine environmental policy (Marine Strategy Framework Directive). <p>Nutrient/Eutrophication related Policy documents</p> <ol style="list-style-type: none"> v. UNEP/MAP MED POL (2003). Eutrophication Monitoring Strategy of UNEP/MAP MED POL. UNEP(DEPI)/MED WG.231/14. UNEP, Athens. vi. Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy. vii. UNEP/FAO/WHO (1996). 'Assessment of the state of eutrophication in the Mediterranean Sea'. MAP Technical Reports Series No 106. UNEP, Athens, 211 pp. viii. UNEP/MAP MED POL (1990a). Activity IV: Research on the effects of pollutants on Marine Organisms and their Populations (UNEP/MAP MED POL Phase I, 1975-1981). ix. UNEP/MAP MED POL (1990b). Activity V: Research on the effects of pollutants on Marine Communities and Ecosystems (UNEP/MAP MED POL Phase I, 1975-1981). 	
<p>Indicator analysis methods</p>	

Indicator Title	13. Concentration of key nutrients in water column (EO5)
Indicator Definition	
<p>Concentration of key (inorganic) nutrients in the water column:</p> <p>Nitrate (NO₃-N) Nitrite (NO₂-N) Ammonium (NH₄-N) Total Nitrogen (TN) Orthophosphate (PO₄-P) Total Phosphorus (TP) Orthosilicate (SiO₄-Si)</p> <p>Sub-Indicators: Nutrient ratios (molar) of silica, nitrogen and phosphorus where appropriate: Si:N, N:P, Si:P</p>	
Methodology for indicator calculation	
All: Spectrophotometry (manually or automated methods and instrumentation)	
Indicator units	
<p>All: micromol per liter, that is micromolar concentration (μmol/L = μM) Ratios: adimensional (simple mathematical derivation of ratios from nutrient concentrations)</p>	
List of Guidance documents and protocols available	
<ol style="list-style-type: none"> i. OSPAR, 2012. OSPAR MSFD Advice Document on Eutrophication. Approaches to determining good environmental status, setting of environmental targets and selecting indicators for Marine Strategy Framework Directive descriptor 5. ii. Piha, H., Zampoucas, N., 2011. Review of Methodological Standards Related to the Marine Strategy Framework Directive Criteria on Good Environmental Status. JRC Scientific and Technical Reports, EUR 24743 EN iii. UNEP/MAP MED POL (2005). Sampling and Analysis Techniques for the Eutrophication Monitoring Strategy of UNEP/MAP MED POL. MAP Technical Reports Series No. 163. UNEP, Athens. 61pp. iv. Durairaj, P., Sarangi, R.K., Ramalingam, S. <i>et al.</i> Seasonal nitrate algorithms for nitrate retrieval using OCEANSAT-2 and MODIS-AQUA satellite data. Environ Monit Assess (2015) 187: 176. v. See also UNEP/MAP website (http://web.unep.org/unepmap) 	
Data Confidence and uncertainties	
<p>Despite the great variability born by the water layers subject to active hydrodynamic processes, monitoring the characteristics of the seawater is still the most direct way of assessing eutrophication. Inorganic nutrients may be determined either at the surface or at various depths.</p>	
Methodology for monitoring, temporal and spatial scope	
Available Methodologies for Monitoring and Monitoring Protocols	
<p>Traditional methods for eutrophication monitoring in coastal waters involve <i>in situ</i> sampling/measurements of commonly measured parameters such as nutrients concentration. Concerning available methods for <i>in situ</i> measurements, ships provide flexible platforms for eutrophication monitoring, while remote sensing provides opportunities for a synoptic view over</p>	

Indicator Title	13. Concentration of key nutrients in water column (EO5)
<p>regions or sub-regions. Besides traditional ship measurements, ferry-boxes and other autonomous measuring devices have been developed that allow high frequency and continuous measurements.</p> <p>Sampling for the determination of <i>in vitro</i> fluorescence and nutrient analysis may be carried out with relatively little effort if a proper pump and hose are mounted on the ship. The measurements may be done at the surface or just below it with a water intake on the hull of the vessel or at fixed or varying depths with a towed “fish” and pumping system.</p>	
<p>Available data sources</p> <p>EMODNET Chemistry: http://www.emodnet-chemistry.eu/data_access.html</p> <p>EEA Waterbase - Transitional, coastal and marine waters: http://www.eea.europa.eu/data-and-maps/data/waterbase-transitional-coastal-and-marine-waters-11</p>	
<p>Spatial scope guidance and selection of monitoring stations</p> <p>The first factor promoting eutrophication is nutrient enrichment. This explains why the main eutrophic areas are to be found primarily not far from the coast, mainly in areas receiving high nutrient loads, despite some natural symptoms of eutrophication can also be found, such as in upwelling areas. Additionally, the risk of eutrophication is linked to the capacity of the marine environment to confine growing algae in the well-lighted surface layer. The geographical extent of potentially eutrophic waters may vary widely, depending on:</p> <ul style="list-style-type: none"> (i) the extent of shallow areas, i.e. with depth ≤ 20 m; (ii) the extent of stratified river plumes, which can create a shallow surface layer separated by a halocline from the bottom layer, whatever its depth; (iii) extended water residence times in enclosed seas leading to blooms triggered to a large degree by internal and external nutrient pools; and (iv) upwelling phenomena leading to autochthonous nutrient supply and high nutrient concentrations from deep water nutrient pools, which can be of natural or human origin. <p>Therefore, the geographical scale of monitoring for the assessment of GES for eutrophication will depend on the hydrological and morphological conditions of an area, particularly the freshwater inputs from rivers, the salinity, the general circulation, upwelling and stratification. The spatial distribution of the monitoring stations should, prior to the establishment of the eutrophication status of the marine sub-region/area, be risk-based and proportionate to the anticipated extent of eutrophication in the sub-region under consideration as well as its hydrographic characteristics aiming for the determination of spatially homogeneous areas. The eutrophication monitoring programmes should pursue to assess the eutrophication phenomena, based on the differentiation of the scale and time dependant signals from human induced versus natural eutrophication.</p>	
<p>Temporal Scope guidance</p> <p>Flexibility should be incorporated into the design of the monitoring programme to take account of differences in each marine sub-region/area. At the Mediterranean Sea latitudes, in general terms, the pre-summer and Winter primary production bloom intensity peaks of natural eutrophication will define the strategy for the sampling frequency, although year round measurements of nutrients may be more appropriate. The optimum frequency (seasonal 2 to 4 times per year or monthly 12 times per year) for the monitoring of nutrients at the selected stations should be chosen taking into account the necessity of both to control the deviations of the known natural cycles of eutrophication in coastal areas and the control of (decreasing) trends monitoring impacted areas, therefore, from low frequency (mínimum) to high frequency measurements.</p>	

Indicator Title	13. Concentration of key nutrients in water column (EO5)	
<p>Therefore, either for impacted or non-impacted coastal waters the optimal frequency per year and sampling locations needs to be selected at a local scales, whilst for open waters the sampling frequency to be determined on a sub-regional level following a risk based approach.</p> <p>Mainly, in order to build a robust sampling frequency scale in future a sounded statistical approach has to be developed that take in account the discriminant limit between classes when the nutrient boundaries approach will be widely accepted.</p>		
Data analysis and assessment outputs		
<p>Despite the individual nutrient concentrations and nutrient ratios will be evaluated based on statistical analysis against known reference levels and known marine eutrophication processes, following the evaluation of information provided by a number of countries and other available information, it has to be noted that the Mediterranean countries are using different eutrophication non-mandatory assessment methods such as TRIX, UNTRIX, Eutrophication scale, EI, HEAT, OSPAR, etc. Nutrients concentratons are part of these tools and is very important to continue to be used at sub-regional or national levels because there is a long-term experience within countries which can reveal / be used for assessing eutrophication trends.</p> <p>However, in order to increase coherency and comparability regarding eutrophication assessment methodologies is recommended that further efforts should be made to harmonize existing tools through workshops, dialogue and comparative exercises at regional/subregional/subdivision levels in Mediterranean with a view to further develop common assessment methods.</p> <p>EXAMPLE: The trophic index (TRIX; Vollenweider <i>et al.</i>, 1998) may be used for a preliminary assessment of the trophic status of coastal waters in relation to eutrophication providing that its advantages and shortcomings are taken into account (Primpas and Karydis, 2011). The adopted UNEP/MAP MED POL short-term eutrophication monitoring strategy monitored parameters to support the TRIX. This Index is widely used to synthesize key eutrophication variables into a simple numeric expression to make information comparable over a wide range of trophic situations:</p> <p>TRIX = (Log10 [ChA·aD%O·DIN·TP]+ k)·m, where:</p> <p>ChA = Chlorophyll <i>a</i> concentration as µg/L; aD%O = Oxygen as absolute % deviation from saturation; DIN = Dissolved Inorganic Nitrogen, N-(NO₃+NO₂+NH₄) as µg/L; TP = Total Phosphorus as µg/L; k=1.5; m = 10/12 = 0.833</p>		
Expected assessments outputs		
<p>As sugested by the on line expert group on eutrophication established by the Contracting parties it is recommended that with regard to nutrient concentrations, until commonly agreed thresholds have been determined and agreed upon, GES may be determined on a levels and trend monitoring basis.</p>		
Known gaps and uncertainties in the Mediterranean		
<p>For a complete assessment of eutrophication and GES achievement, GES thresholds and reference conditions (natural background concentrations) are needed not only for chlorophyll <i>a</i>, but such values must be set in the near future, through dedicated workshops and exercises also for nutrients, transparency and oxygen as minimum requirements (see also related Common Indicator 14). This should include quality assurance schemes, as well as data quality control protocols.</p> <p>Nutrient, transparency and oxygen thresholds and reference values may not be identical for all areas, since is recognized that area-specific environmental conditions must define threshold values. GES could be defined on a sub-regional level, or on a sub-division of the sub-region (such as the Northern Adriatic), due to local specificities in relation to the trophic level and the morphology of the area.</p>		
Contacts and version Date		
http://www.unepmap.org		
Version No	Date	Author
V.1	28.04.17	MEDPOL

Common Indicator 14 (EO5): Chlorophyll *a* concentration in water column⁴

Indicator Title	14. Chlorophyll <i>a</i> concentration in water column (EO5)	
Relevant GES definition	Related Operational Objective	Proposed Target(s)
Natural levels of algal biomass, water transparency and oxygen concentrations in line with prevailing physiographic, geographic and weather conditions	Direct and indirect effects of nutrient over-enrichment are prevented	<ol style="list-style-type: none"> 1. Chlorophyll <i>a</i> concentrations in high-risk areas below thresholds 2. Decreasing trend in chl-<i>a</i> concentrations in high risk areas affected by human activities 3. Index of turbidity behind threshold in high risk areas 4. Increasing trend of transparency in areas impacted by human activities 5. Dissolved oxygen concentrations in high-risk areas above local threshold 6. Increasing trend in dissolved oxygen concentrations in areas impacted by human activities
Rational		
<p>Justification for indicator selector</p> <p>Eutrophication is a process driven by enrichment of water by nutrients, especially compounds of nitrogen and/or phosphorus, leading to: increased growth, primary production and biomass of algae; changes in the balance of nutrients causing changes to the balance of organisms; and water quality degradation. The consequences of eutrophication are undesirable if they appreciably degrade ecosystem health and/or the sustainable provision of goods and services, such as excessive algal blooms, dissolved oxygen deficiency, declines in sea-grasses, mortality of benthic organisms and/or fish. Although, these changes may also occur due to natural processes, the management concern begins when they are attributed to anthropogenic sources.</p>		
<p>Scientific References</p> <ol style="list-style-type: none"> i. Boyer J.N. Kelble C.R., Ortner P.B., Rudnick D.T., 2009. Phytoplankton bloom status: Chlorophyll <i>a</i> biomass as an indicator of water quality condition in the southern estuaries of Florida, USA. <i>Ecological Indicators</i> 9s:s56- s67. ii. Primpas I., Karydis M., 2011. Scaling the trophic index (TRIX) in oligotrophic marine environments. <i>Environmental Monitoring and Assessment</i> July 2011, Volume 178, Issue 1-4, pp 257-269. iii. Vollenweider, R.A., Giovanardi F., Montanari, G., Rinaldi A., 1998. Characterization of the trophic conditions of marine coastal waters, with special reference to the NW Adriatic Sea: 		

⁴ MSFD Descriptor 5: Human-induced eutrophication is minimized, especially adverse effects thereof, such as losses in biodiversity, ecosystem degradation, harmful algae blooms and oxygen deficiency in bottom waters.

Indicator Title	14. Chlorophyll <i>a</i> concentration in water column (EO5)
proposal for a trophic scale, turbidity and generalized water quality index. <i>Environmetrics</i> , 9, 329-357.	
Policy Context and targets	
Policy context description	
<p>In the Mediterranean, the UNEP/MAP MED POL Monitoring programme included from its inception the study of eutrophication as part of its seven pilot projects approved by the Contracting Parties at the Barcelona meeting in 1975 (UNEP MAP, 1990a,b). The issue of a consistent monitoring strategy and assessment of eutrophication was first raised at the UNEP/MAP MED POL National Coordinators Meeting in 2001 (Venice, Italy) which recommended to the Secretariat to elaborate a draft programme for monitoring of eutrophication in the Mediterranean coastal waters (UNEP/MAP MED POL, 2003). In spite of a series of assessments reviewing the concept and state of eutrophication, there are important gaps in the capacity to assess the intensity of this phenomenon. Efforts have been devoted to define the concepts to assess the intensity and to extend experience beyond the initial sites in the Adriatic Sea, admittedly, the most eutrophic area in the entire Mediterranean Sea. In the context of the Mediterranean Sea, the European Marine Strategy Framework Directive (200/56/EC) and the Integrated Monitoring and Assessment Programme (UNEP/MAP, 2016), are the two main policy tools for the eutrophication phenomenon.</p>	
Targets	
<p>For each defined marine spatial scale (region, sub-region, etc.) the levels should be compared against agreed threshold levels defining High/Good and Good/Medium environmental status based on the indicative thresholds and reference values of Chlorophyll <i>a</i>- in Mediterranean coastal water types, according to the Commission Decision of 20 September 2013 (2013/480/EU) establishing, pursuant to Directive 2000/60/EC (WFD), the values of the Member State monitoring system classifications as a result of the intercalibration exercise and repealing Decision 2008/915/EC, recalling on reference conditions (High/Good) and boundaries of good/moderate status (G/M).</p>	
Policy documents	
General Policy documents	
<ul style="list-style-type: none"> i. 19th COP to the Barcelona Convention, Athens, Greece, 2016. Decision IG.22/7 - Integrated Monitoring and Assessment Programme (IMAP) of the Mediterranean Sea and Coast and Related Assessment Criteria (UNEP(DEPI)/MED IG.22/28) ii. 19th COP to the Barcelona Convention, Athens, Greece, 2016. Draft Integrated Monitoring and Assessment Guidance (UNEP(DEPI)/MED IG.22/Inf.7) iii. 18th COP to the Barcelona Convention, Istanbul, Turkey, 2013. Decision IG.21/3 - Ecosystems Approach including adopting definitions of Good Environmental Status (GES) and Targets. UNEP(DEPI)/MED IG.21/9 iv. Directive 2008/56/EC of the European Parliament and of the Council of 17 June 2008 establishing a framework for community action in the field of marine environmental policy (Marine Strategy Framework Directive). 	
Nutrient/Eutrophication related Policy documents	
<ul style="list-style-type: none"> v. UNEP/MAP MED POL (2003). Eutrophication Monitoring Strategy of UNEP/MAP MED POL. UNEP(DEPI)/MED WG.231/14. UNEP, Athens. vi. Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy. vii. UNEP/FAO/WHO (1996). 'Assessment of the state of eutrophication in the Mediterranean Sea'. MAP Technical Reports Series No 106. UNEP, Athens, 211 pp. viii. UNEP/MAP MED POL (1990a). Activity IV: Research on the effects of pollutants on Marine Organisms and their Populations (UNEP/MAP MED POL Phase I, 1975-1981). 	

Indicator Title	14. Chlorophyll <i>a</i> concentration in water column (EO5)
ix. UNEP/MAP MED POL(1990b). Activity V: Research on the effects of pollutants on Marine Communities and Ecosystems (UNEP/MAP MED POL Phase I, 1975-1981).	
Indicator analysis methods	
Indicator Definition	
Chlorophyll <i>a</i> concentration in the water column (State, Impact Indicator);	
Sub-Indicators: Water Transparency (State, Impact Indicator) and Dissolved oxygen (State, Impact Indicator)	
Methodology for indicator calculation	
Chlorophyll <i>a</i> : Spectrophotometry. ISO 10260 (1992) on spectrometric determination of the chlorophyll <i>a</i> concentration provides a standard method for quantification of chlorophyll <i>a</i> . Water transparency: measured as Secchi disk depth or according to ISO 7027:1999 Water Quality-Determination of Turbidity Dissolved Oxygen: Chemical methods, Oxygen sensors, etc. measured near the bottom (under the euphotic layer/oxycline)	
Indicator units	
microgram per liter (µg/L) - Chlorophyll <i>a</i> meters – Secchi disk depth; NTU Turbidity Scale (Nephelometric Turbidity Units) – Water transparency milligram per liter (mg/L) and % Saturation (if temperature and salinity is known) – Dissolved Oxygen	
List of Guidance documents and protocols available	
<ul style="list-style-type: none"> i. OSPAR, 2012. OSPAR MSFD Advice Document on Eutrophication. Approaches to determining good environmental status, setting of environmental targets and selecting indicators for Marine Strategy Framework Directive descriptor 5 ii. Piha, H., Zampoucas, N., 2011. Review of Methodological Standards Related to the Marine Strategy Framework Directive Criteria on Good Environmental Status. JRC Scientific and Technical Reports, EUR 24743 EN iii. UNEP/MAP MED POL, 2005. Sampling and Analysis Techniques for the Eutrophication Monitoring Strategy of UNEP/MAP MED POL. MAP Technical Reports Series No. 163. UNEP, Athens. 61pp. 	
Data Confidence and uncertainties	
<p>Despite the great variability born by the water layers subject to active hydrodynamic processes, monitoring the characteristics of the seawater is still the most direct way of assessing eutrophication. A number of parameters have been identified as providing most information relative to eutrophication e.g. chlorophyll <i>a</i>, dissolved oxygen, inorganic nutrients, organic matter, suspended solids, light penetration, aquatic macro-phytes, zoo benthos, etc. They all may be determined either at the surface or at various depths.</p> <p>If only limited means are available, determination of those parameters that synthesize the most information should be retained. Chlorophyll <i>a</i> determinations for example, although not very precise representations of the system, are data which provide a great deal of information. Turbidity may also be a good measure of eutrophication, except near the mouths of rivers where inert suspended solids may be extremely abundant. Dissolved oxygen is one parameter that integrates much information on the processes involved in eutrophication, provided it is measured near the bottom or, at least, below the euphotic zone where an oxycline usually appears.</p>	

Indicator Title	14. Chlorophyll <i>a</i> concentration in water column (EO5)
Methodology for monitoring, temporal and spatial scope	
Available Methodologies for Monitoring and Monitoring Protocols	
<p>Traditional methods for eutrophication monitoring in coastal waters involve <i>in situ</i> sampling/measurements of commonly measured parameters such as nutrients concentration, chlorophyll <i>a</i> concentration, phytoplankton abundance and composition, transparency and dissolved oxygen concentration. Concerning available methods for <i>in situ</i> measurements, ships provide flexible platforms for eutrophication monitoring, while remote sensing provides opportunities for a synoptic view over regions or sub-regions. Besides traditional ship measurements, ferry-boxes and other autonomous measuring devices have been developed that allow high frequency and continuous measurements.</p> <p>Modelling and remote sensing should also be considered as area integrating in addition to <i>in situ</i> measurements, depending on the requirements with respect to data. In general, <i>in situ</i> measurements always remain necessary to validate and calibrate the models and data calculated from satellite measurements.</p> <p>However, satellite data need to be supported by ground truth data. A good strategy appears to be a combination of remote sensing and scanning of the area known or suspected to be affected with automatic measuring instruments such as thermo-salinometer, dissolved oxygen sensors and <i>in vivo</i> fluorometer and/or nephelometer. Sampling for the determination of <i>in vitro</i> fluorescence and nutrient analysis may be carried out with relatively little effort if a proper pump and hose are mounted on the ship. The measurements may be done at the surface or just below it with a water intake on the hull of the vessel or at fixed or varying depths with a towed “fish” and pumping system.</p>	
<p>Available data sources http://www.unepmap.org Satellite databases such as in EMIS http://mcc.jrc.ec.europa.eu/emis/</p>	
Spatial scope guidance and selection of monitoring stations	
<p>The extent of eutrophication shows spatial variation, for instance coastal regions versus the open sea. The frequency and spatial resolution of the monitoring programme should reflect this spatial variation in eutrophication status and pressures following a risk based approach and the precautionary principle. The geographical extent of potentially eutrophic waters may vary widely, depending on:</p> <ul style="list-style-type: none"> (i) the extent of shallow areas, i.e. with depth ≤ 20 m; (ii) the extent of stratified river plumes, which can create a shallow surface layer separated by a halocline from the bottom layer, whatever its depth (iii) extended water residence times in enclosed seas leading to blooms triggered to a large degree by internal and external nutrient pools; and (iv) upwelling phenomena leading to autochthonous nutrient supply and high nutrient concentrations from deep water nutrient pools, which can be of natural or human origin. <p>Therefore, the geographical scale of monitoring for the assessment of GES for eutrophication will depend on the hydrological and morphological conditions of an area, particularly the freshwater inputs from rivers, the salinity, the general circulation, upwelling and stratification. The spatial distribution of the monitoring stations should, prior to the establishment of the eutrophication status of the marine sub-region/area, be risk-based and proportionate to the anticipated extent of eutrophication in the sub-region under consideration as well as its hydrographic characteristics aiming for the determination of spatially homogeneous areas. The eutrophication monitoring programmes should pursue to assess the eutrophication phenomena, based on the differentiation of the scale and time dependant signals from human induced versus natural eutrophication.</p>	
Temporal Scope guidance	
<p>The current national eutrophication monitoring programme implemented so far by the Contracting Parties in the framework of the UNEP/MAP MED POL programme should be used as a sound basis for monitoring under the EcAp. It could be recommended:</p>	

Indicator Title	14. Chlorophyll <i>a</i> concentration in water column (EO5)
<p>Chlorophyll <i>a</i>: For coastal stations minimum sampling 4/year, 6-12 /year recommended; For open waters sampling frequency to be determined on a sub-regional level following a risk based approach</p> <p>Water transparency: <i>id.</i> Chlorophyll <i>a</i></p> <p>Dissolved Oxygen: <i>id.</i> Chlorophyll <i>a</i></p> <p>Additionally, in order to build a robust sampling frequency scale in future a sounded statistical approach has to be developed that take in account the discriminant limit between classes when the class boundary approach will be widely accepted.</p>	
Data analysis and assessment outputs	
Statistical analysis and basis for aggregation	
<p>The classification scheme on chlorophyll <i>a</i> concentration developed by MEDGIG as an assessment method easily applicable by all Mediterranean countries based on the indicative thresholds and reference values adopted. Further, developments within the European MSFD and OSPAR Comission with regard eutrophication should also be taken into account.</p> <p>Further, it has to be noted that the Mediterranean countries are using different eutrophication non-mandatory assessment methods such as TRIX, UNTRIX, Eutrophication scale, EI, HEAT, OSPAR, etc. These tools are very important to continue to be used at sub-regional or national levels because there is a long-term experience within countries which can reveal / be used for assessing eutrophication trends.</p> <p>However, in order to increase coherency and comparability regarding eutrophication assessment methodologies is recommended that further efforts should be made to harmonize existing tools through workshops, dialogue and comparative exercises at regional/subregional/subdivision levels in Mediterranean with a view to further develop common assessment methods.</p> <p>EXAMPLE: The trophic index (TRIX, Vollenweider <i>et al.</i>, 1998) may be used for a preliminary assessment of the trophic status of coastal waters in relation to eutrophication providing that its advantages and shortcomings are taken into account (Primpas and Karydis, 2011). The adopted UNEP/MAP MED POL short-term eutrophication monitoring strategy monitored parameters to support the TRIX. This Index is widely used to synthesize key eutrophication variables into a simple numeric expression to make information comparable over a wide range of trophic situations: $TRIX = (\text{Log}_{10} [\text{ChA} \cdot \text{aD}\% \text{O} \cdot \text{DIN} \cdot \text{TP}] + k) \cdot m$, where: ChA = Chlorophyll <i>a</i> concentration as $\mu\text{g/L}$; aD%O = Oxygen as absolute % deviation from saturation; DIN = Dissolved Inorganic Nitrogen, N-(NO₃+NO₂+NH₄) as $\mu\text{g/L}$; TP = Total Phosphorus as $\mu\text{g/L}$; k=1.5; m = 10/12 = 0.833</p>	
Expected assessments outputs	
<p>GES thresholds and trends are recommended to be used in a combined way, according to data availability and agreement on GES threshold levels. In the framework of UNEP/MAP MED POL there is experience with regard to using quantitative thresholds. It is proposed that for the Mediterranean region, quantitative thresholds between “good” (GES) and “moderate” (non GES) conditions for coastal waters could be based as appropriate on the work carried out in the framework of the MEDGIG intercalibration process of the EU Water Framework Directive (WFD). The Contracting Parties are recommended to rely on the classification scheme on chlorophyll <i>a</i> concentration ($\mu\text{g/L}$) in coastal waters as a parameter easily applicable by all Mediterranean countries based on the indicative thresholds and reference values of chlorophyll <i>a</i> in Mediterranean coastal water types (according to 2013/480/EU, see reference below), recalling on reference conditions and boundaries of good/moderate status (G/M).</p> <p>In this context regarding the definition of subregional thresholds for chlorophyll <i>a</i> water typology is very important for further development of classification schemes of a certain area. Within the MEDGIG exercise the recommended water types for applying eutrophication assessment is based on hydrological parameters characterizing a certain area dynamics and circulation.</p>	

Indicator Title	14. Chlorophyll <i>a</i> concentration in water column (EO5)	
2013/480/EU: Commission Decision of 20 September 2013 establishing, pursuant to Directive 2000/60/EC of the European Parliament and of the Council, the values of the Member State monitoring system classifications as a result of the intercalibration exercise and repealing Decision 2008/915/EC		
Known gaps and uncertainties in the Mediterranean		
<p>For a complete assessment of eutrophication and GES achievement, GES thresholds and reference conditions (natural background concentrations) are needed not only for chlorophyll <i>a</i>, but such values must be set, in the near future, through dedicated workshops and exercises also, water transparency and oxygen as minimum requirements, where appropriate. This should include quality assurance schemes, as well as data quality control protocols.</p> <p>Further, in order to increase coherency and comparability regarding eutrophication assessment methodologies is recommended that further efforts should be made to harmonize existing tools through workshops, dialogue and comparative exercises at regional/subregional/subdivision levels in Mediterranean with a view to further improve and develop common assessment methods.</p>		
Contacts and version Date		
http://www.unepmap.org		
Version No	Date	Author
V.1	28.04.17	MEDPOL

Common Indicator 17 (EO9): Concentration of key harmful contaminants measured in the relevant matrix⁵

Indicator Title	17. Concentration of key harmful contaminants measured in the relevant matrix (EO9)	
Relevant GES definition	Related Operational Objective	Proposed Target(s)
Level of pollution is below a determined threshold defined for the area and species	Concentration of priority contaminants is kept within acceptable limits and does not increase	<p>1. Concentrations of specific contaminants below either Background Assessment Criteria or Environmental Assessment Criteria (BACs/EACs) or below reference concentrations (from other sources)</p> <p>2. No deterioration trends in contaminants concentrations in sediment and biota from human impacted areas, statistically defined</p> <p>3. Reduction of contaminants emissions from land based sources</p>
Rational		
Justification for indicator selector		
<p>Environmental chemical pollution is directly linked with humankind activities and advancements. Marine environmental investigations have detected thousands of man-made chemicals (both inorganic and organic compounds) all over the world oceans, which have been shown to impair the health of the marine ecosystems and their ecosystem services. The study of the occurrence, transport, transformation and fate, through the different ecosystem compartments (seawater column, marine biota, sediment, etc.), as well as the study of their sources and entry routes (land-based, marine and atmospheric) are the first steps to understand and discover a growing environmental problem. The monitoring of the spatial and temporal scales of the harmful and noxious substances occurrence determines either a chronic or acute contamination/pollution episode. Currently, new man-made chemicals and emerging pollutants continue to enter the marine environment and interact with the different marine ecosystems (coastal, open ocean, deep-sea areas), increasing the complexity of the chemical pollution threats for the marine environment and their future sustainability to deliver its benefits.</p>		
Scientific References		
<ul style="list-style-type: none"> i. Clark, R.B., 1986. Marine Pollution, Oxford University Press. ii. Neff, J.M., 1979. Polycyclic aromatic hydrocarbons in the aquatic environment. Sources, fates and biological effects. Applied Science Publishers, Ltd., London. iii. Goldberg, E. D., 1975. The Mussel Watch - a first step in global marine monitoring. <i>Mar.Poll.Bull.</i>, 6, 111. iv. Bricker, S., Lauenstein, G., Maruya, K., 2014. NOAA's Mussel Watch Program: Incorporating contaminants of emerging concern (CECs) into a long-term monitoring program. <i>Mar.Poll.Bull.</i>, 81, 289–290. v. Furdek, M., Vahcic, M., Šcancar, J., Milacic, R., Kniewald, G., Mikac, N., 2012. Organotin compounds in seawater and <i>Mytilus galloprovincialis</i> mussels along the Croatian Adriatic Coast. <i>Mar.Poll.Bull.</i>, 64, 189–199 		

⁵ MSFD Descriptor 8: Concentrations of contaminants are at levels not giving rise to pollution effects

Indicator Title	17. Concentration of key harmful contaminants measured in the relevant matrix (EO9)
<ul style="list-style-type: none"> vi. Nakata, H., Shinohara, R.I., Nakazawa, Y., Isobe, T., Sudaryanto, A., Subramanian, A., Tanabe, S., Zakaria, M.P., Zheng, G.J., Lam, P.K.S., Young Kim, E., Yoon Min, B., Wef, S.U., Hung Viet, P., Tana, T.S., Prudente, M., Donnell, F., Lauenstein, G., Kannan, K., 2012. Asia-Pacific mussel watch for emerging pollutants: Distribution of synthetic musks and benzotriazole UV stabilizers in Asian and US coastal waters. <i>Mar. Pollut. Bull.</i>, 64, 2211–2218 vii. Richardson, S., 2004. Environmental Mass Spectrometry: Emerging contaminants and current issues. <i>Anal. Chem.</i>, 76, 3337-3364. viii. Schulz-Bull, D.E., Petrick, G., Bruhn, R., Duinker, J.C., 1998. Chlorobiphenyls (PCB) and PAHs in water masses of the northern North Atlantic. <i>Mar. Chem.</i>, 61, 101-114. 	
Policy Context and targets	
<p>Policy context description</p> <p>In most Mediterranean countries, the monitoring of a range of hazardous chemical substances in different marine ecosystem compartments are undertaken in response to the UNEP/MAP Barcelona Convention (1975) and its Land-Based Protocol, the UNEP/MAP MED POL Monitoring Program, as well as international, european (e.g. EU WFD or EU MSFD) or other national policy drivers. A considerable amount of founding actions are available through the pollution monitoring and assessment component of the UNEP/MAP MED POL Programme from the past decades, including monitoring pilot programmes (ecotoxicological effects of contaminants). The environmental assessments have been used for the identification and confirmation of significant marine contaminants occurrence, distributions, levels and trends; as well as, for the continuous development of monitoring strategies and guidance. With respect to the Ecosystem Approach and IMAP, their implementation will continue under the benefits gained from this past knowledge and its policy framework built in the Mediterranean Sea.</p>	
<p>Targets</p> <p>Initial targets of GES under Common Indicator 17 will be focused on the control of environmental levels, trend improvements and the reduction of emissions at sources. The targets monitoring will be based upon data of a relatively small number of both legacy and ‘traditional’ chemicals reflecting the scope of current programmes and the availability of suitable agreed assessment criteria for them. The inclusion of emerging chemical compounds of environmental concern and their targets for GES within IMAP will be implemented as the scientific knowledge develops.</p>	
<p>Policy documents</p> <p>General Policy documents</p> <ul style="list-style-type: none"> i. 19th COP to the Barcelona Convention, Athens, Greece, 2016. Decision IG.22/7 - Integrated Monitoring and Assessment Programme (IMAP) of the Mediterranean Sea and Coast and Related Assessment Criteria (UNEP(DEPI)/MED IG.22/28) ii. 19th COP to the Barcelona Convention, Athens, Greece, 2016. Draft Integrated Monitoring and Assessment Guidance (UNEP(DEPI)/MED IG.22/Inf.7) iii. 18th COP to the Barcelona Convention, Istanbul, Turkey, 2013. Decision IG.21/3 - Ecosystems Approach including adopting definitions of Good Environmental Status (GES) and Targets. UNEP(DEPI)/MED IG.21/9 iv. Directive 2008/56/EC of the European Parliament and of the Council of 17 June 2008 establishing a framework for community action in the field of marine environmental policy (Marine Strategy Framework Directive). v. Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy. <p>Contaminants related Policy documents</p>	

Indicator Title	17. Concentration of key harmful contaminants measured in the relevant matrix (EO9)
	<ul style="list-style-type: none"> vi. UNEP/MAP, 1987. Report of the Fifth Meeting of the Contracting Parties to the Convention for the Protection of the Mediterranean Sea against pollution and its Related Protocols. UNEP/IG. 74/5. UNEP/MAP, Athens. vii. UNEP/MAP, 2005. Fact sheets on Marine Pollution Indicators. Meeting of the UNEP/MAP MED POL National Coordinators. Barcelona, Spain, 24-27 May 2005. UNEP (DEC)/MED/WG.264/ Inf.14. UNEP, Athens. viii. UNEP/MAP MED POL – Phase III, Programme for the Assessment and Control of Pollution in the Mediterranean Region. MAP Technical Report Series No. 120, UNEP, Athens, 1999. ix. OSPAR Commission, 2013. Levels and trends in marine contaminants and their biological effects - CEMP Assessment Report 2012. Monitoring and Assessment Series, 2013. x. EEA, 2003. Hazardous substances in the European marine environment: Trends in metals and persistent organic pollutants. Topic Report 2/2003. EEA, European Environmental Agency, Copenhagen, 2003. http://www.eea.eu.int xi. EEA, 1999 State and pressures of the marine and coastal Mediterranean environment. Environmental issues series n°5. European Environmental Agency, Copenhagen, 1999. http://www.eea.eu.int
Indicator analysis methods	
Indicator Definition	
<p>Concentrations of key contaminants in the following matrices (note this is a multicomponent pressure indicator):</p> <p>BIOTA: In marine organisms, whole soft tissues or dissected parts according sampling and sample preparation protocols, and primarily in bivalve species and/or fish: Trace/Heavy Metals (TM): Total mercury (HgT), Cadmium (Cd) and Lead (Pb) Organochlorinated compounds (PCBs, Hexachlorobenzene, Lindane and ΣDDTs) Polycyclic aromatic hydrocarbons (US EPA 16 Reference PAHs Compounds),</p> <p>Lipid content, flesh fresh/dry weight ratio for normalisation purposes</p> <p>SEDIMENTS: In coastal, platform and offshore sediments (< 2 mm particle size fraction): Trace/Heavy Metals: Total mercury (HgT), Cadmium (Cd) and Lead (Pb) Organochlorinated compounds (PCBs, Hexachlorobenzene, Lindane and ΣDDTs) Polycyclic aromatic hydrocarbons (US EPA 16 Reference PAHs Compounds)</p> <p>Aluminium (Al), Total Organic Carbon (TOC) in the < 2mm particle size fraction for normalization purposes for TM and OCs, respectively. The < 63µm sediment fraction is recommended to be complementary for metals. The liophilization ratio (dry/wet sediment ratio).</p> <p>SEAWATER: the monitoring for environmental assessment purposes and the determination of contaminants in seawater presents specific challenges and higher costs. For the mid/long-term monitoring programmes, such as IMAP, these are recommended to be carried out on a country decision basis.</p> <p><u>Sub-indicators:</u> other relevant chemicals (such as tributyltin, TBT) and emerging pollutants are recommended to be carried out on a country decision basis until a firm COP Meeting Decision will be taken.</p>	
Methodology for indicator calculation	

Indicator Title	17. Concentration of key harmful contaminants measured in the relevant matrix (EO9)
<p>Trace/Heavy Metals (TM) and Aluminium: Spectrometry, Mass Spectrometry</p> <p>Organic compounds: Gas or Liquid Chromatography (GC/LC) coupled to a variety of detectors, such as Electron Capture Detectors or Mass Spectrometry, atomic adsorption.</p> <p>TOC: Elemental Analyser</p> <p>Particle fractions: in-house mesh validated methods (for < 2 mm) and/or geological sieving methods.</p>	
Indicator units	
<p>Trace/Heavy Metals (TM) and Aluminium: mass/dry or wet weight mass of sample according MEDPOL Database Format Protocols. The dry/wet mass ratios should be calculated and reported.</p> <p>Organic compounds (OCs): mass/dry or wet weight mass of sample according MEDPOL Database Format Protocols. The dry/wet mass ratios should be calculated and reported.</p> <p>TOC: Elemental Analyser (as %)</p> <p>Particle fractions (as %)</p>	
List of Guidance documents and protocols available	
<p>Refer to UNEP Methods and Protocols for Marine Pollution, as well as from other recent documents from regional conventions (e.g. OSPAR) and European Guidelines, such as the Guidance Document No. 33 ON ANALYTICAL METHODS FOR BIOTA MONITORING UNDER THE WATER FRAMEWORK DIRECTIVE, Technical Report - 2014 – 084, ISBN 978-92-79-44679-5.</p>	
Data Confidence and uncertainties	
<p>Selected analytical methods are subject to Quality Assurance Protocols and interlaboratory exercises: QA/QC through UNEP/MAP MED POL/IAEA MESL, National QA/QC Procedures</p>	
Methodology for monitoring, temporal and spatial scope	
Available Methodologies for Monitoring and Monitoring Protocols	
<p>With regard the Ecosystem Approach and IMAP implementation, there are considerable benefits to be gained from taking advantage of previous knowledge and information developed through the UNEP/MAP MED POL. These actions include (1) the use of existing experience in the design of monitoring programmes, (2) the use of existing guidance on sampling and analytical methods to inform technical aspects of ecosystem approach monitoring, (3) the use of existing sampling station networks as a framework for the ecosystem approach monitoring networks, (4) the use of existing statistical assessment tools and work on assessment criteria as the basis for the assessments of ecosystem approach data, (5) the use of existing data to describe the distributions of contaminants and effects in the sea, and (6) the use of existing time series as the basis of monitoring against a “no deterioration” target. The availability of quality assured data is of importance for the assessment of trends in pollutant concentrations.</p>	
Available data sources	
<p>i. UNEP(DEPI)/MED WG.365/Inf.5. Analysis of the trend monitoring activities and data for the MED POL Phase III and IV (1999-2010). Consultation Meeting to Review MED POL Monitoring Activities. Athens, 22-23 November 2011.</p>	

Indicator Title	17. Concentration of key harmful contaminants measured in the relevant matrix (EO9)
ii. UNEP(DEPI)/MED WG. 365/Inf.8. Development of assessment criteria for hazardous substances in the Mediterranean. Consultation Meeting to Review MED POL Monitoring Activities. Athens, 22-23 November 2011.	
Spatial scope guidance and selection of monitoring stations	
<p>The spatial scope for monitoring should include long-term master stations, distributed spatially as relevant and include local spatial refinements, such as transect sampling (for sediment and/or active biomonitoring), and therefore, is a direct function of the assessment of risks and the monitoring purpose (long-term). The selection of the sampling sites for the monitoring of contaminants and biological effects in the marine environment should consider:</p> <ul style="list-style-type: none"> • Areas of concern identified on the basis of the review of the existing information. • Areas of known past and/or present release of chemical contaminants. • Offshore areas where risk warrants coverage (aquaculture, offshore oil and gas activity, dredging, mining, dumping at sea). • Sites representative in monitoring of other sea-based (shipping) and atmospheric sources. • Reference sites: For reference values and background concentrations. • Representative sensitive pollution sites/areas at sub regional scale. • Deep-sea sites/areas of potential particular concern <p>The selected sites should allow the collection of a realistic number of samples over the years (e.g. be suitable for sediment sampling, allow sampling a sufficient number of biota for the selected species during the duration of the programme). It is essential that the monitoring strategies are being coordinated at regional and/or sub regional level. Coordination with monitoring for other Ecological Objectives is crucial for cost-effective and future integrated assessment.</p>	
Temporal Scope guidance	
<p>Sampling frequencies will be determined by the purpose and the status of the national marine monitoring.</p> <p>INITIAL PHASE MONITORING: BIOTA (mussel yearly) and SEDIMENTS (coastal every two years)</p> <p>ADVANCED PHASE MONITORING (fully completed and reported MED POL Phase III datasets): BIOTA (from 1 to 3 years according trends and chemicals) and SEDIMENTS (from 3 to 6 years depending on the characteristics of sedimentation areas and the chemical concerned).</p> <p>The temporal scope may range from seasonally variable parameters up to large time scales, e.g. sediment core monitoring (years to decades). For trend determinations the sampling frequencies will depend on the ability to detect trends considering the environmental and the analytical variability (ca. total uncertainty). It can be possible to decrease the sampling frequencies and target chemicals in cases where established time trends and levels show concentrations well below levels of concern, and without any upward trend over a number of years.</p>	
Data analysis and assessment outputs	
Statistical analysis and basis for aggregation	
Monitoring should allow the necessary statistical data treatments and long-term time-trend data analysis.	
Expected assessments outputs	
For chemical contaminants trends analysis and distribution levels for the assessment could be carried out on sub-regional and/or regional level, provided appropriate quality assured datasets are available.	

Indicator Title	17. Concentration of key harmful contaminants measured in the relevant matrix (EO9)	
<p>For the assessment of GES, it would be carried out using Mediterranean data from the MEDPOL database and applying a two level threshold classification (Background Assessment Criteria-BACs and Environmental Assessment Criteria-EACs), such as the OSPAR methodology. Therefore, the Mediterranean BACs and EACs for chemical contaminants, such as trace metals (mercury, cadmium and lead) and organic contaminants (chlorinated compounds and PAHs) in sediments and biota in the Mediterranean Sea should be applied.</p>		
<p>Known gaps and uncertainties in the Mediterranean</p> <p>Important development areas in the Mediterranean Sea over the next few years will include harmonization of monitoring targets (determinants and matrices) within assessment sub-regions, development of suites of assessment criteria integrated chemical and biological assessment methods, and review of the scope of the monitoring programmes to ensure that those contaminants which are considered to be important within each assessment area are included in monitoring programmes. Through these, and other actions, it will be possible to develop targeted and effective monitoring programmes tailored to meet the needs and conditions within each GES assessment sub-region. It has been recognized that the open and deep sea is much less covered by monitoring efforts than coastal areas. There is a need to include within monitoring programmes also areas beyond the coastal areas in a representative and efficient way, where risks warrant coverage.</p>		
<p>Contacts and version Date</p> <p>http://www.unepmap.org</p>		
Version No	Date	Author
V.2	28.04.17	MEDPOL

Common Indicator 18 (EO9): Level of pollution effects of key contaminants where a cause and effect relationship has been established⁶

Indicator Title	18. Level of pollution effects of key contaminants where a cause and effect relationship has been established (EO9)	
Relevant GES definition	Related Operational Objective	Proposed Target(s)
Concentrations of contaminants are not giving rise to acute pollution events	Effects of released contaminants are minimized	1. Contaminants effects below thresholds. Levels of biomarkers identified comply with agreed Mediterranean Background Assessment Criteria or Environmental Assessment Criteria (BACs/EACs).
Rational		
Justification for indicator selector		
<p>Upon exposure to certain dosis of harmful contaminants, marine organisms start manifesting a number of symptoms that are indicative of biological damage, the first ones appearing after a short while at the subcellular level. These 'sublethal' effects, when integrated, often converge to visible harm for the organisms and possibly to the whole population at a later stage, when it will be too late to limit the extent of biological damage resulting from environmental chemical exposure and ecosystems deterioration. Most of these symptoms have been reproducibly obtained in the laboratory (at high dosis) and the various biological mechanisms of response to major xenobiotics are now sufficiently well documented. In the latest decades, scientific research has been intensified towards these alternative cellular and subcellular methods for integrated pollution monitoring, despite it revealed a more complex panorama with samples exposed to environmental concentrations, which includes a number of confounding factors hindering the cost-effective and reliable determination of biological effects at cellular and sub-cellular levels. As a consequence, most of these methods (biomarkers), based on the chemical exposure to biological effects cause relationships, are envisaged to monitor hotpots stations, dredging materials assessments and local damage evaluations rather than for continuous long-term environmental monitoring (surveillance). Ongoing research (biomarkers, bioassays) and future research trends, suchs as 'omics' developments, will futher define the indicators and the methodologies for these common indicator for toxicological effects.</p>		
Scientific References		
<ul style="list-style-type: none"> i. European Comission, 2014. Technical report on aquatic effect-based monitoring tools. Technical Report - 2014 – 077. ii. Davies, I. M. And Vethaak, A.D., 2012. Integrated marine environmetal monitoring of chemicals and their effects. ICESCoopérative Research Report N). iii. Moore, M.N. (1985), Cellular responses to pollutants. <i>Mar.Pollut.Bull.</i>, 16:134-139 iv. Moore, M.N. (1990), Lysosomal cytochemistry in marine environmental monitoring. <i>Histochem.J.</i>, 22:187-191 v. Scarpato, R., L. Migliore, G. Alfinito-Cognetti and R. Barale (1990), Induction of micronuclei in gill tissue of <i>Mytilus galloprovincialis</i> exposed to polluted marine waters <i>Mar.Pollut.Bull.</i>, 21:74-80 vi. Lowe, D., M.N. Moore and B.M. Evans (1992), Contaminant impact on interactions of molecular probes with lysosomes in living hepatocytes from dab <i>Limanda limanda</i>. <i>Mar.Ecol.Progr.Ser.</i>, 91:135-140 vii. Lowe, D.M., C. Soverchia and M.M. Moore (1995), Lysosomal membrane responses in the blood and digestive cells of mussels experimentally exposed to fluoranthene. <i>Aquatic Toxicol.</i>, 33:105-112 		

⁶ MSFD Descriptor 8: Concentrations of contaminants are at levels not giving rise to pollution effects

Indicator Title	18. Level of pollution effects of key contaminants where a cause and effect relationship has been established (EO9)
viii.	George, S.G. and Per-Erik Olsson (1994), Metallothioneins as indicators of trace metal pollution in Biomonitoring of Coastal Waters and Estuaries, edited by J.M. Kees. Boca Raton, FL 33431, Kramer CRC Press Inc., pp.151-171
Policy Context and targets	
Policy context description	
<p>In most Mediterranean countries, the monitoring of a range of hazardous chemical substances in different marine ecosystem compartments are undertaken in response to the UNEP/MAP Barcelona Convention (1975) and its Land-Based Protocol, the UNEP/MAP MED POL Monitoring Program, as well as international, european (e.g. EU WFD or EU MSFD) or other national policy drivers. A considerable amount of founding actions are available through the pollution monitoring and assessment component of the UNEP/MAP MED POL Programme from the past decades, including monitoring pilot programmes (ecotoxicological effects of contaminants). The environmental assessments have been used for the identification and confirmation of significant marine contaminants occurrence, distributions, levels and trends; as well as, for the continuous development of monitoring strategies and guidance. With respect to the Ecosystem Approach and IMAP, their implementation will continue under the benefits gained from this past knowledge and its policy framework built in the Mediterranean Sea.</p>	
Targets	
<p>Initial targets of GES under Common Indicator 18 will be based upon data of a selected biological effects parameters and biomarkers (reflecting the scope of current programmes and research, see Indicator Justification above) and the availability of suitable agreed assessment criteria.</p>	
Policy documents	
General Policy documents	
<ul style="list-style-type: none"> i. 19th COP to the Barcelona Convention, Athens, Greece, 2016. Decision IG.22/7 - Integrated Monitoring and Assessment Programme (IMAP) of the Mediterranean Sea and Coast and Related Assessment Criteria (UNEP(DEPI)/MED IG.22/28) ii. 19th COP to the Barcelona Convention, Athens, Greece, 2016. Draft Integrated Monitoring and Assessment Guidance (UNEP(DEPI)/MED IG.22/Inf.7) iii. 18th COP to the Barcelona Convention, Istanbul, Turkey, 2013. Decision IG.21/3 - Ecosystems Approach including adopting definitions of Good Environmental Status (GES) and Targets. UNEP(DEPI)/MED IG.21/9 iv. Directive 2008/56/EC of the European Parliament and of the Council of 17 June 2008 establishing a framework for community action in the field of marine environmental policy (Marine Strategy Framework Directive). v. Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy. 	
Contaminants related Policy documents	
<ul style="list-style-type: none"> vi. UNEP (1997), The MED POL Biomonitoring Programme Concerning the Effects of Pollutants on Marine Organisms Along the Mediterranean Coasts. UNEP(OCA)/MED WG.132/3, Athens, 15 p. vii. UNEP (1997), Report of the Meeting of Experts to Review the MED POL Biomonitoring Programme. UNEP(OCA)/MED WG.132/7, Athens, 19 p. viii. Targets: UNEP(DEPI)/MED WG.421/Inf.9. Integrated Monitoring and Assessment Guidance. Agenda item 5.7: Draft Decision on Integrated Monitoring and Assessment Programme (IMAP) of the Mediterranean Sea and Coast and Related Assessment Criteria. Meeting of the MAP Focal Points. Athens, Greece, 13-16 October 2015. 	

Indicator Title	18. Level of pollution effects of key contaminants where a cause and effect relationship has been established (EO9)
Indicator analysis methods	
Indicator Definition	
<p>In marine bivalves (such as <i>Mytilus galloprovincialis</i>) and/or fish (such as <i>Mullus barbatus</i>)</p> <p>Lysosomal Membrane Stability (LMS) as a method for general status screening.</p> <p>Acetylcholinesterase (AChE) assay as a method for assessing neurotoxic effects in aquatic organisms.</p> <p>Micronucleus assay as a tool for assessing cytogenetic/DNA damage in marine organisms.</p> <p><u>Sub-indicators</u>: complementary biomarkers, bioassays and histology techniques and methods are also recommended to be carried out on a country basis (such as, comet assay, hepatic pathologies assessment, reduction of survival in air by Stress on Stress (SoS), larval embryotoxicity assay).</p>	
Methodology for indicator calculation	
<p>Lysosomal Membrane Stability (LMS) : Biological techniques (neutral red retention), including microscopy</p> <p>Acetylcholinesterase (AChE) assay: Biochemical techniques, including spectrophotometry</p> <p>Micronucleus assay: Biochemical techniques, including microscopy</p> <p>Additional parameters to be recorded: biometrics (size/length, age), biological parameters such as condition index (mussels), condition factor, gonadosomatic index, hepatosomatic index (fish) and data on temperature, salinity and oxygen dissolved.</p>	
Indicator units	
<p>(retention) minutes - Lysosomal Membrane Stability (LMS)</p> <p>nmol/min mg protein in gills (bivalves) - Acetylcholinesterase (AChE) assay</p> <p>Number of cases, ‰ in haemocytes - Micronucleus assay</p>	
List of Guidance documents and protocols available	
<ol style="list-style-type: none"> i. European Commission, 2014. Technical report on effect-based monitoring tools. Technical Report 2014 – 077. European Commission, 2014. ii. UNEP/RAMOG: Manual on the Biomarkers Recommended for the UNEP/MAP MED POL Biomonitoring Programme. UNEP, Athens, 1999. iii. UNEP/MAP, 2005. Fact sheets on Marine Pollution Indicators. Meeting of the UNEP/MAP MED POL National Coordinators. Barcelona, Spain, 24-27 May 2005. UNEP(DEC)/MED/ WG.264/ Inf.14. UNEP, Athens. iv. ICES Cooperative Research Report. No.315. Integrated marine environmental monitoring of chemicals and their effects. I.M. Davies and D. Vethaak Eds., November, 2012. 	
Data Confidence and uncertainties	

Indicator Title	18. Level of pollution effects of key contaminants where a cause and effect relationship has been established (EO9)
Selected analytical validated methods should be subject to Quality Assurance Protocols and interlaboratory exercises: QA/QC through UNEP/MAP MED POL intercalibration supported exercises in agreement with University of Piemonte Orientale (Italy).	
Methodology for monitoring, temporal and spatial scope	
Available Methodologies for Monitoring and Monitoring Protocols	
<p>With regard the Ecosystem Approach and IMAP implementation, there are considerable benefits to be gained from taking advantage of previous knowledge and information developed through the UNEP/MAP MED POL. These actions include (1) the use of existing experience in the design of monitoring programmes, (2) the use of existing guidance on sampling and analytical methods to inform technical aspects of ecosystem approach monitoring, (3) the use of existing sampling station networks as a framework for the ecosystem approach monitoring networks, (4) the use of existing statistical assessment tools and work on assessment criteria as the basis for the assessments of ecosystem approach data, (5) the use of existing data to describe the distributions of contaminants and effects in the sea, and (6) the use of existing time series as the basis of monitoring against a “no deterioration” target. The availability of quality assured data is of importance for the assessment of trends. Therefore, based on the work already carried out, the results of the intercalibration exercises and the scientific and technical publications within the UNEP/MAP MED POL programme on biological effects monitoring, there is a network of laboratories in the Mediterranean region with the capacity to carry out biomonitoring activities, in line with the new monitoring requirements.</p>	
Available data sources	
<ol style="list-style-type: none"> i. MED POL Database. ii. UNEP/RAMOGGE: Manual on the Biomarkers Recommended for the UNEP/MAP MED POL Biomonitoring Programme. UNEP, Athens, 1999. 	
Spatial scope guidance and selection of monitoring stations	
<p>The spatial scope for monitoring should include long-term master stations, distributed spatially as relevant and include local spatial refinements, such as transect sampling (for sediment and/or active biomonitoring), and therefore, is a direct function of the assessment of risks and the monitoring purpose (long-term). The selection of the sampling sites for the monitoring of contaminants and biological effects in the marine environment should consider:</p>	
<ul style="list-style-type: none"> • Areas of concern identified on the basis of the review of the existing information. • Areas of known past and/or present release of chemical contaminants. • Offshore areas where risk warrants coverage (aquaculture, offshore oil and gas activity, dredging, mining, dumping at sea). • Sites representative in monitoring of other sea-based (shipping) and atmospheric sources. • Reference sites: For reference values and background concentrations. • Representative sensitive pollution sites/areas at sub regional scale. • Deep-sea sites/areas of potential particular concern 	
<p>The selected sites should allow the collection of a realistic number of samples over the years (e.g. allow to sample sufficient number of biota for the selected species during the duration of the programme). It is essential that the monitoring strategies are being coordinated at regional and/or sub regional level, in particular with chemical monitoring.</p>	

Indicator Title	18. Level of pollution effects of key contaminants where a cause and effect relationship has been established (EO9)
The coordination with monitoring for other Ecological Objectives is crucial for cost-effective and future integrated assessment.	
Temporal Scope guidance	
<p>Sampling frequencies will be determined by the purpose and the status of the national marine monitoring.</p> <p>INITIAL PHASE MONITORING: BIOTA (mussel yearly) and SEDIMENTS (coastal every two years), as for chemical monitoring focusing on few locations (hotspots and reference stations) if biological effects will be determined for both.</p> <p>ADVANCED PHASE MONITORING (fully completed and reported MED POL Phase III datasets, including biological effects): At these stage the objective should be the integration of the chemical and biological monitoring on a efficient manner. Therefore, a refinement of the biological effects long-term monitoring should be implemented and maintained based on previous pilot monitoring activities (Initial Phase).</p> <p>For trend determinations the sampling frequencies will depend on the ability to detect trends considering the environmental and the analytical variability (ca. total uncertainty). It can be possible to decrease the sampling frequencies in cases where established time trends and levels show concentrations well below levels of concern, and without any upward trend over a number of years.</p>	
Data analysis and assessment outputs	
Statistical analysis and basis for aggregation	
Monitoring should allow the necessary statistical data treatments and long-term time-trend analysis.	
Expected assessments outputs	
<p>For biological effects, trends analysis and distribution levels could be carried out on sub-regional level, provided appropriate quality assured datasets are available. For the integrated assessment of GES, it would be carried out using Mediterranean data from the MEDPOL database and applying a two level threshold classification (such as the OSPAR methodology). Assessing biomarker responses against Background Assessment Criteria (BACs) and Environmental Assessment Criteria (EACs) allows establishing if the responses measured are at levels that are not causing deleterious biological effects, at levels where deleterious biological effects are possible or at levels where deleterious biological effects are likely in the long-term. In the case of biomarkers of exposure, only BAC can be estimated, whereas for biomarkers of effects both BAC and EAC can be established.</p>	
Known gaps and uncertainties in the Mediterranean	
<p>Important development areas in the Mediterranean Sea over the next few years will include harmonization of monitoring targets (determinants and matrices) within assessment sub-regions, development of suites of assessment criteria integrated chemical and biological assessment methods, and review of the scope of the monitoring programmes to ensure that those contaminants which are considered to be important within each assessment area are included in monitoring programmes. Through these, and other actions, it will be possible to develop targeted and effective monitoring programmes tailored to meet the needs and conditions within each GES assessment sub-region.</p> <p>It has been recognized that the open and deep sea is much less covered by monitoring efforts than coastal areas. There is a need to include within monitoring programmes also areas beyond the coastal areas in a representative and efficient way, where risks warrant coverage.</p>	

Indicator Title	18. Level of pollution effects of key contaminants where a cause and effect relationship has been established (EO9)	
Contacts and version Date		
http://www.unepmap.org		
Version No	Date	Author
V.2	28.04.17	MEDPOL

Common Indicator 19 (EO9): Occurrence, origin (where possible), and extent of acute pollution events (e.g. slicks from oil, oil products and hazardous substances) and their impact on biota affected by this pollution

Indicator Title	19. Occurrence, origin (where possible), and extent of acute pollution events (e.g. slicks from oil, oil products and hazardous substances) and their impact on biota affected by this pollution (EO9)	
Relevant GES definition	Related Operational Objective	Proposed Target(s)
Occurrence of acute pollution events is reduced to the minimum.	Acute pollution events are prevented and their impacts are minimized.	1. Decreasing trend in the occurrences of acute pollution events. Achieve the elimination of intentional pollution of the marine environment by oil and other harmful and noxious substances (HNS) and the minimization of accidental discharge of such substances.
Rational		
<p>Justification for indicator selector</p> <p>Oil and HNS products released at sea may impact an environment as follows:</p> <ul style="list-style-type: none"> - physical smothering with an impact on physiological functions; - chemical toxicity giving rise to lethal or sub-lethal effects or causing impairment of cellular functions; - ecological changes, primarily the loss of key organisms from a community and the takeover of habitats by opportunistic species; - indirect effects, such as the loss of habitat or shelter and the consequent elimination of ecologically important species. <p>In addition, pollution by oil and HNS have socio-economic impact (recreational activities; fisheries, maricultures as well as other activities such as power plants, shipping, salt production or seawater desalination). Occurrence of acute pollution events involving oil or HNS and need to be measured and possible impacts monitored.</p>		
Scientific References		
<p>ITOPF. "Effect of oil pollution on the marine environment". ITOPF, Technical Information Paper 13.</p> <p>GESAMP. Report n° 75: "Estimates of Oil Entering the Marine Environment from Sea-Based Activities", IMO/FAO/UNESCO-IOC/WMO/WHO/IAEA/UN/UNEP Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection (2007).</p> <p>Zeina G. Kassaify, Rana H. El Hajj, Shady K. Hamadeh, Rami Zurayk and Elie K. Barbour. "Impact of Oil Spill in the Mediterranean Sea on Biodiversified Bacteria in Oysters", Journal of Coastal Research, Vol. 25, No. 2 (2009), pp. 469-473. Published by: Coastal Education & Research Foundation, Inc.</p> <p>Peterson CH, Rice SD, Short JW, Esler D, Bodkin JL, Ballachey BE, Irons DB. "Longterm ecosystem response to the Exxon Valdez oil spill". Science 302:2082–2086(2003).</p>		
Policy Context and targets		
Policy context description		

Indicator Title	19. Occurrence, origin (where possible), and extent of acute pollution events (e.g. slicks from oil, oil products and hazardous substances) and their impact on biota affected by this pollution (EO9)
<p>Acute pollution from oil and other hazardous substances, resulting either from maritime casualties or from ships' routine operations, are addressed in a number of international conventions under the aegis of the International Maritime Organization (IMO is the UN agency regulating pollution incidents from ships worldwide), some of which provide for stricter regimes in the Mediterranean Sea, including discharges of oil and oily mixtures. At regional level, the UNEP/MAP-Barcelona Convention and its Prevention and Emergency Protocol are crucial instruments enabling cooperation and joint-action to support all Mediterranean Coastal States implementing and enforcing IMO Conventions on pollution prevention and preparedness and response to oil and Hazardous and Noxious Substances (HNS) spills.</p> <p>The Regional Marine Pollution Emergency Response Centre for the Mediterranean Sea (REMPEC), administrated by the IMO and operating within the framework of UNEP/MAP, is responsible for the implementation of the Prevention and Emergency Protocol. The Centre maintains a database on alerts and accidents causing or likely to cause pollution of the sea by oil (since 1977) and by other harmful substances (since 1989) in the Mediterranean Sea. Further, following the adoption by the Contracting Parties to the Barcelona Convention of the Protocol for the Protection of the Mediterranean Sea against Pollution from the Exploration and Exploitation of the Continental Shelf and the Seabed and its Subsoil (Offshore Protocol), Parties should endeavor to ratify the Protocol and develop and adopt monitoring procedures and programmes for offshore activities, which is envisaged to take place building on the IMAP of the EcAp.</p>	
<p>Targets</p> <p>To measure the trend of occurrence of oil and HNS accidental pollution events, the following indicator can be used: number of pollution events (of 50 cubic meters or more) per year in each Contracting Party marine waters. A target could be a maximum of 1 occurrence per year per Contracting Party. Regarding illicit discharges of oil and oily waters (MARPOL Convention Annex I), minimum tolerance (near to 0 events) can be retained.</p>	
<p>Policy documents</p> <p>General Policy documents</p> <ol style="list-style-type: none"> i. 19th COP to the Barcelona Convention, Athens, Greece, 2016. Decision IG.22/7 - Integrated Monitoring and Assessment Programme (IMAP) of the Mediterranean Sea and Coast and Related Assessment Criteria (UNEP(DEPI)/MED IG.22/28) ii. 19th COP to the Barcelona Convention, Athens, Greece, 2016. Draft Integrated Monitoring and Assessment Guidance (UNEP(DEPI)/MED IG.22/Inf.7) iii. 18th COP to the Barcelona Convention, Istanbul, Turkey, 2013. Decision IG.21/3 - Ecosystems Approach including adopting definitions of Good Environmental Status (GES) and Targets. UNEP(DEPI)/MED IG.21/9 <p>Related Policy documents</p> <ol style="list-style-type: none"> iv. Establishment of a Mediterranean Network of Law Enforcement Officials relating to MARPOL within the framework of the Barcelona Convention. UNEP(DEPI)/MED IG.21/9 Annex II – Thematic Decisions (p. 181). v. Protocol concerning cooperation in preventing pollution from ships and, in case of emergency, combating pollution of the Mediterranean Sea (2002) (“Prevention and Emergency” Protocol of the Barcelona Convention) vi. Protocol for the Protection of the Mediterranean Sea against Pollution from the Exploration and Exploitation of the Continental Shelf and the Seabed and its Subsoil (Offshore Protocol of the Barcelona Convention) 	

Indicator Title	19. Occurrence, origin (where possible), and extent of acute pollution events (e.g. slicks from oil, oil products and hazardous substances) and their impact on biota affected by this pollution (EO9)
vii.	International Convention for the Prevention of Pollution from Ships (MARPOL Convention), specifically its Annex I (Regulations for the Prevention of Pollution by Oil), Annex II (Regulations for the Control of Pollution by Noxious Liquid Substances in Bulk) and Annex III (Harmful Substances carried at Sea in Packaged Form).
viii.	International Convention on Oil Pollution Preparedness, Response and Cooperation (OPRC, 1990) and Protocol on Preparedness, Response and Cooperation for pollution incidents by hazardous and noxious substances (OPRC-HNS Protocol).
Indicator analysis methods	
Indicator Definition In the case of oil and HNS acute pollution events, the indicator will be obtained from the information of oil and HNS pollution events recorded and submitted in the Mediterranean Sea each year.	
Methodology for indicator calculation Under the 2002 Prevention and Emergency Protocol, Contracting Parties have an obligation (Article 9) to inform on the following (see the format below): (1) all accidents causing or likely to cause pollution of the sea by oil and other harmful substances; (2) the presence, characteristics and extent of spillages of oil or other harmful substances observed at sea which are likely to present a serious and imminent threat to the marine environment or to the coast or related interests of one or more of the Contracting Parties; (3) their assessments and any pollution combating actions taken or envisaged to be taken; and (4) the evolution of the situation. BCRS (Barcelona Convention Reporting System) format: (a) accident location (latitude and longitude or closest shore location); (b) accident type* (*cargo transfer failure, contact, collision, engine breakdown, fire/explosion, grounding, foundering/weather, hull structural failure, machinery breakdown, other); (c) vessel IMO number or vessel name; (d) vessel flag; (e) whether any product has been released or not. If yes, the type of product released (Oil/Hazardous and Noxious Substances) should be specified; and (f) whether any actions have been taken or not. If yes, the actions taken should be specified. In addition to monitoring pollution events occurrences against the target (incidents involving oil or hazardous substances that are < or = 1 event per year in each Contracting Parties waters), it is recommended to carry out a trend analysis in order to measure performance against the target. Data on actual pollution events from ships would be collected every year and compared to the data for the previous year, to calculate a % increase or a % decrease in occurrences yearly frequency.	
Indicator units	
The Guidelines for Co-operation in Combating Marine Oil Pollution in the Mediterranean (UNEP/IG.74/5, UNEP/MAP, 1987) recommended Parties to report to REMPEC all spillages or discharges of oil in excess of 100 cubic metres. To align with the <i>Revised reporting formats for a mandatory reporting system under MARPOL 73/78</i> ("one-line" entry format) adopted by IMO in 1996 (see MEPC/Circ.318), a Joint Session of MEDPOL and REMPEC Focal Points Meeting agreed to report spillages over 50 cubic meters.	

Indicator Title	19. Occurrence, origin (where possible), and extent of acute pollution events (e.g. slicks from oil, oil products and hazardous substances) and their impact on biota affected by this pollution (EO9)
List of Guidance documents and protocols available	
<ul style="list-style-type: none"> i. ITOPF. “<i>Aerial Observation of Marine Oil Spills</i>”, Technical Information Paper 1; ii. ITOPF. “<i>Recognition of Oil on Shorelines</i>”, Technical Information Paper 6; iii. ITOPF. “<i>Fate of Marine Oil Spills</i>”, Technical Information Paper 2. iv. ITOPF. “<i>Response to Marine Chemical Incidents</i>”, Technical Information Paper 17. v. Bonn Agreement. “<i>Bonn Agreement Oil Appearance Code</i>”. vi. IPIECA/IMO/GPO/CEDRE: “<i>Aerial Observation of Oil Spills at Sea</i>”, February 2015. vii. CEDRE: “<i>Surveying Sites Polluted by Oil</i>” (April 2006). viii. REMPEC: “<i>Mediterranean Guidelines on Oiled Shorelines Assessment</i>” (September 2009). ix. GESAMP: “<i>Revised GESAMP Hazard Evaluation Procedure for Chemical Substances Carried by Ships</i>” (2014). x. IMO Codes: <ul style="list-style-type: none"> - For packaged goods: International Maritime Dangerous Goods Code (IMDG Code). - For Bulk liquids: International Code for the Construction and Equipment of Ships Carrying Dangerous Chemicals in Bulk (IBC Code). - For Gases: International Code for the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk (IGC Code). - For solids in bulk: Appendix 9 of Code of Safe Practice for Solid Bulk Cargoes (BC Code) if also covered by IMDG Code in packaged form. 	
Data confidence and uncertainties	
<p>Although characterization of impact of oil and oily products at sea and on shore is well documented and response strategies well defined, there has been much less investment in research for HNS spills. Chemical spills occur at a much lower frequency than spills of oil and involve a very large variety of products with different physical and toxicity properties. Therefore, the characterization of impacts from HNS pollution due to maritime casualties is more complex and response strategies and indicators will vary according to the specific chemical product involved.</p>	
Methodology for monitoring, temporal and spatial scope	
Available methodologies for monitoring and monitoring Protocols	
<p>As oil and HNS accidental spills and discharges from ships take the form of acute pollution events, there are no specific pollution methodologies for systematic oil and HNS pollution surveillance in IMO Conventions and guidance documents, where monitoring is essentially addressed from the perspective of ships’ compliance monitoring (flag state surveys; coastal state and port state controls) or in the context of pollution response operations. In this latter case, a monitoring protocol has been developed to detect and survey pollution events.</p>	
<p>Pollution events are monitored using the following methods/protocols:</p>	
Oil:	
<ul style="list-style-type: none"> - Expert human eye observation; - Aerial observation (human eye observation and/or remote sensing equipment); - Satellite imagery analysis; - Sampling and analysis. 	
<p>Monitoring at sea will provide the following information:</p>	
<ul style="list-style-type: none"> - Volume of oil: use ITOPF guidance based on oil type and appearance to assess thickness (mm) and volume of oil (m³/km²) at sea, or the guidance of the Bonn Agreement Oil Appearance Code (BAOAC) identifying the following relations between oil appearances and oil volume: <ul style="list-style-type: none"> 1 sheen, 0.15-0.3 m³/km² 2 rainbow, 0.3 - 5 m³/km² 	

Indicator Title	19. Occurrence, origin (where possible), and extent of acute pollution events (e.g. slicks from oil, oil products and hazardous substances) and their impact on biota affected by this pollution (EO9)
	<p>3 metallic, 5 - 50 m³/km²</p> <p>4 discontinuous true color, 50-200 m³/km²</p> <p>5 continuous true color, >200 m³/km².</p> <ul style="list-style-type: none"> - Location and coverage of slick at sea (latitude and longitude - GPS); - Oil characteristics (persistent vs. non persistent / viscosity); - Origin of slick (if visible ship name and IMO number, offshore installations ID number). <p>On-shore monitoring will be used to assess the extent of impacted shorelines, type and degree of contamination as well as impact on habitats and wildlife casualties.</p> <p>HNS: Detection of HNS pollution events and assessment of impacts is primarily achieved on site by expert human eye observation, complemented with real time monitoring, sampling and analysis, as well as the use of modelling tools. Conclusions of any risk assessment for HNS will be based on a number of information including identification of incident circumstances and location; identification of the chemical involved, its properties / toxicity, and its form (packaged / bulk) as well as identification of sensitive neighbouring areas and environment conditions. Further, Article 18 of the Offshore Protocol states that in cases of emergency the Contracting Parties shall implement mutatis mutandis the provisions of the Emergency Protocol.</p> <p>Available data sources</p> <p>Because pollution events originating from ships must lead to response operations and investigations, there are a number of reporting obligations and reporting protocols that are useful for the purpose of determining the frequency of occurrences and assess trends:</p> <ol style="list-style-type: none"> (1) Contents and forms of reports that ships must send following maritime casualties involving oil and other hazardous substances are detailed in MARPOL Protocol I. In addition, IMO has developed the General Principles for Ship Reporting Systems and Ship Reporting Requirements, including Guidelines for Reporting Incidents Involving Dangerous Goods, Harmful Substances and/or Marine Pollutants, containing recommendations on reporting requirements (when to report, information required, whom to report to). (2) At regional level, REMPEC has developed a oil pollution reporting format (POLREP) for use between Contracting Parties to the Prevention and Emergency Protocol of the Barcelona Convention and between these Contracting Parties and REMPEC when a pollution event at sea has occurred or when there is a threat of pollution. (3) With respect to illegal discharges of oil from ships, REMPEC has organised pilot projects on surveillance and monitoring of oil discharges et sea in the past. These initiatives have led to the creation of the Mediterranean Network of Law Enforcement Officials (MENELAS). This network works as a forum where information is exchanged and it is expected that data on pollution incidents (as well as on investigation and prosecution as the case may be) will be collected. REMPEC presently acts as Secretariat for the MENELAS initiative, which has developed a reporting format. (4) The Reporting System for the Barcelona Convention and its Protocols (BCRS) also requests information on spill incidents that have occurred during a biennium. <p>Databases available:</p> <p>- REMPEC Alert and Accidents Database available in the following versions:</p> <ul style="list-style-type: none"> • On-line database (accidents can be sorted by: date; accident location (country); vessel type; and release quantity and type.) • Report containing the data and statistical analysis; and • A Geographical Information System (GIS).

Indicator Title	19. Occurrence, origin (where possible), and extent of acute pollution events (e.g. slicks from oil, oil products and hazardous substances) and their impact on biota affected by this pollution (EO9)	
<p>- MEDGIS-MAR 2012-2015, http://medgismar.rempec.org/ provides data (private access) on offshore, marine incidents, oil handling facilities, and response equipment.</p> <p>- IMO Database: IMO maintains a Global Integrated Shipping Information System (GISIS) http://gisis.imo.org with a module on marine casualties and incidents.</p>		
<p>Spatial scope guidance and selection of monitoring stations REMPEC will continue to be the central organisation coordinating and maintaining data on oil and HNS acute events and pollution surveillance in the Mediterranean Sea. REMPEC has implemented pilot projects involving aerial surveillance exercises and satellite imagery analysis jointly with Mediterranean Coastal States and this effort should be strengthened.</p>		
<p>Temporal Scope guidance As oil and HNS pollution incidents from ships occurs unexpectedly (as a consequence of maritime casualties) or are not systematic (MARPOL illicit discharges), it is expected that pollution monitoring will continue to essentially take place “in real time” when pollution incidents actually happen or are detected.</p>		
<p>Data analysis and assessment outputs</p>		
<p>Statistical analysis and basis for aggregation Frequencies and quantitative statistical analysis. The basis for aggregation would be a “nested approach” over a geographical scale. Trend analysis to calculate the percentage of occurrences for oil and HNS incidents over a period of time (yearly) in the Mediterranean Sea.</p>		
<p>Expected assessments outputs Temporal trends analysis and distribution maps. If possible, relate this trend to the maritime traffic crossing the Mediterranean Sea.</p>		
<p>Known gaps and uncertainties in the Mediterranean While Contracting Parties to the Barcelona Convention and the Prevention and Emergency Protocol have a pollution monitoring and reporting obligation, data submitted to REMPEC are still scarce. Thus the main aim during the Initial Phase of the IMAP will be to strengthen monitoring efforts towards this already existing obligation.</p>		
<p>Contacts and version Date</p>		
<p>http://www.rempec.org</p>		
Version No	Date	Author
V.1	28.04.17	MEDPOL/REMPEC

Common Indicator 20 (EO9): Actual levels of contaminants that have been detected and number of contaminants which have exceeded maximum regulatory levels in commonly consumed seafood⁷

Indicator Title	20. Actual levels of contaminants that have been detected and number of contaminants which have exceeded maximum regulatory levels in commonly consumed seafood (EO9)	
Relevant GES definition	Related Operational Objective	Proposed Target(s)
Concentrations of contaminants are within the regulatory limits for consumption by humans. No regulatory levels of contaminants in seafood are exceeded.	Levels of known harmful contaminants in major types of seafood do not exceed established standards	1. Concentrations of contaminants are within the regulatory limits set by legislation. 2. Decreasing trend in the frequency of cases of seafood samples above regulatory limits for contaminants
Rational		
<p>Justification for indicator selector</p> <p>One of the potential risks associated with the occurrence of harmful substances (chemicals, nanoparticles, microplastics, toxins) in the marine environment is the human exposure through commercial fish and shellfish species (primarily, from wild fisheries and aquaculture). These organisms are exposed to environmental contaminants which enter their organism through different mechanisms and pathways according their trophic level, which include from filter feeding to predatory strategies (crustaceans, bivalves, fish). Consequently, there exist both bioaccumulation and biomagnification processes of these chemicals released in the marine environment. Common examples are the well-known bioaccumulation of metals and organic compounds in commercial bivalve species (such as the <i>Mytilus galloprovincialis</i> in the Mediterranean Sea) or alkyl mercury compounds (methylmercury) in tuna fish, which should be increased by new and emerging contaminants in the near future.</p>		
Scientific References		
<ul style="list-style-type: none"> i. Vandermeersch, G. <i>et al.</i> 2015. Environmental contaminants of emerging concern in seafood – European database on contaminant levels. <i>Environmental Research</i>, 143B, 29-45. ii. Maulvault, A.M. <i>et al.</i> 2015. Toxic elements and speciation in seafood samples from different contaminated sites in Europe. <i>Environmental Research</i>, 143B, 72-81. iii. Molin, M. <i>et al.</i>, 2015. Arsenic in the human food chain, biotransformation and toxicology – Review focusing on seafood arsenic. <i>Journal of Trace Elements in Medicine and Biology</i>, 31, 249-259. iv. Bacchiocchi, S. <i>et al.</i> 2015. Two-year study of lipophilic marine toxin profile in mussels of the North-central Adriatic Sea: First report of azaspiracids in Mediterranean seafood. <i>Toxicon</i>, 108, 115-125. v. Perello, G. <i>et al.</i>, 2015. Human exposure to PCDD/Fs and PCBs through consumption of fish and seafood in Catalonia (Spain): Temporal trend. <i>Food and Chemical Toxicology</i>, 81, 28-33. vi. Zaza, S. <i>et al.</i> 2015. Human exposure in Italy to lead, cadmium and mercury through fish and seafood product consumption from Eastern Central Atlantic Fishing Area. <i>Journal of Food Composition and Analysis</i>, 40, 148-153. vii. Cruz, R. Brominated flame retardants and seafood safety: A review. <i>Environment International</i>, 77, 116-131. viii. Dellate, E. <i>et al.</i> 2014. Individual methylmercury intake estimates from local seafood of the Mediterranean Sea, in Italy. <i>Regulatory Toxicology and Pharmacology</i>, 69, 105-112. 		

⁷ MSFD Descriptor 9: Contaminants in fish and other seafood for human consumption do not exceed levels established by Union legislation or other relevant standards

Indicator Title	20. Actual levels of contaminants that have been detected and number of contaminants which have exceeded maximum regulatory levels in commonly consumed seafood (EO9)
ix.	Spada, L. <i>et al.</i> 2014. Mercury and methylmercury concentrations in Mediterranean seafood and surface sediments, intake evaluation and risk for consumers. <i>International Journal of Hygiene and Environmental Health</i> , 215, 418-42.
Policy Context and targets	
Policy context description	
<p>The understanding of the health risks to humans (maximum levels, intake, toxic equivalent factors, etc.) and the food safety prevention, including emerging contaminants, through the consumption of potentially poisoned seafood is a challenge and a priority policy issue for governments, as well as a major societal concern. There are different initiatives and regulations at national and international levels mainly for the fishery economic sector, which have established public health recommendations and maximum regulatory levels for different contaminants in numerous marine commercial target species. Methylmercury poisoning continues as a global priority policy issue and in 2013 the Global Legally Binding Treaty (Minamata Convention on Mercury) was launched by UNEP. Further, the US Food and Drugs Administration, the European Food Safety Authority and FAO are also national and international authorities with regard seafood safety.</p>	
Targets	
<p>Initial targets of GES under Common Indicator 20 will be to maintain the chemical contaminants of human health concern under regulatory levels in seafood set/recommended/agreed by national and/or international authorities and their trends with regard their occurrence should decrease pointing towards zero events.</p>	
Policy documents	
General Policy documents	
<ul style="list-style-type: none"> i. 19th COP to the Barcelona Convention, Athens, Greece, 2016. Decision IG.22/7 - Integrated Monitoring and Assessment Programme (IMAP) of the Mediterranean Sea and Coast and Related Assessment Criteria (UNEP(DEPI)/MED IG.22/28) ii. 19th COP to the Barcelona Convention, Athens, Greece, 2016. Draft Integrated Monitoring and Assessment Guidance (UNEP(DEPI)/MED IG.22/Inf.7) iii. 18th COP to the Barcelona Convention, Istanbul, Turkey, 2013. Decision IG.21/3 - Ecosystems Approach including adopting definitions of Good Environmental Status (GES) and Targets. UNEP(DEPI)/MED IG.21/9 iv. Directive 2008/56/EC of the European Parliament and of the Council of 17 June 2008 establishing a framework for community action in the field of marine environmental policy (Marine Strategy Framework Directive). v. Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy. 	
Contaminants related Policy documents	
<ul style="list-style-type: none"> vi. EU 1881/2006. Commission Regulation (EC) No 1881/2006 of 19 December 2006 setting maximum levels for certain contaminants in foodstuffs. European Commission. vii. US FDA http://www.fda.gov/Food/FoodborneIllnessContaminants/Metals/ucm115644.htm viii. Joint FAO/WHO Expert consultation on the risk and benefits of fish consumption. FAO Fisheries and Aquaculture Report No. 978. ISSN 2070-6987. Rome, January, 2010. ix. List of maximum levels for contaminants in foods set by the FAO/WHO Codex Alimentarius Commission can be found at ftp://ftp.fao.org/codex/Meetings/cccf/cccf7/cf07_INFe.pdf x. Global Legally Binding Treaty (Minamata Convention on Mercury) http://www.mercuryconvention.org/ 	

Indicator Title	20. Actual levels of contaminants that have been detected and number of contaminants which have exceeded maximum regulatory levels in commonly consumed seafood (EO9)
Indicator analysis methods	
<p>Indicator Definition</p> <p>Number of detected regulated contaminants* in commercial species.</p> <p>Number of detected regulated contaminants* exceeding regulatory limits.</p> <p>(*list of contaminants can be found in the links from the previous section)</p> <p>Additional parameters required: sample identification, location, date and biometrics</p> <p><u>Sub-indicators</u>: other relevant chemicals and emerging pollutants are recommended to be carried out on a country decision basis.</p>	
<p>Methodology for indicator calculation</p> <p>Number of detected contaminants: monitoring by national regulatory and inspection bodies through statistics and databases</p> <p>Number of detected contaminants exceeding regulatory limits: monitoring by national regulatory and inspection bodies through statistics and databases</p>	
<p>Indicator units</p> <p>(frequencies, %) - Number of detected contaminants in individual commercial species</p> <p>(frequencies, %) - Number of detected contaminants exceeding regulatory limits in appropriate units, for example, mg/kg fresh weight (parts per million, ppm, fresh weight) or µg/g fresh weight (part per billion, ppb, fresh weight).</p>	
<p>List of Guidance documents and protocols available</p> <p>Refer to UNEP Methods and Protocols for Marine Pollution, as well as from other regional conventions for the determination of contaminants in marine organisms (Note, pre-treatment of samples from marine organisms might differ between sample preparation and analytical methods and care should be taken when comparing the different reference values.</p>	
<p>Data Confidence and uncertainties</p> <p>The data confidence is directly related to the number of available tests performed to commercial species and their regularity, beyond the analytical quality assurance (QA/QC) related to the determination of contaminants in fish</p>	
Methodology for monitoring, temporal and spatial scope	
<p>Available Methodologies for Monitoring and Monitoring Protocols</p> <p>There are no directly-applicable monitoring protocols in order to fulfil the requirement of this Common Indicator. Risk-based public health methodologies to define the monitoring are recommend.</p>	
<p>Available data sources</p> <p>At present national databases (if available), research papers and environmental databases (the MED POL Database)</p>	
Spatial scope guidance and selection of monitoring stations	

Indicator Title	20. Actual levels of contaminants that have been detected and number of contaminants which have exceeded maximum regulatory levels in commonly consumed seafood (EO9)	
<p>Risk-based methodologies to define monitoring are recommended. Guidance for monitoring stations: environmental monitoring, fish markets, aboard fishing fleets, sampling at regular inspections by national authorities</p>		
<p>Temporal Scope guidance</p> <p>Risk-based methodologies to define monitoring are recommended. The temporal scope is highly linked to the data confidence and uncertainty of the indicator. Yearly statistics would be the basic time period.</p>		
<p>Data analysis and assessment outputs</p>		
<p>Statistical analysis and basis for aggregation</p> <p>Monitoring should allow the necessary statistical data treatments and long-term time-trend evaluations. Geographic reporting scales (within IMAP implementation) should be also considered in terms of indicator aggregation:</p> <ol style="list-style-type: none"> (1) Whole region (i.e. Mediterranean Sea); (2) Mediterranean sub-regions, as presented in the Initial Assessment of the Mediterranean Sea, UNEP(DEPI)/MED IG.20/Inf.8; (3) Coastal waters and other marine waters; (4) Subdivisions of coastal waters provided by Contracting Parties 		
<p>Expected assessments outputs</p> <p>Assessment outputs would be based on trend analysis and annual statistics</p>		
<p>Known gaps and uncertainties in the Mediterranean</p> <p>As this is a new Common Indicator within the context of marine environmental protection policy (<i>ca.</i> Ecosystem Approach and IMAP implementation) its applicability beyond food consumer protection and public health would need to be determined, although intuitively reflects the health status of the marine environment in terms of their delivery of benefits (e.g. fisheries industry). Thus, monitoring protocols, risk-based approaches, analytical testing and assessment methodologies would need to be further examined between Contracting Parties national food safety authorities, research organisations and/or environmental agencies.</p>		
<p>Contacts and version Date</p>		
<p>http://www.unepmap.org</p>		
<p>Version No</p>	<p>Date</p>	<p>Author</p>
<p>V.2</p>	<p>28.04.17</p>	<p>MEDPOL</p>

Common Indicator 21 (EO9): Percentage of intestinal enterococci concentration measurements within established standards

Indicator Title	21. Percentage of intestinal enterococci concentration measurements within established standards (EO9)	
Relevant GES definition	Related Operational Objective	Proposed Target(s)
Concentrations of intestinal enterococci are within established standards	Water quality in bathing waters and other recreational areas does not undermine human health	1. Increasing trend in the measurements within established standards (levels of intestinal enterococci comply with established national or international standards, such as EU 2006/7 Directive)
Rational		
Justification for indicator selector		
<p>The Mediterranean Sea continues to attract every year an ever increasing number of international and local tourists that among their activities use the sea for recreational purposes. The establishment of sewage treatment plants and the construction of submarine outfall structures have decreased the potential for microbiological pollution, despite major hotspots still exist. High levels of enterococci bacteria in recreational marine waters (coasts, beaches, tourism spots, etc) are known to be indicative of human pathogens due to non-treated discharges into the marine environment and cause human infections. Therefore, enterococci concentrations are frequently used as a faecal indicator bacteria, or general indicators of faecal contamination. Particularly, <i>E. faecalis</i> and <i>E. faecium</i> species are related to urinary tract infections, endocarditis, bacteriemia, neonatal infections, central nervous system, abdominal and pelvic infections. It has been also shown a correlation between elevated levels of enterococci and the risks of human gastroenteritis. It has been suggested and later on demonstrated that <i>enterococci sp.</i> might be more appropriate than traditional <i>Escherichia coli</i> in marine waters as an index of faecal pollution. Currently, is the only faecal indicator bacteria recommended by the US Environmental Protection Agency (EPA) for brackish and marine waters, since they correlate better than faecal coliforms or <i>E.coli</i>. The abundance in human and animal feces and the simplicity of the analytical methods for their measurements has favoured the use of enterococci as a surrogate of polluted recreational waters, and therefore, as a Common Indicator for GES</p>		
Scientific References		
<ul style="list-style-type: none"> i. Cabelli VJ, Dufour AP, Levin MA, McCabe LJ, Haberman PW. 1979. Relationship of microbial indicators to health effects at marine bathing beaches. <i>Am. J. Public Health</i>, 69, 690–696 ii. Byappanahalli, MN. <i>et al.</i>, 2012. Enterococci in the environment. <i>Microbiol. Mol. Biol. Rev.</i>, 76, 685-706 iii. Moellering RC Jr. 1992. Emergence of Enterococcus as a significant pathogen. <i>Clin. Infect. Dis.</i>, 15, 58–62 iv. Mote BL, Turner JW, Lipp EK. 2012. Persistence and growth of the faecal indicator bacteria enterococci in detritus and natural estuarine plankton communities. <i>Appl. Environ. Microbiol.</i>, 78, 2569–2577 v. Sadowsky MJ, Whitman RL (Ed). 2010. <i>The faecal bacteria</i>. ASM Press, Washington, DC. vi. Kay D, <i>et al.</i> 1994. Predicting likelihood of gastroenteritis from sea bathing: results from randomised exposure. <i>Lancet</i>, 344, 905–909 vii. Prüss A. 1998. Review of epidemiological studies on health effects from exposure to recreational water. <i>Int. J. Epidemiol.</i>, 27, 1–9 		
Policy Context and targets		

Indicator Title	21. Percentage of intestinal enterococci concentration measurements within established standards (EO9)
<p>Policy context description</p> <p>The World Health Organisation has been concerned with health aspects of the management of water resources for many years and published various documents concerning the safety of the water environment, including marine waters, and its importance for health. Revised Mediterranean guidelines for bathing water quality were formulated in 2007 based on the WHO guidelines for “Safe Recreational Water Environments” and on the EC Directive for “Bathing Waters” (EU/2006/7). The proposal was made in an effort to provide updated criteria and standards that can be used in the Mediterranean countries and to harmonize their legislation in order to provide homogenous data. Therefore, the standards for bathing waters quality in the framework of the implementation of Article 7 of the LBS Protocol, could be further used to define GES for the indicator on pathogens in bathing waters.</p>	
<p>Targets</p> <p>Initial target of GES under Common Indicator 21 will be an increasing trend in measurements to test that levels of intestinal enterococci comply with established national or international standards and the methodological approach itself. Particularly, under the EU 2006/7 Directive, excellent (95th percentile < 100 CFU/100 mL) or good (95th percentile < 200 CFU/100 mL) quality categories for the “last assessment”, the last four years (see document below, Directive 2006/7/EC)</p>	
<p>Policy documents</p> <p>General Policy documents</p> <ul style="list-style-type: none"> i. 19th COP to the Barcelona Convention, Athens, Greece, 2016. Decision IG.22/7 - Integrated Monitoring and Assessment Programme (IMAP) of the Mediterranean Sea and Coast and Related Assessment Criteria (UNEP(DEPI)/MED IG.22/28) ii. 19th COP to the Barcelona Convention, Athens, Greece, 2016. Draft Integrated Monitoring and Assessment Guidance (UNEP(DEPI)/MED IG.22/Inf.7) iii. 18th COP to the Barcelona Convention, Istanbul, Turkey, 2013. Decision IG.21/3 - Ecosystems Approach including adopting definitions of Good Environmental Status (GES) and Targets. UNEP(DEPI)/MED IG.21/9 iv. Directive 2008/56/EC of the European Parliament and of the Council of 17 June 2008 establishing a framework for community action in the field of marine environmental policy (Marine Strategy Framework Directive). v. Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy. <p>Contaminants related Policy documents</p> <ul style="list-style-type: none"> vi. UNEP(DEPI)/MED IG 20/8. Decision IG.20/9. Criteria and Standards for bathing waters quality in the framework of the implementation of Article 7 of the LBS Protocol. COP17, Paris, 2012. vii. UNE/MAP MED POL, 2010. Assessment of the state of microbial pollution in the Mediterranean Sea. MAP Technical Reports Series No. 170 (Amended). viii. WHO, 2003. Guidelines for safe recreational water environments. VOLUME 1: Coastal and fresh waters. WHO Library. ISBN 92 4 154580. World Health Organisation, 2003. ix. Directive 2006/7/EC of the European Parliament and of the council of 15 February 2006 concerning the management of bathing water quality and repealing Directive 76/160/EEC http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32006L0007&from=EN 	
<p>Indicator analysis methods</p>	
<p>Indicator Definition</p>	

Indicator Title	21. Percentage of intestinal enterococci concentration measurements within established standards (EO9)
Percentage of intestinal enterococci concentration measurements within established standards.	
Concentration (CFU) of intestinal enterococci in the sample (normalised to 100 mL)	
Methodology for indicator calculation	
<p>An ISO methodology has been proposed by Directive 2006/7/EC with the following specification: Based upon percentile evaluation of the log₁₀ normal probability density function of microbiological data acquired from the particular bathing water, the percentile value is derived as follows:</p> <ol style="list-style-type: none"> 1) Take the log₁₀ value of all bacterial enumerations in the data sequence to be evaluated. (If a zero value is obtained, take the log₁₀ value of the minimum detection limit of the analytical method used instead) 2) Calculate the arithmetic mean of the log₁₀ values (μ). 3) Calculate the standard deviation of the log₁₀ values (σ). <p>The upper 90- percentile point of the data probability density function is derived from the following equation: upper 90- percentile = antilog ($\mu + 1,282 \sigma$). The upper 95- percentile point of the data probability density function is derived from the following equation: upper 95- percentile = antilog ($\mu + 1,65 \sigma$).</p>	
Indicator units	
Percentage of intestinal enterococci (as %)	
CFU (Colony Forming Units)/100 mL sample – Concentration of intestinal enterococci	
List of Guidance documents and protocols available	
<ol style="list-style-type: none"> i. ISO 7899-1[Water quality – Detection and enumeration of intestinal enterococci: Part 1: Miniaturized method (Most Probable Number) for surface and wastewater] ii. ISO 7899-2 [Water quality – Detection and enumeration of intestinal enterococci: Part 2: Membrane filtration method]. 	
Data Confidence and uncertainties	
<p>ISO 7899-2 describes the isolation of intestinal enterococci (<i>Enterococcus faecalis</i>, <i>E. faecium</i>, <i>E. durans</i> and <i>E. hirae</i>). In addition, other Enterococcus species and some species of the genus Streptococcus (namely <i>S. bovis</i> and <i>S. equinus</i>) may occasionally be detected. These Streptococcus species do not survive long in water and are probably not enumerated quantitatively. For purposes of water examination, <i>enterococci sp.</i> can be regarded as indicators of faecal pollution, despite it should be mentioned that some enterococci found in water can occasionally also originate from other habitats.</p>	
Methodology for monitoring, temporal and spatial scope	
Available Methodologies for Monitoring and Monitoring Protocols	
<p>Revised Mediterranean guidelines for bathing waters were formulated in 2007 based on the WHO guidelines for “Safe Recreational Water Environments” and on the EC Directive for “Bathing Waters” (EU/2006/7). The proposal was made in an effort to provide updated criteria and standards that can be used in the Mediterranean countries and to harmonize their legislation in order to provide homogenous data.</p>	
Available data sources	
<p>Directive 2006/7/EC of the European Parliament and of the council of 15 February 2006 concerning the management of bathing water quality and repealing Directive 76/160/EEC http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32006L0007&from=EN</p>	
Spatial scope guidance and selection of monitoring stations	

Indicator Title	21. Percentage of intestinal enterococci concentration measurements within established standards (EO9)	
Sampling should be performed in recreational waters where microbiological pollution could threaten the recreational uses.		
Temporal Scope guidance		
Accordinging Annex IV (EU Directive 2006/7EC), the temporal scope guidance is as follows:		
<ol style="list-style-type: none"> 1. One sample is to be taken shortly before the start of each bathing season. Taking account of this extra sample and subject to paragraph 2 (below), no fewer than four samples are to be taken and analysed per bathing season. 2. However, only three samples need be taken and analysed per bathing season in the case of a bathing water that either: <ol style="list-style-type: none"> (a) has a bathing season not exceeding eight weeks; or (b) is situated in a region subject to special geographical constraints. 3. Sampling dates are to be distributed throughout the bathing season, with the interval between sampling dates never exceeding one month. 4. In the event of short-term pollution, one additional sample is to be taken to confirm that the incident has ended. This sample is not to be part of the set of bathing water quality data. If necessary to replace a disregarded sample, an additional sample is to be taken seven days after the end of the short-term pollution. 		
Data analysis and assessment outputs		
Statistical analysis and basis for aggregation		
<p>Monitoring should allow the necessary statistical data treatments, as well as time-trend evaluations. In order to comply with the stated Common Indicator within IMAP the geographic reporting scales (nested approach) should be taken into account. However, the balance between data, location and spatial resolution should be carefully considered for coherence in areas (1) and (2), as this Common Indicator is largely (if not entirely) evaluated in coastal waters (3):</p> <ol style="list-style-type: none"> (1) Whole region (i.e. Mediterranean Sea); (2) Mediterranean sub-regions, as presented in the Initial Assessment of the Mediterranean Sea, UNEP(DEPI)/MED IG.20/Inf.8; (3) Coastal waters and other marine waters; (4) Subdivisions of coastal waters provided by Contracting Parties 		
Expected assessments outputs		
<p>For pathogenic microorganisms in bathing water, monitoring for the assessment of GES could be carried out on a sub-regional and/or local level due to the nature of microbiological contamination (the impact is restricted to a relatively short distance from the pollution source due to the short survival time of microorganisms in seawater and dilution effects).</p> <p>Distribution maps and temporal trend assessment (short periods) are also envisaged.</p>		
Known gaps and uncertainties in the Mediterranean		
<p>Within the context of Ecosystem Approach and IMAP implementation its applicability beyond bathing waters (recreational waters) protection and management would need to be determined, although intuitively reflects the health status of the coastal environment in terms of their delivery of benefits (e.g. tourism).</p>		
Contacts and version Date		
http://www.unepmap.org		
Version No	Date	Author
V.2	28.04.17	MEDPOL

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	<i>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).</i>	
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		
<p>Marine litter found on the coastlines (washed ashore and/or deposited) is one of the most obvious signs of marine litter pollution. Beach marine litter originates from major land-based (tourism, recreation, illegal fly tipping, waste disposal sites,) and sea-based (commercial shipping, fisheries activities, pleasure crafts and off-shore installations) sources following very diverse pathways to reach the marine environment (e.g. input from rivers, sewage and storm water outflows, etc.). Beach marine litter items may range from very large items (metres) down to smaller pieces and fragments i.e. macro-litter (≥ 25 mm), meso-litter (5-25 mm), micro-litter (≤ 5 mm), and nano-litter (< 1000 μm) (GESAMP 2017). Surveys of litter stranded on the coastline are a primary tool for monitoring the load of litter in the marine environment and have been used world-wide to quantify and describe marine litter pollution (JRC, 2011). The results of the surveys, in a later stage, shall be used to assess the effectiveness of management or mitigation measures, identify the sources and activities leading to pollution from marine litter and determine threats to marine biota and ecosystems (Cheshire et al., 2009).</p> <p>The overviews by UN Environment (Cheshire et al. 2009) and the National Oceanic and Atmospheric Administration (NOAA) (Opfer et al., 2012), are the most comprehensive and useful overviews for monitoring methods on the coast. The UN Environment overview includes a comprehensive comparison of existing marine litter survey and monitoring methods and protocols in which beach surveys were assessed (Cheshire et al., 2009). The European Commission through its Marine Strategy Framework Directive (MSFD), Technical Group on Marine Litter (TGML) published the Guidance Document on Monitoring of Marine Litter in European Seas (2013) which proposes a common implementation strategy for the MSFD on several aspects of marine litter. Recently the IPA-Adriatic DeFishGear⁸ project has also developed comprehensive guidelines for monitoring marine litter in the Adriatic-Ionian macro- region while a marine litter assessment is already available for the Adriatic and Ionian Seas (Vlachogianni et al., 2017).</p> <p>When designing marine litter surveys it is necessary to differentiate between standing-stock surveys, where the total load of litter is assessed during a one-off count, and the assessment of accumulation and loading rates during regularly repeated surveys of the same stretch of beach with initial and subsequent removal of litter. Both types of survey provide information on the amount and types of marine litter, however, only the accumulation surveys provide information on the rate of deposition of litter and trends in litter pollution.</p> <p>The type of survey selected i.e. strandline surveys, cleaning and regular surveys depends on the objectives of the assessment and on the magnitude of the pollution on the coastline (UNEP(DEPI)/MED WG.417/Inf.15Part2⁹). A single survey method has been recommended by</p>		

⁸ <http://www.defishgear.net/>

⁹ 2nd Report of the Informal Online Working Group on Marine Litter

	Related Ecological Objective: (EO 10) Marine and coastal litter do not adversely affect the coastal and marine environment
Indicator Title	<i>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).</i>
TGML with different spatial parameters for light to moderately polluted coastline and for heavily polluted coastlines.	
Scientific References	
<ul style="list-style-type: none"> • Cheshire, A. C., Adler, E., Barbière, J., Cohen, Y., Evans, S., Jarayabhand, S., Jetic, 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. • 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. • IPA-Adriatic DeFishGear project, 2014. Methodology for Monitoring Marine Litter on Beaches (Macro-Debris >2.5 cm). • IPA-Adriatic DeFishGear project, 2014. Methodology for Monitoring Marine Litter on the Sea Surface-Visual observation (> 2.5 cm). • IPA-Adriatic DeFishGear project, 2014. Methodology for Monitoring Marine Litter on the Seafloor (continental shelf) - bottom trawl surveys. • IPA-Adriatic DeFishGear project, 2014. Methodology for Monitoring Marine Litter on the Seafloor (Shallow coastal waters 0 - 20 m) - Visual surveys with SCUBA/snorkelling. • 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. • Opfer, S., Arthur, C. and Lippiatt, S., 2012. NOAA Marine Debris Shoreline Survey Field Guide. National Oceanic and Atmospheric Administration. Vlachogianni, Th., Zeri, Ch., Ronchi, F., Fortibuoni, T., Anastasopoulou, A., 2017. Marine Litter Assessment in the Adriatic and Ionian Seas. IPA-Adriatic DeFishGear Project, MIO-ECSDE, HCMR and ISPRA. pp. 180 (ISBN: 978-960-6793-25-7) 	
Policy Context and targets (other than IMAP)	
Policy context description	
<p>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-</p>	

	<p>Related Ecological Objective: (EO 10) Marine and coastal litter do not adversely affect the coastal and marine environment</p>
<p>Indicator Title</p>	<p><i>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).</i></p>
<p>economic aspects of marine litter management, the development of marine litter data banks, the development of national monitoring programmes on marine litter etc.</p> <p>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 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".</p>	
<p>Indicator/Targets</p> <p>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.</p> <p>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):</p> <p>Baseline Values for Beach Marine Litter:</p> <ul style="list-style-type: none"> - Minimum value: 11 items/100m - Maximum value: 3600 items/100m - Mean value: 920 items/100m - Proposed Baseline: 450-1400 items/100m <p>Environmental Targets for Beach Marine Litter:</p> <ul style="list-style-type: none"> - Types of Target: % of decrease - Minimum: Significant - Maximum: 30% - Reduction Targets: 20% by 2024 	
<p>Indicator analysis methods</p>	
<p>Indicator Definition</p> <p>GES Definition: Number/amount of marine litter items on the coastline do not have negative impacts on human health, marine life and ecosystem services.</p>	
<p>Methodology for indicator calculation</p> <p>All items found on the survey 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.</p> <p>A standard list of marine litter items should be used including all possible marine litter items. Several relevant lists exist. 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 be recorded during</p>	

	Related Ecological Objective: (EO 10) Marine and coastal litter do not adversely affect the coastal and marine environment
Indicator Title	<i>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).</i>
<p>beach litter surveys. Based on this Master list, the UN Environment /Mediterranean Action Plan, Mediterranean Pollution Assessment and Control Programme (MED POL) as part of the Integrated Monitoring and Assessment Programme (IMAP) has elaborated a reduced list including the items more frequently found on the Mediterranean beaches, avoiding those that are found rarely. The MSFD derived MED POL list merge some types of beach litter (e.g. different types of plastic drink bottles or different types of caps/lids and rings, etc), split glass and ceramic items categories, consider the sanitary and medical wastes as a separate category and not to include several specific items that have not appeared in the running Mediterranean countries monitoring programmes. In order to homogenize and harmonize the information collected in the Contracting Parties Monitoring Programmes, this reduced MED POL list should be used .</p> <p>It has been strongly recommended to produce regional photo guides including pictures of all litter items on the survey protocol. This will assist in the correct identification and allocation of recorded items.</p> <p>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. The IMAP guidance document (UNEP(DEPI)/MED IG.22/Inf.7) suggest a lower limit of 0.5 cm in the longest dimension is recommended for litter items monitored during beach surveys. However in many other cases the lower size limit, which is considered in such cases is 2.5 cm¹⁰.</p> <p>Special attention should be drawn upon the environmental sound waste disposal of the collected litter from the Mediterranean coastlines. The removal of the beach marine litter ítems should be done according to specific rules and guidelines, also the proper waste disposal taking into account several factors, as for example that the weathered marine litter ítems cannot be recycled. <u>In that extent there is a need to develop of a corresponding document in the future.</u> There are some projects lead by NOAA where they focus on the removal of the collected marine litter items¹¹</p>	
<p>Indicator units</p> <p>Counts of items per item type per survey unit are recommended as the standard unit of litter to be assessed on the coastline.</p> <p>Survey 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 document Error! Bookmark not defined.).</p> <ul style="list-style-type: none"> - 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). <p>For assessing trends on marine litter, the percent (%) of decrease should be assessed. OSPAR recommends a minimum of 6 years monitoring in order to assess trends. The information on items/km² should be coupled with information on weight per different category. In cases where more than one section is selected, then a 50m separation zone, between the two transects, should be selected.</p>	
List of Guidance documents and protocols available	

¹⁰ <http://publications.jrc.ec.europa.eu/repository/bitstream/JRC83985/lb-na-26113-en-n.pdf>

¹¹ <https://marinedebris.noaa.gov/current-efforts/removal>

	Related Ecological Objective: (EO 10) Marine and coastal litter do not adversely affect the coastal and marine environment
Indicator Title	<i>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).</i>
	<ul style="list-style-type: none"> - 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	
<p>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.</p> <p>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. 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 (MOOC¹²) 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.</p> <p>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.</p> <p>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.</p>	
Methodology for monitoring, temporal and spatial scope	
Available Methodologies for Monitoring and Monitoring Protocols	

¹² <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	<i>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).</i>
<p>The selection of survey sites should be based on the following criteria:</p> <ul style="list-style-type: none"> • 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. <p>Within the above constraints, the location of survey sites within each zone should be stratified such that counts are obtained from beaches subject to different litter exposures, including:</p> <ul style="list-style-type: none"> • 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. <p>At least two surveys per year in winter and summer 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.</p> <p>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 survey 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.</p> <p>Counts of items per item type are recommended as the standard unit of litter to be assessed on the coastline. Once a beach is chosen survey units can be identified. A survey 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:</p> <ul style="list-style-type: none"> • 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) 	

	<p>Related Ecological Objective: (EO 10) Marine and coastal litter do not adversely affect the coastal and marine environment</p>
<p>Indicator Title</p>	<p><i>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).</i></p>
<p>All items found on the survey 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.</p> <p>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. This lower limit was agreed in the IMAP Guidance presented at COP 19. However a revised higher limit in line with MSFD and other Regional Seas of 2.5 cm may be discussed with experts and Contracting Parties in the future.</p> <p>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.</p>	
<p>Available data sources</p> <ul style="list-style-type: none"> - National Monitoring Programmes - European Environment Agency (EEA) Marine LitterWatch (MLW) Smartphone Application: http://www.eea.europa.eu/themes/coast_sea/marine-litterwatch - Hellenic Marine Environment Protection Association (HELMPEPA): http://www.helmepa.gr/en/home.php - Legambiente International: http://international.legambiente.it/ - IPA Adriatic DeFishGear Project: http://www.defishgear.net/ - 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/ 	
<p>Spatial scope guidance and selection of monitoring stations</p> <p>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 perform a survey (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 survey sites should be selected in such a way that samples are obtained from beaches subject to different litter exposures, including:</p> <ul style="list-style-type: none"> - Urban coasts may better reflect the contribution of land-based inputs; 	

	Related Ecological Objective: (EO 10) Marine and coastal litter do not adversely affect the coastal and marine environment
Indicator Title	<i>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).</i>
<ul style="list-style-type: none"> - Minimum settlement sites 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. 	
<p>Temporal Scope guidance</p> <p>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.</p> <p>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.</p> <p>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, 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.</p>	
Data analysis and assessment outputs	
<p>Statistical analysis and basis for aggregation</p> <p>Basic analysis involves spreadsheet development, aggregations per category and type of marine litter items, mean values and corresponding standard deviation. Since there are no available long-term data at the moment, there is no statistical method recommended. Six years of monitoring is considered as the minimum to assess trends. 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.</p>	
<p>Expected assessments outputs</p> <ul style="list-style-type: none"> - Abundance of beach marine litter with detailed information on densities (items/100m transect and items/m²), different types of material and/or use; - Temporal and spatial distribution; - Identify sources; - Most frequent items list found at 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*

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Version No	Date	Author
V.1	28.04.17	MEDPOL

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	<i>Common Indicator 23: Trends in the amount of litter in the water column including microplastics and on the seafloor</i>	
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		
<p>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. Marine litter items may range from very large items (metres) down to smaller pieces and fragments i.e. macro-litter (≥ 25 mm), meso-litter (5-25 mm), micro-litter (≤ 5 mm), and nano-litter ($< 1000 \mu\text{m}$) (GESAMP 2016). 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).</p> <p>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 Cauwenberghes et al., 2013; Woodall et al., 2014) and further work should be encouraged.</p>		
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	<p>Related Ecological Objective: (EO 10) Marine and coastal litter do not adversely affect the coastal and marine environment</p>
<p>Indicator Title</p>	<p><i>Common Indicator 23: Trends in the amount of litter in the water column including microplastics and on the seafloor</i></p>
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	Related Ecological Objective: (EO 10) Marine and coastal litter do not adversely affect the coastal and marine environment
Indicator Title	<i>Common Indicator 23: Trends in the amount of litter in the water column including microplastics and on the seafloor</i>
Policy Context and targets (other than IMAP)	
Policy context description	
<p>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.</p> <p>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".</p>	
Indicator/Targets	
<p>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.</p> <p>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):</p> <p>Baseline Values for Seafloor Marine Litter:</p> <ul style="list-style-type: none"> - Minimum value: 0 items/km² - Maximum value: 7,700 items/ km² - Mean value: 179 items/ km² - Proposed Baseline: 130 – 230 items/ km² 	

	Related Ecological Objective: (EO 10) Marine and coastal litter do not adversely affect the coastal and marine environment
Indicator Title	<i>Common Indicator 23: Trends in the amount of litter in the water column including microplastics and on the seafloor</i>
<p>Environmental Targets for Seafloor Marine Litter:</p> <ul style="list-style-type: none"> - Types of Target: % of decrease - Minimum: Stable - Maximum: 10% in 5 years - Reduction Targets: Statistically Significant (15% in 15 years is possible) 	
<p>Policy documents</p> <ul style="list-style-type: none"> • UN Environment / Mediterranean Action Plan, Regional Plan on Marine Litter Management in the Mediterranean, Decision IG.21/7 (2013)¹³. • 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	
<p>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.</p>	
Methodology for indicator calculation	
<p>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 distribution is to use perform opportunistic surveys often coupled with regular fisheries surveys (marine reserve, offshore platforms, etc.) and programmes on biodiversity. These 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.</p> <p><u>Shallow sea-floor (<20m):</u> 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</p>	

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

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](http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32010D0477(01)&from=EN)

	<p>Related Ecological Objective: (EO 10) Marine and coastal litter do not adversely affect the coastal and marine environment</p>
<p>Indicator Title</p>	<p><i>Common Indicator 23: Trends in the amount of litter in the water column including microplastics and on the seafloor</i></p>
<p>trained observers. Only litter items above 2.5 cm are considered, between 0 and 20 m (to 40 meters with skilled divers).</p> <p>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 (yi - for the estimation of detection probability, measured with the use of a 2 m plastic rod), and litter size category (wi) 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 on litter density are often expressed in items/m², items/100 m², and/or items/100m transect.</p> <p>In surveys using the distance-sampling method, detectability is used to correct marine litter abundance estimations (Katsavenakis, 2009). The standard software for modelling detectability and estimating density/abundance, based on surveys using distance-sampling method, is DISTANCE (Thomas et al., 2006).</p> <p><u>Monitoring the Sea-floor (20-800m):</u> 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:</p> <ol style="list-style-type: none"> 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. <p>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) provide useful and valuable means for monitoring marine litter. These are using common gears depending on region (MEDITS net in the Mediterranean with their stratification scheme) and provide standardized and harmonized survey conditions (20 mm mesh, 30-60 min tows, large survey surface covered) and hydrographical and environmental information (priority: surface & bottom temperature, surface & bottom salinity, Optional: surface & bottom current direction & speed, wind direction & speed, swell direction and height).</p>	
<p>Indicator units</p> <ul style="list-style-type: none"> • Litter on the seafloor shallow coastal waters(0-20m): visually surveyed litter items size above 2.5cm expressed on items/m² • Litter on the seafloor 20-800m: (items/ha or) items/km² of litter collected in bottom trawl surveys and if possible to be coupled with dry weight information (kg/km²) 	
<p>List of Guidance documents and protocols available</p> <ul style="list-style-type: none"> - UN Environment / Intergovernmental Oceanographic Commission, Guidelines on Survey and Monitoring of Marine Litter” (2009). 	

	Related Ecological Objective: (EO 10) Marine and coastal litter do not adversely affect the coastal and marine environment
Indicator Title	<i>Common Indicator 23: Trends in the amount of litter in the water column including microplastics and on the seafloor</i>
<ul style="list-style-type: none"> - 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 (2016). - IPA-Adriatic DeFishGear project, 2014. Methodology for Monitoring Marine Litter on the Sea Surface-Visual observation (> 2.5 cm). - IPA-Adriatic DeFishGear project, 2014. Methodology for Monitoring Marine Litter on the Seafloor (continental shelf) – bottom trawl surveys. - IPA-Adriatic DeFishGear project, 2014. Methodology for Monitoring Marine Litter on the Seafloor (Shallow coastal waters 0 – 20 m) - Visual surveys with SCUBA/snorkelling. 	
<p>Data Confidence and uncertainties</p> <p>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 seafloor 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 survey strategy.</p> <p>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. 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.</p>	
Methodology for monitoring, temporal and spatial scope	
<p>Available Methodologies for Monitoring and Monitoring Protocols</p> <p><u>Monitoring the shallow sea-floor (<20m):</u> Recreational and professional scuba divers can provide valuable information on litter they see underwater and they are uniquely positioned to support seafloor 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 organize underwater clean-ups, often in partnerships with NGOs or local governments. Many of these events, when managed, can be a valuable source of information and possibly be a part of a regular survey, monitoring or even assessment efforts while using volunteers.</p> <p>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 survey 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.</p>	

	Related Ecological Objective: (EO 10) Marine and coastal litter do not adversely affect the coastal and marine environment
Indicator Title	<i>Common Indicator 23: Trends in the amount of litter in the water column including microplastics and on the seafloor</i>
<p><u>Monitoring the Sea-floor (20-800m):</u> Templates for data recording have been integrated in the 2016 MEDITS Instruction Manual (v.8)¹⁸. 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 the 2016 MEDITS Instruction Manual v.8) for the Mediterranean. Data on litter should be reported as items/ha or items/km² before further processing and reporting.</p> <p>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.</p> <p>Site information and trawling survey 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.</p> <p>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.</p>	
<p>Available data sources</p> <ul style="list-style-type: none"> - 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://www.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 	
<p>Spatial scope guidance and selection of monitoring stations</p> <p><u>Monitoring the shallow sea-floor (<20m):</u> 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 scheme, although good spatial coverage of the study area is desirable. Line</p>	

¹⁸ http://www.sibm.it/MEDITS%202011/docs/Medits_Handbook_2016_version_8_042016.pdf

	Related Ecological Objective: (EO 10) Marine and coastal litter do not adversely affect the coastal and marine environment
Indicator Title	<i>Common Indicator 23: Trends in the amount of litter in the water column including microplastics and on the seafloor</i>
<p>transect are defined with a nylon line, marked every 5 meters with resistant paints, that is deployed using a diving reel while SCUBA diving.</p> <p><u>Monitoring the Sea-floor (20-800m):</u> UN Environment (Cheshire, 2009) recommends that at least 20 survey units will be selected at regional level although a higher level of redundancy (i.e. replication) in survey units within each region is highly recommended.</p> <p>Moreover, the protocol of the EU MSFD TGML for surveying 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 2016 MEDITS Instruction Manual v.8¹⁹). The hauls are positioned following a depth stratified surveying 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 1260; covering the shelves and slopes from 10 countries in the Mediterranean.</p>	
Temporal Scope guidance	
<p><u>Monitoring the shallow sea-floor (<20m):</u> The minimum surveying 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).</p> <p><u>Monitoring the Sea-floor (20-800m):</u> 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 surveying between May and July, at 3 knots between 20 and 800 m depth.</p>	
Data analysis and assessment outputs	
Statistical analysis and basis for aggregation	
<p>Basic statistics may be applied during the analysis and aggregation of the results. The coefficient of variation (i.e. Standard deviation) should be included in the processed data for seafloor marine litter, to couple the abundance/density figures (e.g. items/km²).</p>	
Expected assessments outputs	
<ul style="list-style-type: none"> - Assess marine litter found on the seafloor of the Mediterranean sea at basin, sub-basin and or national scale; - Assess abundance, density (items/ha or items/km²), 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 	

¹⁹ http://www.sibm.it/MEDITS%202011/docs/Medits_Handbook_2016_version_8_042016.pdf

	Related Ecological Objective: (EO 10) Marine and coastal litter do not adversely affect the coastal and marine environment	
Indicator Title	<i>Common Indicator 23: Trends in the amount of litter in the water column including microplastics and on the seafloor</i>	
Known gaps and uncertainties in the Mediterranean		
<p>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.</p>		
Contacts and version Date: UNEP/MAP 16 January 2017		
Key contacts within UN Environment for further information		
<ul style="list-style-type: none"> - 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.2	28.04.17	MEDPOL

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	<i>Common indicator 23: Trends in the amount of litter in the water column including microplastics and on the seafloor</i>	
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		
<p>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. Marine litter items may range from very large items (metres) down to smaller pieces and fragments i.e. macro-litter (≥ 25 mm), meso-litter (5-25 mm), micro-litter (≤ 5 mm), and nano-litter ($< 1000 \mu\text{m}$) (GESAMP 2016). 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.</p> <p>Floating marine litter items of different size (nano-, 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).</p> <p>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.</p>		
Scientific References		
<ul style="list-style-type: none"> • Aliani S., Griffa A., A.Molcard (2003) Floating debris in the Ligurian Sea, north-western Mediterranean, Marine Bulletin, 46, 1142-1149. 		

	Related Ecological Objective: (EO 10) Marine and coastal litter do not adversely affect the coastal and marine environment
Indicator Title	<i>Common indicator 23: Trends in the amount of litter in the water column including microplastics and on the seafloor</i>
	<ul style="list-style-type: none"> • 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. • 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 - Méditerranée 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 project, 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. • Vlachogianni, Th., Zeri, Ch., Ronchi, F., Fortibuoni, T., Anastasopoulou, A., 2017. Marine Litter Assessment in the Adriatic and Ionian Seas. IPA-Adriatic DeFishGear Project, MIO-ECSDE, HCMR and ISPRA. pp. 180 (ISBN: 978-960-6793-25-7)
Policy Context and targets (other than IMAP)	
<p>Policy context description</p> <p>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.</p> <p>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".</p>	

	Related Ecological Objective: (EO 10) Marine and coastal litter do not adversely affect the coastal and marine environment
Indicator Title	<i>Common indicator 23: Trends in the amount of litter in the water column including microplastics and on the seafloor</i>
<p>Indicator/Targets</p> <p>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 10.1.2: Decreasing trend in the number of/amounts of marine litter items in the water surface and the seafloor.</p> <p>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):</p> <p>Baseline Values for Floating Marine Litter:</p> <ul style="list-style-type: none"> - Minimum value: 0 items/km² - Maximum value: 195 items/ km² - Mean value: 3.9 items/ km² - Proposed Baseline: 3-5 items/ km² <p>Environmental Targets for Floating Marine Litter:</p> <ul style="list-style-type: none"> - Types of Target: % of decrease - Minimum: - - Maximum: - - Reduction Targets: Statistically Significant <p>Baseline Values for Floating Microplastics:</p> <ul style="list-style-type: none"> - Minimum value: - items/km² - Maximum value: 4,860,000 items/ km² - Mean value: 340,000 items/ km² - Proposed Baseline: 200,000 – 500,000 items/ km² <p>Environmental Targets for Floating Microplastics:</p> <ul style="list-style-type: none"> - Types of Target: % of decrease - Minimum: - - Maximum: - - Reduction Targets: Statistically Significant 	
<p>Policy documents</p> <ul style="list-style-type: none"> • UN Environment / Mediterranean Action Plan, Regional Plan on Marine Litter Management in the Mediterranean, Decision IG.21/7 (2013)²⁰. • 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)²¹. 	

²⁰ <https://wedocs.unep.org/rest/bitstreams/8222/retrieve> (ENG) / <https://wedocs.unep.org/rest/bitstreams/8223/retrieve> (FR)

²¹ <https://wedocs.unep.org/rest/bitstreams/8385/retrieve>

	Related Ecological Objective: (EO 10) Marine and coastal litter do not adversely affect the coastal and marine environment
Indicator Title	<i>Common indicator 23: Trends in the amount of litter in the water column including microplastics and on the seafloor</i>
	<ul style="list-style-type: none"> • UN Environment, Marine Litter Legislation Toolkit for Policymakers (2016)²². • European Commission, Marine Strategy Framework Directive, Directive 2008/56/EC (2008)²³. • European Commission, Decision on criteria and methodological standards on good environmental status of marine waters (2010)²⁴.
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	
<p>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.</p> <p>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.</p>	
Indicator units	
For floating marine litter the unit of reporting will be items of floating litter, 2.5 to 50 cm per km ² . The data will be available for the different categories and size classes.	
List of Guidance documents and protocols available	
<ul style="list-style-type: none"> - UN Environment / Intergovernmental Oceanographic Commission, Guidelines on Survey and Monitoring of Marine Litter (2009). 	

²² <http://www.unep.org/stories/Ecosystems/Marine-Litter-Legislation-A-toolkit-for-Policymakers.asp>

²³ <http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32008L0056&from=EN>

²⁴ [http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32010D0477\(01\)&from=EN](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	<i>Common indicator 23: Trends in the amount of litter in the water column including microplastics and on the seafloor</i>		
<ul style="list-style-type: none"> - 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). IPA-Adriatic DeFishGear project, 2014. Methodology for Monitoring Marine Litter on the Sea Surface-Visual observation (> 2.5 cm). 			
Data Confidence and uncertainties			
<p>The observation of floating marine litter from ships is subject to numerous variables in the observation conditions. They can be divided into operational parameters, related to the ship properties and observation location. 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.</p> <p>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.</p>			
Methodology for monitoring, temporal and spatial scope			
Available Methodologies for Monitoring and Monitoring Protocols			
<p>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:</p> <ul style="list-style-type: none"> - 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 surveys; - It should cover short transects; and - Also record necessary metadata. <p>The observation from ships-of-opportunity (i.e. volunteer merchant and passenger ships which routinely transit strategic shipping routes) 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.</p>			
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

	Related Ecological Objective: (EO 10) Marine and coastal litter do not adversely affect the coastal and marine environment
Indicator Title	<i>Common indicator 23: Trends in the amount of litter in the water column including microplastics and on the seafloor</i>
<p>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).</p>	
<p>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.</p>	
<p>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.</p>	
<p>Available data sources</p> <ul style="list-style-type: none"> - IPA Adriatic DeFishGear Project: http://www.defishgear.net/ - Hellenic Marine Environment Protection Association (HELMPEA): http://www.helmepa.gr/en/home.php 	
<p>Spatial scope guidance and selection of monitoring stations</p>	
<p>The monitoring of floating marine litter by 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.</p>	
<p>Temporal Scope guidance</p>	
<p>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.</p>	
<p>The initial, investigative monitoring should be performed with a higher frequency in order to understand the variability of litter quantities in time. Even burst surveying, i.e. high surveying frequency over short period, might be appropriate in order to understand the variability of floating marine litter occurrence.</p>	
<p>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.</p>	

	Related Ecological Objective: (EO 10) Marine and coastal litter do not adversely affect the coastal and marine environment	
Indicator Title	<i>Common indicator 23: Trends in the amount of litter in the water column including microplastics and on the seafloor</i>	
Data analysis and assessment outputs		
Statistical analysis and basis for aggregation		
<p>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) and wind speed (m/s). This accompanying data shall allow the evaluation of the data in the correct context.</p>		
Expected assessments outputs		
<ul style="list-style-type: none"> - Assess accumulation zones for floating marine litter items; - Assess abundance, density and types of floating marine litter items in a more precise way; - Comparison with marine litter found in other sea compartments. 		
Known gaps and uncertainties in the Mediterranean		
<p>Only a few studies have been published on the abundance of floating macro debris in Mediterranean waters (Aliani et al., 2003; UNEP, 2009; Topcu et al., 2010, Gerigny et al., 2011, Suaria and Aliani, 2015, Vlachogianni et a; 2017), 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.</p>		
Contacts and version Date: UNEP/MAP 16 January 2017		
Key contacts within UN Environment for further information		
<ul style="list-style-type: none"> - 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.2	28.04.17	MEDPOL

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	<i>Candidate Common indicator 24: Trends in the amount of litter ingested by or entangling marine organisms, especially mammals, marine birds and turtles</i>	
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		
<p>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).</p> <p>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 (CIESM Workshop Monographs, 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.</p> <p>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. Moreover, in the Adriatic Sea, fish have been found ingesting marine litter particles at a rate of 2.6% in the North Adriatic, 25.9% South Adriatic, and 2.7% in the northeastern Ionian Sea (Vlachogianni et al., 2017)</p> <p>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 (<i>Caretta caretta</i>) 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,</p>		

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<p>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 ones (Cameda et al., 2014), with analyses showing homogeneity in relation of the total abundance, weight, and composition among alive and dead individuals.</p> <p>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.</p>	
<p>Scientific References</p> <ul style="list-style-type: none"> - 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 (<i>Caretta caretta</i>) and marine litter in Sardinia (Western Mediterranean Sea). <i>Marine Environmental Research</i>, 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). <i>Mar. Pollut. Bull.</i> 74, 225-230. - Casale P., D.Margaritoulis (2010) <i>Sea Turtles in the Mediterranean: Distribution, Threats and Conservation Priorities</i>. IUCN: Gland, Switzerland. 304 pages. - CBD (2016). <i>Marine Debris: Understanding, Preventing and Mitigating the Significant Adverse Impacts on Marine and Coastal Biodiversity</i>. Technical Series No.83. Secretariat of the Convention on Biological Diversity, Montreal, 78 pages. - CIESM Workshop Monographs (2014). <i>Marine Litter in the Mediterranean and Black Seas</i>. CIESM ed., Tirana, Albania, 18 - 21 June 2014, (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). <i>Rep. Stud. GESAMP No. 90</i>, 96 p. - Lazar B., R.Gracan (2011) Ingestion of marine debris by loggerhead sea turtle, <i>Caretta caretta</i> in the Adriatic Sea. <i>Mar. Pollut. Bull.</i> 62, 43-47. - Mrosovsky N., Ryan G.D., A.James (2009) Leatherback turtles: the menace of plastic. <i>Mar. Pollut. Bull.</i> 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 <i>Fulmarus glacialis</i> in the North Sea. <i>Environ. Pollut.</i>, 159 (2011), pp. 2609–2615. - Vlachogianni, Th., Anastasopoulou, A., Fortibuoni, T., Ronchi, F., Zeri, Ch., 2017. <i>Marine Litter Assessment in the Adriatic and Ionian Seas</i>. IPA-Adriatic DeFishGear Project, MIO-ECSDE, HCMR and ISPRA. pp. 168 (ISBN: 978-960-6793-25-7). 	
Policy Context and targets (other than IMAP)	
Policy context description	
<p>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</p>	

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<p>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.</p> <p>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".</p>	
<p>Indicator/Targets</p> <p>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.</p> <p>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):</p> <p>Baseline Values for Affected Sea Turtles (%):</p> <ul style="list-style-type: none"> - Minimum value: 14% - Maximum value: 92.5% - Mean value: 45.9% - Proposed Baseline: 40-60% <p>Environmental Targets for Affected Sea Turtles (%):</p> <ul style="list-style-type: none"> - Types of Target: % of decrease in the rate of affected animals - Minimum: - - Maximum: - - Reduction Targets: Statistically Significant <p>Baseline Values for Ingested Marine Litter (gr):</p> <ul style="list-style-type: none"> - Minimum value: 0 gr - Maximum value: 14 gr - Mean value: 1.37 gr - Proposed Baseline: 1-3 gr <p>Environmental Targets for Ingested Marine Litter (gr):</p> <ul style="list-style-type: none"> - Types of Target: % decrease in quantity of ingested weight (gr) - Minimum: - - Maximum: - 	

	Related Ecological Objective: (EO 10) Marine and coastal litter do not adversely affect the coastal and marine environment
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- Reduction Targets: Statistically Significant	
Policy documents	
<ul style="list-style-type: none"> • UN Environment / Mediterranean Action Plan, Regional Plan on Marine Litter Management in the Mediterranean, Decision IG.21/7 (2013)²⁵. • 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)²⁶. • UN Environment, Marine Litter Legislation Toolkit for Policymakers (2016)²⁷. • European Commission, Marine Strategy Framework Directive, Directive 2008/56/EC (2008)²⁸. • European Commission, Decision on criteria and methodological standards on good environmental status of marine waters (2010)²⁹. 	
Indicator analysis methods	
Indicator Definition	
Methodology for indicator calculation	
<p><u>Seabirds:</u> 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 (<i>Fulmarus glacialis</i>). 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).</p> <p><u>Sea Turtles:</u> The digestive tract contents of stranded Loggerhead sea turtles <i>Caretta caretta</i> (Linnaeus, 1758) are used to measure trends and regional differences in marine litter. In many case the stranded animals are stored into freezers and when the adequate number of specimens is collected then the analysis is performed. 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. <i>Caretta caretta</i> 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.</p> <p><u>Entanglement rates among beached animals:</u> 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</p>	

²⁵ <https://wedocs.unep.org/rest/bitstreams/8222/retrieve> (ENG) / <https://wedocs.unep.org/rest/bitstreams/8223/retrieve> (FR)

²⁶ <https://wedocs.unep.org/rest/bitstreams/8385/retrieve>

²⁷ <http://www.unep.org/stories/Ecosystems/Marine-Litter-Legislation-A-toolkit-for-Policymakers.asp>

²⁸ <http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32008L0056&from=EN>

²⁹ [http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32010D0477\(01\)&from=EN](http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32010D0477(01)&from=EN)

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<p>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.</p> <p>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.</p> <p>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.</p> <p>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.</p> <p><u>Ingestion of litter by marine mammals and entanglement:</u> 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.</p> <p>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.\</p>	
<p>Indicator units</p> <ul style="list-style-type: none"> • For sea turtles: Abundance by mass (weight in grams, accurate to 3th decimal) is the main information useful for the monitoring programme. 	
<p>List of Guidance documents and protocols available</p> <ul style="list-style-type: none"> - 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). 	
<p>Data Confidence and uncertainties</p> <p><u>Seabirds:</u> 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</p>	

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<p>EcoQO methodology has been fully tested and implemented on Northern <i>Fulmars Fulmarus glacialis</i>, 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.</p> <p><u>Sea turtles:</u> 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.</p>	
Methodology for monitoring, temporal and spatial scope	
Available Methodologies for Monitoring and Monitoring Protocols	
<p><u>Seabirds:</u> 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.</p> <p>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.</p> <p>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.</p> <p>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</p>	

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<p>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:</p> <ol style="list-style-type: none"> 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) <p>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. 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.</p> <p><u>Sea Turtle:</u></p> <p>The Loggerhead sea turtle <i>Caretta caretta</i> 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.</p> <p>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 $\pm 1\text{g}$). 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.</p> <p>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.</p> <p>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.</p> <p>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 be measured, through the variation of water level in a graduated beaker, when the items are immersed without air. If possible,</p>	

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<p>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.</p> <p>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 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).</p>	
<p>Available data sources</p> <ul style="list-style-type: none"> - Mediterranean Association to Save the Sea Turtles (MEDASSET): http://www.medasset.org - Rescue centres and stranding networks 	
<p>Spatial scope guidance and selection of monitoring stations</p> <p><u>Seabirds:</u> 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.</p> <p><u>Sea turtles:</u> Dead sea turtles are collected from beaches or at sea from accidental mortalities such as victims of fishing gear (by catch) or of boat collisions. The tool is applicable to the Mediterranean Sea region.</p>	
<p>Temporal Scope guidance</p> <p><u>Seabirds:</u> 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.</p> <p><u>Sea turtles:</u> 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.</p>	
<p>Data analysis and assessment outputs</p> <p>Statistical analysis and basis for aggregation</p> <p><u>Seabirds:</u> 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.</p>	

	Related Ecological Objective: (EO 10) Marine and coastal litter do not adversely affect the coastal and marine environment	
Indicator Title	<i>Candidate Common indicator 24: Trends in the amount of litter ingested by or entangling marine organisms, especially mammals, marine birds and turtles</i>	
<p>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.</p> <p>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.</p> <p><u>Sea turtles:</u> Specific long-term monitoring programmes are required in order to assess trends.</p>		
Expected assessments outputs		
<ul style="list-style-type: none"> - 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,) through laboratory and field evaluation, and define thresholds for harm. 		
Known gaps and uncertainties in the Mediterranean		
<ul style="list-style-type: none"> - 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 top-predator and “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. 		
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