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Report of the online groups on eutrophication, contaminants and marine litter

UNEP/MAP
Athens, 2015

2st Report of the Informal Online Working Group on Eutrophication

I. Introduction

In the framework of the gradual application of the ecosystem approach (EcAp) for the management of human activities in the Mediterranean region, it is necessary to assess the environmental status of marine areas using well defined methodological criteria. In order to decide if a marine area is in "Good Environmental Status" (GES), it is necessary to establish threshold values for key parameters in order to distinguish between acceptable (good) and unacceptable (not good) environmental conditions.

In the Mediterranean region, threshold values for eutrophication related parameters are lacking and have to be developed. To date UNEP/MAP-MED POL work on monitoring of nutrients and chlorophyll-a in marine environment has resulted in background information and on the methodology to be followed for the definition of thresholds for the Mediterranean.

In line with the recommendations of the Integrated EcAp Correspondence Group on Good Environmental Status (GES) and Targets Meeting (UNEP(DEPI)/MED WG.3940/4), in the context of the Barcelona Convention a common indicator is an indicator that summarizes data into a simple, standardized and communicable figure and which is ideally applicable in the whole Mediterranean basin, but at least on the level of sub-regions and is monitored by all CPs. A common indicator is able to give an indication of the degree of threat or change in the marine ecosystem and can deliver valuable information to decision makers.

In accordance with the relevant decisions of COP 18, there is now a need to advance this important work in order to finalize the development of well-defined methodological criteria. The CorrGEST meeting held in February 2014 in Athens agreed on the following common indicators with regards to ecological objective 5 on Eutrophication:

Table 1. Eutrophication common indicators (ecological objective 5)

Common Indicator 7	Concentration of key nutrients in the water column
Common Indicator 8	Chlorophyll α concentration in the water column

II. Objectives of the informal online working group on eutrophication

Based on the above common indicators, the main objective of the work of the informal online expert working group is to deliver threshold values based on data availability and a proposal on eutrophication assessment criteria.

III. Composition of the group and preparation of the report

Group members with experience in providing practical scientific advice and the range of expertise applicable to the task are nominated by contracting parties. The nominated expert have scientific background and experience on statistical interpretation of field data, including trend analysis. Following communication on this matter the list the group's members is given in Annex I.

The work of the informal online working group on eutrophication (Eutrophication Working Group) is chaired by Dr Kalliopi Pagou (Greece). Eutrophication Working Group experts who provided input into this First Report of the Eutrophication Working Group include : Professor Mohamed Dorgham (Egypt), Dr Dilek Ediger (Turkey), Dr Robert Precali (Croatia), while comments and information was given by Dr Marinko Antunović (Bosnia Hercegovina), Dr Franco Giovanardi and Dr Erika Magaletti (Italy), Dr Jesus Mercado, Dr Soluna Salles and Dr Marta Martinez (Spain)and Dr Suleyman Tugrul (Turkey). Furthermore, the chair of the group, Dr Kalliopi Pagou (Greece) was supported by a group of HCMR experts: Dr A. Pavlidou, Dr G. Assimakopoulou and Dr I. Varkitzi.

The full list of experts of the Eutrophication Working Group is given in Annex I.

IV. Common definitions on thresholds, baseline and assessment criteria for eutrophication

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 (UNEP(DEPI)/MED WG.411/3). Therefore core group of experts accept the definitions of common indicators 7 & 8.

For the purpose of the UNEP/MAP Barcelona Convention Integrated Monitoring and Assessment Programme, Integrated (Ecosystem) Assessment means both a process and a product (UNEP(DEPI)/MED WG.411/3).

As a process, an assessment is a procedure by which information is collected and evaluated following agreed methods, rules and guidance. It is carried out from time to time to determine the level of available knowledge and to evaluate the environmental state.

As a product, an assessment is a report which synthesises and documents this information, presenting the findings of the assessment process, typically according to a defined methodology, and leading to a classification of environmental status in relation to GES

According to UNEP(DEPI)MED WG 401/3 three approaches may be used for GES determination:

a. In order to assess quantitatively the achievement of GES in relation to eutrophication, a measurable assessment threshold may be set, including the definition of reference conditions. GES assessment thresholds and reference conditions (background concentrations) may not be identical for all areas, especially where the marine environment is already disturbed by human presence for many years. In these cases a decision has to be made whether to set the threshold value for GES achievement independently to the setting of the reference conditions. The approach is based on the recognition that area-specific environmental conditions must define threshold values. A threshold value could include provisions to allow for statistical fluctuations (example: No nutrients and chl-a values exceeding the 90th percentile are present in a frequency more than statistically expected for the entire time series). 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.

b. A second approach to determine GES for eutrophication is to use trends for nutrients contents, and direct and indirect effects of eutrophication. When using the trend approach, a reference value representing the actual situation is needed, for comparison. In the case of nutrients and chl-a, such reference values exist due to data availability in most areas. Therefore, GES could be defined as no increasing trends in nutrient and/or chlorophyll-a concentrations over a defined period of time in the past (ex. 6 years), which are not explained by hydrological variability. For indirect effects, GES could ask for no decreasing trend in oxygen saturation beyond what would be statistically expected.

c. 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 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 that is being carried out in the framework of the MED GIG intercalibration process of the EU Water Framework Directive (WFD), a project closely followed by the MED POL programme.

In this context, sub-regional thresholds have been proposed for chlorophyll-a only, in the coastal types of marine water described below based on seawater density (Sigma_t annual mean values). Description of this water typology follows:

1. *Description of the Typology scheme*

A considerable number of eutrophication experts have built a typology scheme for the Mediterranean during the first inter-calibration phase for the EU Water Framework Directive implementation which is still in use after their update according to Commission Decision 2013/480/UE and represents a very simple typology approach that could be easily applied Mediterranean wide for coastal waters (sensu WFD, i.e. 1nm), since these coastal waters have been intercalibrated.

Typology is very important for further development of classification schemes of a certain area.

The recommended water types for applying eutrophication assessment are based on hydrological parameters characterizing a certain area dynamics and circulation. The typological approach is based on the introduction of a static stability parameter (derived from temperature and salinity values in the water column): such a parameter, on a robust numerical basis, can describe the dynamic behaviour of a coastal system. It is accepted that surface density is adopted as a proxy indicator for static stability as both temperature and salinity are relevant in the dynamic behaviour of a coastal marine system.

On the basis of surface density and salinity values the major coastal water types have been defined:

Table 2. Definition of major coastal water types in Mediterranean that have been intercalibrated (applicable for phytoplankton only) according to Commission Decision 2013/480/UE.

	Type I	Type IIA, IIA Adriatic	Type IIIW	Type IIIE	Type Island-W
σ t (density)	<25	25<d<27	>27	>27	All range
salinity	<34.5	34.5<S<37.5	>37.5	>37.5	All range

The different coastal water types, in an ecological perspective, can be described as follows:

- Type I coastal sites highly influenced by freshwater inputs
- Type IIA coastal sites moderately influenced by freshwater inputs (continent influence)
- Type IIIW Continental coast , not influencedby freshwater inputs (Western Basin)
- Type IIIE Not influenced by freshwater input (Eastern Basin)

In addition, the splitting of the coastal water type III in two different sub-basins, the Western and the Eastern Mediterranean ones, according to the different trophic conditions, well documented in literature was also done.]

Table xxx. Spanish water typologies. * Water typologies non-common with other EU countries (not intercalibration required).

Type	Description	Spain	Density (kg/m^3)	Annual Mean salinity (psu)
Type II-A	Moderately influenced by freshwater input	x	25-27	34.5-37.5
Type III-W	Continental coast, not influenced by	x	>27	>37.5

	freshwater input (Western basin)			
Type Island-W	Island coast (Western basin)	x	All range	All range
Type AC-T09*	Coastal Mediterranean waters highly influenced by freshwaters (shallow sandy)	x		
Type AC-T10*	Coastal Mediterranean waters highly influenced by Atlantic waters	x		
Type AC-T11*	Coastal Lagoon	x		

Some examples of Water Types presence defined for the European countries, parties to the Barcelona convention and LBS Protocol are shown in the Table 3. Coastal water types in these countries have been intercalibrated.

Table 3. Examples of coastal water types in Mediterranean countries

New types		**Croatia**	**Cyprus**	**France**	**Greece**	**Italy**	**Slovenia**	**Spain**
	Description							
Type I	Highly influenced by freshwater input			**X**		**X**		
Type II	Moderately influenced by freshwater input	**X**		**X**		**X**	**X**	**X**
Type III WM	Not influenced by freshwater input	**X**		**X**		**X**		**X**
Type III EM	Not influenced by freshwater input		**X**		**X**			

2. *Thresholds and reference conditions for chlorophyll-a in the different water types*

Reference and threshold (Good/Moderate status) derived values (G-mean annual values based on long time series (>5 years) of monthly sampling at least) differ from type to type on a sub-regional scale and were built with different strategies. Summaries values are given in Table 4.

Table 4. Reference and threshold values of Chla in Mediterranean coastal water types.

Coastal waters Typology	Reference conditions of Chla (μg L^{-1})		Boundaries of Chla (μg L^{-1}) for G/M status	
	G_mean	90% percentile	G_mean	90% percentile
Type I	1.4	3.93	6.3	17.7
Type II-FR-SP		1.29		3.58
Type II-A Adriatic	0.33	0.8	1.5	4.0
Type II-B Tyrrhenian	0.32	0.77	1.2	2.9
Type III-W Adriatic			0.64	1.7
Type III-W Tyrrhenian			0.48	1.17
Type III_W FR-SP		0.79		1.80
Type IIIE GR-CY		0.1		0.4
Type Island-W		0.6		1.2

Note 1: The 90th percentile and the geometrical mean can be derived one from the other according to the following equation:

Chl-a 90th p. = 10^(Log10 (G_mean Chl-a) + 1.28 x SD).

Note 2: The MEDGIG exercise phase III is in progress, therefore an update of the above table may occur, which will be considered, accordingly.

The above boundaries were developed under the EU WFD 2nd intercalibration phase and published in the "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. However these boundaries will be modified accordingly to the future publications of the results of the third phase of the intercalibration exercise (see also Table 4a) With regard to nutrient concentrations, until commonly agreed thresholds have been determined, negotiated and agreed upon at a sub-regional or regional level under the ECAP process, GES may be determined on a trend monitoring basis (as discussed on paragraph b above).
Table 4a. Reference and threshold values of Chla in Mediterranean water types.EQR, boundaries and RC for common indicator 8 (chl-a). Values in parenthesis correspond with the outcomes of the 3rd IC exercise (to be published). [EQR= CR/Boundary (P90)].*RC are currently under study.

Type	Ecological Quality Ratios (EQR) for Chl-a G-M	Boundaries for Chl-a (P90) (μg L^{-1}) G-M	Reference conditions (RC) (P90 chl-a) (μg L^{-1})
Type II-A	0.53 (0.37)	3.58 (3.50)	1.90 (1.28)
Type III-W	0.50 (0.37)	1.80 (1.89)	0.90 (0.79)
Type Island-W	0.5	1.2	0.60
Type AC-T09	0.47	11.11	5.22
Type AC-T10	*	6	*
Type AC-T11	0.50	1.8	0.90

V. List, review and analysis of the available metadata and reports on eutrophication common indicators in Mediterranean Sea.

The eutrophication working group experts had and will continue uploading in the InfoMAP groupware MED POL library, information on eutrophication metadata and reports, according to:

- Geographical axis (national, subregional, regional)
- Temporal axis

based on:

- Relevant available data and/or reports and papers,
- Relevant web-sites links

At the time of the drafting of this preliminary report of the eutrophication working group (March 2015), the core group of experts from several Mediterranean countries made available data and metadata on eutrophication from several countries from 2000 up to day. The metadata are listed to table 5. However, more metadata and information is needed to be incorporated from other Mediterranean countries and especially from Southern Mediterranean.

These meta data and data will be used to find out potential differences or similarities on eutrophication studies among Mediterranean countries in regional and sub-regional axis, in order to identify today existing inconsistencies and gaps, research needs, to propose ways to overcome and apply common methodologies feasible to follow regionally, in order to deliver if possible common threshold values sub-regionally based on data availability and a proposal on common eutrophication assessment criteria, as those in Tables 2 and 4, applicable in at least sub-regional level.

For examble: Eutrophication related data from Greece, such as nutrient concentrations (nitrates, ammonium, phosphates) and phytoplankton parameters (mostly chlorophyll-a, less phytoplankton density) are available from a wide range of coastal areas. In the frame of the WFD implementation, a great number of monitoring sites were added recently, covering all coastal water bodies of Greece. In the case of two metropolitan coastal areas, long times series data are available (Saronikos and Thermaikos Gulfs).

At this stage this work has been initiated but still is far from being completed. The data from table 5, already show that they differ among the countries which submitted them in relation to sampling frequencies, depths, whereas sampled parameters were more or less in agreement.

Furthermore, the Eutrophication Working Group experts noted that more detailed information on meta-data can also be found in the European project IRIS-SES inventory and meta-data base including pressure analysis and EMODNET data base and PERSEUS outcomes.

***Table 5.* Metadata on eutrophication related monitoring in some Mediterranean countries**

Country	Croatia	Greece	Egypt	Turkey-1	Turkey-2	Turkey-3	Turkey-4	Turkey-5	Spain
Organization	IOF & CMR	HCMR: Hellenic Centre for Marine Research	MSEA: Ministry of State for Environmental Affairs and EEAA: Egyptian Environmental Assessment Authority	METU_IMS / Ministry of Environment	Derinsu LTD (company consortium) / Ministry of Environment and Urbanization	ALKA (company consortium) / Ministry of Environment and Urbanization	TUBITAK-MRC consortium including METU-IMS / Ministry of Environment and Urbanization	DEU-IMST	Spanish Institute of Oceanography/Ministry of Agriculture, Food and Environment
Sub_Basin	Adriatic	Eastern Mediterranean	Eastern Mediterranean	Eastern Mediterranean	Eastern Mediterranean	Eastern Mediterranean	Eastern Mediterranean	Eastern Mediterranean	Western Mediterranean
Area	Eastren Adriatic	Saronikos Gulf, Thermaikos Gulf, WFD stations network	Along the Egyptian Mediterranean coast, from Salloum in the west to Rafah in the east.	Mersin Bay	Mediterranean and Aegean Sea_coastal waters	Mediterranean and Aegean Sea_coastal waters	Mediterranean and Aegean Sea_coastal waters	İzmir Bay	Alboran Sea/ Balearic Sea
Activities associated to pressures	Harbours, marinas, sewerage and untreated sewage discharges, riverine inputs, industrial zone, tourism, aquaculture farms.	Harbours, marinas, sewerage and untreated sewage discharges, riverine inputs, industrial zone, tourism, aquaculture farms.	Harbours, marinas, sewerage and untreated sewage discharges, riverine inputs, industrial zone, tourism, aquaculture farms.	Harbours, marinas, sewerage and untreated sewage discharges, riverine inputs, industrial zone, tourism, aquaculture farms.					Harbours, marinas, sewerage and untreated sewage discharges, riverine inputs, industrial zone, tourism, aquaculture farms.
Proposed frequency	monthly or seasonally	monthly or seasonally	seasonally	bimonthly	2 times/yr (summer, autumn)	2 times/yr (summer, autumn)	2 times/yr (winter, summer)	seasonally	seasonally

Actual frequency	seasonally	seasonally	seasonally	4-8 times/yr	2 times/yr (summer, autumn)	2 times/yr (summer, autumn)	2 times/yr (winter, summer)	seasonally	seasonally
Number of Stations	17	80	47	16	85	139	122	37	50
Surface/water column	water column	water column	surface/botto m	water column	at 3 depths	at 3 depths	water column	water column	Water column
Start/end of data series	2000-to date	2000-to date	1998 to date	2005-2010	2011	2013	2014-2016	2000-2015	2010-2015
PO4	X	X	X	X	X	X	X	x	X
TP	X	X	X	X	X	X	X	x	X
DOP									
SiO4	X	X	X	X	X	X	X	x	X
TNOx	X	X	X	X	X	X	X	x	X
NO2	X	X	X	X	X	X		x	X
NH4	X	X	X	X	X	X	X	x	
TN	X	X	X						X
DON									
POC									X
DOC									
HumicSubs									
Chla	X	X	X	X	X	X	X	x	X
Dissolved Oxygen	X	X	X	X	X	X	X	x	X
Secchi disk	X	X	X		X	X	X	x	X
Phytoplankton	X (some stations)	X	X (some sts)	X	X (some sts)	X (some sts)	X (some sts)	x	X
In-situ fluorescence profile	X (some stations)	X (some sts)					X		X
Method	Survey and laboratory analysis	Standard and common	Various methods	Standard and common	Standard and common	Standard and common	Standard and common	Standard and common	Standard and common
Data availability	available upon request	available upon request	available upon request	available upon request	available upon request	available upon request	available upon request	available upon request	available upon request
Web links	***http://baltazar.izor.hr/azopub/bindex***								
Comments									

VI. Review and catalogue on methods and criteria for eutrophication assessment, existing target values and thresholds of eutrophication parameters

During the Eutrophication Working Group discussions, the current advances on assessment methods, criteria, targets and thresholds were mentioned and described, if possible, according to a:

- National
- Subregional
- Regional

It emerged that in sub-regional level in Mediterranean only the results of the MEDGIG exercise used in the implementation of WFD can be mentioned as an assessment method providing targets and thresholds but regarding only the chla concentrations for marine water quality status, as described above in subchapter 4. However, this method can be applicable in a wider scale in Mediterranean and countries are invited to test it. However, a combination rule to combine all eutrophication parameters assessment has to be defined.

However, a rather large set of methods, criteria and targets for a more integrated eutrophication assessment exist, which are used mostly in national level and less frequently in a multinational level, based either on nationally developed and adopted methods or on adopted and adjusted methods from other European regional seas toolboxes, as those of HELCOM.

Some examples of these used methods in several Mediterranean countries are presented below.

Spain

The integrated assessment of indicators is proposed as a method of evaluation based on the analysis of trends. This procedure is applied to the assessment areas defined by Spain in the initial evaluation of the MSFD performed in 2012. These areas represent a spatial partition of the Spanish Mediterranean basins (Alboran Sea and Balearic Sea) based on the features of their chlorophyll a seasonal cycles. The status of each indicator and criteria is assessed according to the analysis of temporal trends and the changes recorded in the latest years in relation to previous periods. In addition, thresholds used in application of the WFD are also considered for the assessment coastal areas. The result of the assessment of each criterion is integrated in the scheme shown in Figure XX (based on the Common Procedure of OSPAR) in order to obtain the overall assessment of the eutrophication of each area. In applying this scheme, each area is classified into one of the next category: without problem, with potential problem and with problem.

These criteria have been applied according to the following procedure:

1. In relation to the indicator tendencies, it is considered that those are positive (increasing) when in a assessment area more than 10 % of registers obtained during the given assessment period (e.g 2006-2010 in the initial assessment of the MSFD performed in 2012) exceed the base value (90th percentile estimated for the whole time series) and/or if a statistically significant positive tendency (calculated from the annual averages) has been obtained for the whole time series.

2. In relation to the threshold value (TV), it is considered to be exceeded in a particular area if more than 10% of registers obtained in the actual assessment period surpass that value. This criterion has only been applied to coastal water bodies.

Table 1 summarizes different results obtained in application of the assessment criteria and the integration scheme for the Alboran Sea. The integrated procedure assessment methodology and the GES evaluation criteria are presented in Figure 1 and 2.

Table 6. Integrated evaluation of the indicators according to categories (nutrients, direct and indirect effects). The assessment criteria have been applied to each group of indicators: Trends (temporal tendency for the period 2005-2010); TV (threshold values for the limit Good/Moderate are those established by EU decision (2013/480/EU), and/or any further modification according to the intercalibration exercises performed, considering only coastal waters).

	Indicator	Area 1	Area 2	Area 3	Area 4	Area 5	Area 6
		Trend. // TV	Trend. // TV	Trend. // TV	Trend. // TV	Trend. // TV	Trend. // TV
Nutrients	DIN Phosphate	= // NA = // NA	= // NA = // NA	= // OK = // OK	= // OK + // OK	= // OK + // OK	+ // NA = // NA
Direct effects	Chlorophyll a Water transparency Phytoplankton abundance and community composition Nuisance/toxic phytoplankton species	= // OK = // NA	= // NA = // NA	= // OK = // NA	+ // OK = // NA = // NA	= // OK = // NA = // NA	= // NA = // NA = // NA
Indirect effects	Oxygen Benthic communities Macrophytes	¿? // NA	NA	¿? // NA	= // NA	= // NA	= // NA
		Without problems	**Without problems**	**Without problems**	**With potential problems**	**With problems because of phosphate**	**With problems because of DIN**

Legend:

= : without tendency (Trend) or negative tendency

+ : positive tendency

OK: Threshold values (TV) are not exceed for the limit G/M defined in the WFD.

NA: non-appropriate or threshold values are not available to be compared with the current state.

?: Lack of data to carry out the assessment.

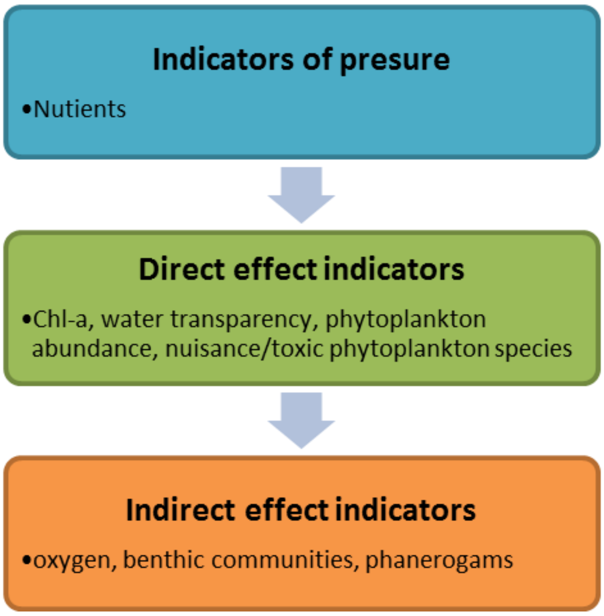

Figure 1. Integrated assessment of indicators procedure.

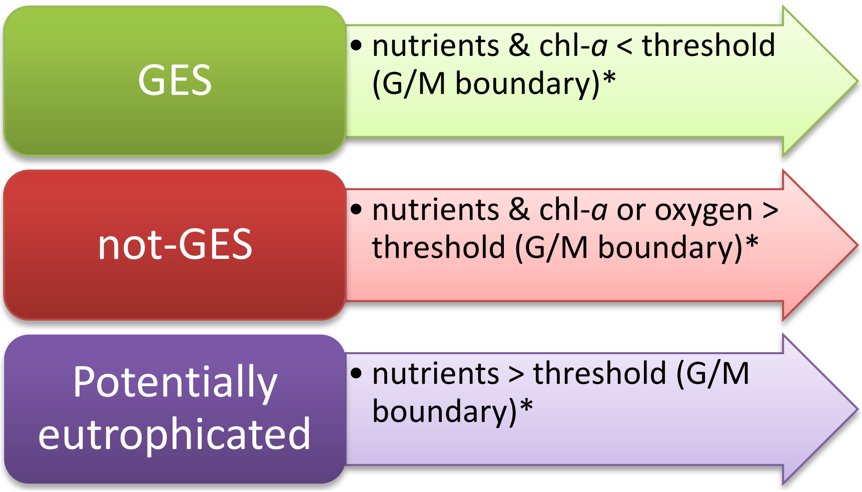

Figure 2. GES evaluation according to the integrated assessment of indicators. (Threshold values are those enforced currently by EU decision (2013/480/EU), and/or any further modification according to the intercalibration exercises performed)

Greece (and Cyprus)

The eutrophication assessment method used in Greece and Cyprus is based on the eutrophication scale developed by Ignatiades *et al.* (1992), Karydis (1999) and Pagou *et al.* (2002), and has been used extensively ever since.

The original eutrophication scale (table 7) included four levels of eutrophication: eutrophic, higher mesotrophic, lower mesotrophic and oligotrophic.

Table 7. The Greek eutrophication scale involves four levels of trophic status, as mentioned above:

	Tophic status			
Parameter	**Oligotrophic**	**Lower mesotrophic**	**Upper mesotrophic**	**Eutrophic**
N-NO_3 (μM)	<0.62	0.62 - 0.65	0.65 - 1.19	>1.19
N-NH_4 (μM)	<0.55	0.55 - 1.05	1.05 - 2.20	>2.20
P-PO_4 (μM)	<0.07	0.07-0.14	0.14 - 0.68	>0.68
Chlorophyll α (μg L^{-1})	<0.10	0.10 - 0.60	0.60 - 2.21	>2.21
Phytoplankton density (cells L^{-1})	<6 10^3	6 10^3 - 1.5 10^5	1.5 10^5 - 9.6 10^5	>9.6 10^5

In order to fit the five step ecological status scale of WFD, chlorophyll-a values were modified by Simboura *et al.* (2005) by splitting the lower mesotrophic range in two, resulting in the good quality class and the moderate quality class (see following Table 8).

The boundaries of this new scale were intercalibrated during the WFD Intercalibration activity (Simboura *et al.* 2015). The five ecological status scale as modified for the WFD needs based on chlorophyll-a values from the Greek eutrophication scale (Simboura *et al.* 2005), is presented below (the splitting of the lower mesotrophic range into two was performed by using the median value of the two boundary limits (0.1–0.6), resulting into the good quality class (0.1–0.4) and the moderate quality class (0.4–0.6) (Simboura *et al*. 2005)).

Table 8. The new eutrophication scale based on chla concentrations (Simboura *et al.* 2005).

Eutrophication scale	**Chlorophyll α (μg L^{-1})**	**Ecological Status**
Oligotrophic	< 0.1	High
Lower mesotrophic	0.1 – 0.4	Good
Mesotrophic	0.4 – 0.6	Moderate
Higher mesotrophic	0.6 – 2.21	Poor
Eutrophic	>2.21	Bad

More recently, the Eutrophication Index (EI) of Primpas *et al.* (2010) was proposed for the assessment of the eutrophication status in Greek coastal waters, combining the concentrations of nutrients (phosphate, nitrate, nitrite, ammonia) and the chlorophyll-α biomass into a single formula. E.I. is also adapted to a five step ecological status scale of WFD (see following Table). Simboura *et al*. (2015) have elaborated E.I. over a wide range of coastal areas in Greece.

According to the Eutrophication Index ranges reported by Primpas *et al.* (2010), oligotrophy corresponds to the ranges of EI (0.04-0.38), mesotrophy to the EI range (0.37-0.87) and eutrophication to EI (0.83-1.51). The upper limit of the moderate range of the EI scale was set as the average of the lower limit of the eutrophic and the upper limit of the mesotrophic groups (Table98).

Table 9. Eutrophication assessment and status scale according to Primpas *et al.* (2010).

Ecological Status	**Eutrophication Index**
High	less than 0.04
Good	0.04-0.38
Moderate	0.38-0.85
Poor	0.85-1.51
Bad	higher than 1.51

It must be reminded here that for Greece, target values are the values consistent with oligotrophic status and thresholds are the boundaries between the lower and upper mesotrophic status.

Croatia (and Slovenia, Italy for Adriatic Sea)

In 2001 an Eutrophication degree (status) classification scheme (Table 10) was developed and used for the evaluation along the Croatian cost. The classification scheme was supplemented with TRIX taken from the Italian legislation (D. LGS. 152/99).

Table 10. Croatian eutrophication degree (status) classification scheme.

Eut. status Eut. degree Color	z_{Sd}/m	$\gamma(O_2/O_2')$	c(TIN) µmol L^{-1}	c(TP) µmol L^{-1}	c(Chla) µg L^{-1}	TRIX	Description
High **Oligotrophic** **Blue**	>10	0.8-1.2	<2	<0.3	<1	2-4	- low trophic level - good water transparency - absence of anomalous colours of water - absence of subsaturation of dissolved oxygen
Good **Mezotrotrophic** **Green**	3-10	s.- 1.2-1.7 b.-0.3-0.8	2-10	0.3-0.6	1-5	4-5	- average trophic level - occasional clouding of water - occasional anomalous colours of water - occasional hypoxia
Moderate **Eutrophic** **Yellow**	<3	s.- >1.7 b.- 0.3-0.8	10-20	0.6-1.3	5-10	5-6	- average trophic level - occasional clouding of water - occasional anomalous colours of water - hypoxia and occasional anoxia - problems in benthic communities
Poor **Ekstremely** **eutro.** **Orange**	<3	s.- >1.7 b.- 0.0-0.3	>20	>1.3	>10	6-8	- high trophic level - high turbidity of water - persistent colouring of water - persistent hypoxia and anoxia - dying of benthic organisms - alteration of benthic communities

z_{Sd} - transparency, γ – oxygen saturation rate, c - concentration, TIN – Total Inorganic nitrogen, TP – Total phosphorous, Chla – Chlorophyll a, TRIX– Trophic index, s.- surface and b.- bottom layer

The scale is still in use and is part of the Croatian legislation (OG 73/13, 151/14). In the meantime, for the purpose of WFD implementation a scale based solely on the chlorophyll *a* concentration was developed and is water type oriented (Table 11).

Table 11. Category limits of ecological status for the concentration of chlorophyll *a* by type of coastal waters (Croatia).

		c(Chl a)/µg L^{-1}	
	Type	**HR-O_3**	**HR-O_4**
Ecological status	**reference**	≤ 0.70	≤ 0.50
	very good	0.71 - 0.94	0.51 - 0.62
	good	0.95 - 1.34	0.63 - 0.91
	moderate	1.35 - 1.95	0.92 - 1.35
	poor	1.96 - 4.00	1.36 - 2.78
	bad	> 4.00	> 2.78

HR-O_3 Polyhaline coastal sea, HR-O_4 Euhaline coastal sea

In parallel through the MedGIG (WFD Mediterranean Geographical Intercalibration Group) Italy, Slovenia and Croatia developed a common approach on the Adriatic scale that resulted in a new classification scheme that is presented in Table 12. The approach and scale is under evaluation by the EU commission.

Table 12. Boundaries in terms of geometric mean and 90th percentile of Chl-a (µg/L) and EQR for Type I, Type II-A.

Type		**Type I**		**Type II-A ADRIATIC**	
		G_Mean	**90th p.**	**G_Mean**	**90th p.**
Ref. Conditions (Chl-a, µg/L)		1.4	3.93	0.33	0.8
Boundaries (Chl-a, µg/L)	**H/G**	2.5	7.1	0.64	1.7
	G/M	6.3	17.7	1.5	4.0
Boundaries (EQR normalized)	**H/G**	0.83		0.81	
	G/M	0.61		0.60	

Turkey

The eutrophication assessment method developed for the Water Framework Directive Biological Quality Element (Chlorophyll-a) have been applied by Turkey in NE Mediterranean (MED-GIG 2011 and JRC, 2009) as part of the “Marine and coastal waters quality status determination and classification project” (Beken *et al.*, 2014) (MED-GIG 2011 and JRC, 2009). The method has been applied to 3 chosen different sites in NE Mediterranean, which are Erdemli (oligotrophic site), Mersin Bay (impacted area) and İzmir Bay. .Class boundary values and Ecological Quality Ratios have been determined and results given in table 13. Details are given in table 14 “National reference conditions and boundary setting”. Seasonal class boundary values have also been calculated in these areas, in order to examine seasonal variations.

Table 13. Boundary class values and EQR for chlorophyll-a in Erdemli, Mersin Bay and İzmir Bay (Beken *et al*., 2014)

ERDEMLI (<30m)					
	HIGH	**GOOD**	**MEDIUM**	**POOR**	**BAD**
ALL DATA	**10%**	**25%**	**50%**	**75%**	**90%**
	0,10	0,17	0,39	0,84	1,30
	<0,10	0,11-0,17	0,18-0,39	0,4-0,84	>0,84
EQR %25 (0,089)	**0,93**	**0,51**	**0,23**	**0,10**	**0,07**
GULF OF MERSIN (<30m)					
	HIGH	**GOOD**	**MEDIUM**	**POOR**	**BAD**
ALL DATA	**10%**	**25%**	**50%**	**75%**	**90%**
	0,33	0,80	1,36	2,47	3,95
	<0,33	0,34-0,80	0,81-1,36	1,37-2,47	>2,47
EQR %25 (0,32)	**0,97**	**0,40**	**0,24**	**0,13**	**0,08**
Gulf of İzmir (<30m inner bay)					
	HIGH	**GOOD**	**MODERATE**	**POOR**	**BAD**
	10%	**25%**	**50%**	**75%**	**90%**
	0.16	0.52	1.50	4.14	8.29
	<0,16	0,17-0,52	0,53-1,5	1,54-4,14	>4,15
EQR % 25 (0,15)	**0.96**	**0.30**	**0.10**	**0.04**	**0.02**
Gulf of İzmir (>30m central)					
	HIGH	**GOOD**	**MODERATE**	**POOR**	**BAD**
	10%	**25%**	**50%**	**75%**	**90%**
	0.11	0.16	0.41	1.08	1.79
	<0,11	0,12-0,16	0,17-0,41	0,42-1,08	>1,08
EQR % 25 (0,10)	**0.93**	**0.64**	**0.25**	**0.09**	**0.06**

The eutrophication assessment is made according to the recently developed HELCOM Eutrophication Assessment Tool (HEAT) in Mersin Bay (NE Mediterranean) (Kaptan, 2014). Some of the key assessment principles of the Water Framework Directive are used by the HEAT tool, for instance, the calculation of an Ecological Quality Ratio (EQR) and also the 'one out, all out' principle (Andersen *et al.*, 2011 and references therein). Therefore, HEAT combines both the principles of the HELCOM Baltic Sea Action Plan and the EU Water Framework Directive. The values for the parameters of Eutrophication Classification in the Eastern Mediterranean coastal and bay surface waters derived from spring-autumn observations (2008-2011) in the Mersin Bay influenced by major rivers in the region (for the water bodies with salinity >38.5).

The reference, threshold, good/moderate and moderate/poor boundary values for Eutrophication classification in NE Mediterranean derived from 2008-2011 seasonal data sets from Mersin Bay, by HEAT method developed for Baltic region are given in table 14 below (Kaptan, 2014).

Table 14

PARAMETER	Poor-Bad (EQR: <0.52)	Moderate (EQR 0.52-0.66)	Good (EQR:0.67-0.80)	High (EQR: >0.80)	Reference Value (oligotrophic water properties)
Phosphate (PO_4) µM	>0.08	>0.06-0.08	0.05-0.06	<0.05	0.04
Otal-P (TP) µM	>0.4	>0.3-0.4	0.25-0.3	<0.25	0.2
Nitrate (NO_3 +NO_2) µM	>0.4	> 0.3- 0.4	0.25-0.3	<0.25	0.2
Ammonium-N (NH_4) µM	>0.4	>0.3-0.4	0.25-0.3	<0.25	0.2
Silicate(Si) µM	<0.4	0.4-0.54	0.55-0.65	>0.65	0.8
Si/(NO_3) Ratio	<1.0	1.0-1.3	>1.3-1.6	>1.6	2.0
Chll-a (µg/l)	>0.6	>0.45- 0.6	0.38-0.45	<0.38	0.3
Secchi Disc Depth (m)	<3.5	3.5-4.5 m	>4.5-6.0 m	>6.0	7
O2- saturation (%) (summer - autum, depth <100m)	<75	75-80	>75-85	>85	95
TRIX Index	>5	>4.0-5.0	3.0-4.0	<3	2.5
Color Code	Red	Yellow	Green	Blue	

The eutrophication risk of NE Mediterranean Turkish coastal waters has been assessed according to TRIX index (Rinaldi and Giovanardi 2011).

In table 14 below, a summary on details regarding national reference conditions and boundary setting are given for some Mediterranean countries.

Table 15. Some national reference conditions and boundary setting.

Country	Type and period of reference conditions	Number of reference sites	Location of reference sites	Reference criteria used for selection	Boundary setting based on Expert judgment – statistical – ecological discontinuity – or mixed for different boundaries?	Specific approach for G/M boundary	Boundary setting procedure: method tested against pressure
Croatia, Italy Slovenia	Period: 2000-2010 Sites: Among the same sites already used for defining typologies (Tyrrhenian and Adriatic sites)	All data used for defining one common reference condition	Threshold values used, defined from common database	Pressure: dilution factor as the primary indicator of pressure from land	Joint boundary setting for Croatia, Slovenia and Italy, a common database was built with Type I and Type IIA data. A combination of expert judgement and statistical approach was used	Derived from expert judgement in combination with statistical analysis of the common database	Yes, Total phosphorus
Greece and Cyprus	Existing pristine-near pristine sites, expert knowledge, historical data since 1980s or 1990s to date depending on the stations (data since 2000 to date for Cyprus)	All data used for defining one common reference condition	Threshold values used, defined from common database	Pressure: Index LUSI ≤ 2 Type III-E 90th percentile Chl-a (µg/l) <0.4	Boundary values resulted mainly from modification of the Greek Eutrophication Scale, in line with expert judgement and consensus from the 1st phase of IC exercise	Derived from an equidistant split of the lower mesotrophic class, where the median is taken as the G/M boundary	Yes, LUSI Index
Turkey	Period 1997-2003 (Erdemli) Period 2005-2011 (Mersin Bay) Period 2000-2012 (İzmir Bay) Sites: Among the same sites already used for defining typologies	All data for each region and seasonal used for defining reference condition	Threshold values used, defined from common database	90th percentile Chl-a (µg/l) Erdemli: <0,09 Mersin: <0,32 İzmir: <0,15	Boundary values resulted from 90th percentile both whole years and seasonal and with expert judgement	Derived from expert judgement in combination with statistical analysis of the common database	Yes, Index LUSI and LUSIVA,

It is obvious that the review and catalogue on existing methods and criteria, thresholds and target values is far of being complete and Mediterranean countries are kindly asked to submit their tools for the purposes of this report.

Again the experts noted that more detailed information can also be found in the European project IRIS-SES inventory and toolboxes (GIS, assessment methods) and PERSEUS outcomes.

VII. Proposals for the definition of thresholds and methodological criteria for eutrophication assessment in Mediterranean.

During the discussions of the Eutrophication Working Group, it was noticed that a considerable amount of work must be devoted on the multiparametric indixes for eutrophication assessment evolving, nutrients, hydrological, bloom frequency, ratio of functional groups, etc considering the geographical approach (E. vs W. Mediterranean, Adriatic, and so on), tailored for all subregions. However, this was not possible during this phase of the work of the Eutrophication Working Group. Nevertheless the experts encourage Mediterranean countries which do not have their own approach, to use one of the existing and described above methods and then based on that to build their own.

Finally, the experts of the Eutrophication Working Group proposed the following recommendations:

- Contracting parties are invited to agree on the proposed criteria for typology of waters as presented in Table 2.
- Contracting parties are invited to apply the above criteria and define their water types with the support from MEDPOL if needed, until end of May 2015.
- The contracting parties are recommended to rely on the classification scheme on chl-a concentration (µg/l) as a parameter easily applicable by all Mediterranean countries based on the indicative thresholds and reference values presented in Table 4.
- However, for a complete assessment of eutrophication and GES achievement, GES thresholds and reference conditions (background concentrations) are needed not only for chlorophyll a, but such values must be set, in the near future, through dedicated workshops and exercises also for ~~nutrients, transparency and oxygen as minimum requirements~~ nutrients, oxygen and possibly transparency (in relation to chlorophyll levels) as minimum requirements
- Nutrient, transparency and oxygen thresholds and reference values may not be identical for all areas, since it 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.
- 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 assessment methods such as TRIX, Eutrophication scale, EI, HEAT, 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.
- 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 level in Mediterranean.

VIII. Next steps

Next steps can be based on:

- Discussion on available data from countries (validation of approaches and data, quality control, statistical approach), inter-calibration, methodologies.
- Development of a common (friendly) data base.
- Common indicators to be used by countries when possible.
- Countries to commit to apply eutrophication assessment

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ANNEX I
List of Experts

List of Experts

ECOLOGICAL OBJECTIVE 5 : EUTROPHICATION				
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2 st Report of the Informal Online Working Group on Marine Litter

1) BACKGROUND INTRODUCTION

Leading scientists and policymakers acknowledged recently in Athens that marine litter remained a "tremendous challenge" in almost all regions of the world, with clear impacts on marine ecosystems and estimates of overall financial damage of plastic to marine ecosystems standing at US$13 billion each year. Marine litter is one of the 8 environmental concerns considered by the UNEP/GPA for the protection of marine environment from land based sources and activities. The European Marine Strategy Framework Directive (2008/ 56/ EC) with a specific descriptor on ML, the adoption of the Honolulu strategy and Honolulu Commitment in 2011, and more recently, the particular emphasis on marine litter issues at the Rio+20 Summit 2012, is a clear indication of the high attention given to such issues at global level.
In the Mediterranean Sea, marine litter has been an issue of concern since the 1970s. The LBS Protocol of the Barcelona Convention recognized the importance of dealing with this problem and this basin was designated a Special Area for the purposes of Annex V of the MARPOL 73/78 Convention and the Mediterranean coastal States Parties to the MARPOL Annex V.
The findings and recommendations of the last assessment performed in 2009 (UNEP, 2009) led to the preparation of a Marine Litter strategic framework in the Mediterranean in 2012 in support to the regional action plan on marine litter management (ML RAP). COP 18 of the Barcelona convention adopted the MLRAP in 2013 to achieve the GES and targets on marine litter. The CORMON meeting on pollution and litter cluster held in Athens in May 2014 recommended establishing expert groups with an in-depth knowledge and access to available data on eutrophication, contaminants and marine litter. For each of the indicators dedicated to marine Litter (Descriptor 10), information is needed to deliver appropriate environmental assessment criteria and to provide scientific and technical basis for monitoring. The present document presents the results of the discussion held within the CORMON group of expert for Marine Litter.

2) OBJECTIVES

In the Decision on criteria and methodological standards on GES, ECAP identified 3 common indicators, one being on trial basis, for the environmental objective 10 (Marine Litter):

Common Indicator 16:	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 17:	Trends in the amount of litter in the water column including microplastics and on the seafloor
Common Indicator 18 (Trial basis)*	Trends in the amount of litter ingested by or entangling marine organisms focusing on selected mammals, marine birds and turtles

** The latter common indicator related to ingested litter (Indicator 10.2.1. in Annex I of Decision IG. 21/3) is proposed to be analyzed by the CORMON groups as a common indicator on a trial basis and further develop it based on available data, best practices and possible sub-regional pilots.*

In order to support the implementation of the regional monitoring plan and support the ECAP management approach, the online expert group on ML is required to deliver environmental and background assessment criteria based on data availability. Based on the specific recommendations of the ECAP CORMON Pollution and Litter on EO 10 (UNEP(DEPI)/MED WG.394/7, Annex I), the expert group has to (i) address further differentiation of thresholds between heavily littered, moderately, and littered beach categories, if possible, based on available data, (ii) consider thresholds and baseline values for floating litter, litter on the sea floor and floating micro plastics in each of the four MEDPOL subregions, (iii) regarding litter in biota, to define thresholds and baseline values for litter digested by sea-turtles, recommended as the main approach of focus, while opportunistically considered for seabirds and marine mammals, (iv) agree on litter categories specified for the Mediterranean Sea, considering compatibility with protocols from MSFD and other European regional seas, and finally (v) to explain the reason for omitting entanglement of litter as a common indicator.

For this, the online group had to (i) agree on definitions (thresholds, baseline, assessment criteria, GES, etc.), (ii) review the available data on marine litter in the MED in relation with ECAP indicators (available data on beaches, at sea, of micro plastics and ingested litter), (iii) analyze data with consideration to geographical and temporal differences (mean values, basin differences, trends, etc.), and (iv) propose different scenario for thresholds and baseline values, based on various realistic parameters (mean values, minimum values, possible decrease vs time, etc.)

3) DEFINITIONS OF TERMS (BASIC UNDERSTANDING AND COMMON DEFINITIONS)

The wording of the ECAP leaves scope for interpretation of the terms used. This is added to the difficulties of a consistent and coherent application. This chapter will provide key concepts based on a glossary of terms (alphabetic order) that are relevant for a common understanding of the implementation of the RAP (baselines, Good Environmental Status, targets, etc.) and in use within the expert group:

Assessment: An assessment is a process by which information is collected and evaluated following agreed methods, rules and guidance. It is carried out from time to time to determine the level of available knowledge and to evaluate the environmental state. It produces a report which synthesizes and documents information and findings, and classifies the environmental status in relation to Good Environmental Status (GES).

Baseline A baseline is a description of environmental state at a specific point against which subsequent values of state are compared. It may refer to a specified level of an impact or a pressure and act as a reference against which limit can be set or trends for the assessment of GES. Baselines can be derived from reference conditions, initial assessment values, the present state or a potential/predicted state.

Degradation: Degradation is the reduction in the quality status of the ecosystem, or any part of it, compared to a more healthy state.

Descriptor: Ecosystem Approach **(**ECAP) provided a list of 'Descriptors' which constitute the basis for the assessment of GES. These descriptors are substantiated and further specified through indicators, criteria and methodological standards, based on specific characteristics determined by Member States. Marine Litter is the descriptor 10 of the ECAP.

Ecosystem approach: The main elements of the ecosystem approach can be described, as defined in the MEDPOL statement, as the comprehensive integrated management of human activities based on best available scientific knowledge about the ecosystem and its dynamics, in order to identify and take action on influences which are critical to the health of the marine ecosystems, thereby achieving sustainable use of ecosystem goods and services and maintenance of ecosystem integrity.

Environmental Target: ECAP defines ‘environmental target’ as a 'qualitative or quantitative statement on the desired condition of the different components of marine waters in respect of each marine region or sub region. The main purpose of environmental targets is to guide progress towards achieving or maintaining GES. Targets can be of different nature, relating to desired conditions for state, impact and pressure and being operational for the implementation of concrete measures.

Good Environmental Status: In this document, GES describes the desired status of the environment and its elements, based on criteria and methodological standards set out in accordance with ECAP. ‘GES boundary’ is used to provide an expression for the deviation from the baseline or reference condition which marks the difference between a state that is acceptable and a state that is not acceptable. For descriptor 10 (Marine Litter) within ECAP, GES is when (i) Litter and its degradation products do not cause harm to marine life and damage to marine habitats, (ii) Litter and its degradation products present in, and entering into MED waters do not pose direct or indirect risks to human health, and (iii) when litter and its degradation products present in, and entering into MED waters do not lead to negative socio-economic impacts.

Impact: An impact is the environmental effect of a pressure resulting from human activities. It is permanent or temporary, and related to any type of harm (physical, chemical or biological) that is undesirable. It also includes the consequence for human welfare based on the use of the marine environment (socio economic impact).

Indicator: For the purposes of assessing environmental status, an indicator specifies the criteria and supports their assessment. For other purposes, "indicators" are understood in general as a scientific/technical assessment tool. An indicator consists of one parameter chosen to represent ('indicate') a certain situation or aspect and to simplify a complex reality and within ECAP, to support the determination of GES and assessment of the status of the marine environment.

Marine litter: Marine litter is any persistent, manufactured or processed solid material discarded, disposed of, or abandoned in the marine and coastal environment. Marine litter consists of items that have been made or used by people and deliberately discarded or unintentionally lost into the sea or coastline including such materials transported into the marine environment from land by rivers, drainage or sewerage systems or wind. Typical examples are plastics, wood, metals, glass, rubber, clothing and paper. This definition does not include semi-solid remains of for example mineral and vegetable oils, paraffin and chemicals that sometime litter sea and shores.

Methodological standard: Methodological standards are understood as established scientific or technical methods for assessing and classifying environmental status. Methodological standards can include assessment tools, methods for aggregation, common elements (contaminants, species, habitats, etc.), criteria, descriptors or approaches to define scale.

Microplastics: Microplastics are small plastic particles in the environment that are less than 5 mm (Arthur et al., 2009). They can come from a variety of sources, including cosmetics, clothing, and industrial processes and are classified as primary microplastics, directly manufactured from industry before processing, and secondary microplastics that are microscopic plastic fragments derived from the breakdown of larger plastic debris.

Parameter / metric: A parameter is a measureable characteristic value (e.g. number, Density of Litter, concentration, etc.). Metric relates to the unit in which the parameter is measured (e.g. number of items/km2, total weight, etc.). Parameters and metrics for assessment of GES are part of the criteria and methodological standards.

Pressure: A pressure is the result from anthropogenic activities at source which acts directly or via pathways on physical, chemical or biological elements of the marine ecosystem. At particular levels of intensity, it has the potential to have a direct or indirect impact on any component of the ecosystem.

Reference state / Reference conditions

For assessment purposes, it is often necessary to define a reference level against which current and future state is compared. Reference state/condition describe the state of the environment (or a component) in which there is considered to be no, or very minor, disturbance from the pressures of human activities.

Reference points

This relates to values, which must be achieved or not exceeded respectively, in order to bring a pressure or impact to a level that achieves the environmental target and consequently allows the marine waters concerned to move towards GES.

Scale: The scale defines the spatial and temporal extent of ecosystem components, their assessment (descriptor/indicators) and good environmental status.

Specifications and standardized methods: Specifications are related to minimum requirements for the design of monitoring (e.g. minimum frequency, spatial resolution) and assessment to make monitoring and assessment results comparable. 'Standardized methods are related to methods for monitoring (e.g. for sampling, analysis, quality assurance) that include agreed standards (e.g. MEDPOL Monitoring protocols), agreed rules for the spatial and temporal aggregation and common quality control mechanisms.

State/status: State refers to the quality/condition of specific elements of the environment. The word 'status', as used in the context of Good Environmental Status or Environmental Quality Status, describe the 'state' of individual ecosystem elements, through use of particular criteria and methodological standards, to assign a 'status' classification (e.g. at GES, below GES). 'Status' can either be applied to the overall quality/condition of the marine environment, at the level of the individual descriptors of GES or at the level of individual functional groups, habitats, species or populations.

4) LITTER IN THE MEDITERRANEAN SEA WITH CONSIDERATION TO ECAP INDICATORS (background scientific information)

The Mediterranean Sea has been described as one of the most affected areas by marine litter in the world. Human activities generate considerable amounts of waste and quantities are increasing, although they vary between countries; some of the largest amounts of Municipal Solid Waste (MSW) are generated annually per person in the Mediterranean Sea (208 – 760 kg/Year, http://www.atlas.d-waste.com/). Plastic, which is the main litter component, has now become ubiquitous in the marine environment and comprises up to 95% of waste accumulated on shorelines. A majority of these materials (plastics) do not decompose or decompose slowly. This phenomenon can also be observed on the sea floor, where 90% of litter caught in benthic trawls is plastic (Galil et al., 1995; Galgani et al., 1995 & 2000; Ioakeimidis et al., 2014) and this figure can reach up to 100% on the sea surface. Surveys conducted to date show considerable spatial variability. Accumulation rates vary widely and are influenced by many factors, such as the presence and magnitude of different pressures, including coastal urban development, tourism activities, maritime activities, etc. and the hydrodynamics and geomorphologic features of the sites. They are higher in enclosed seas such as the Mediterranean Sea with some of the highest densities of marine litter stranded on the sea floor, sometimes reaching over 100,000 items / km² (Galgani et al., 2000). Debris densities on the deep sea floor decreased between 1994 and 2009 in the Gulf of Lions (Galgani et al., 2011). Conversely, the abundance of debris in deep waters was found to increase over the years (Koutsodendris et al., 2008; Ioakeimidis et al., 2014).

In the Mediterranean and related to the sources, reports from Greece (Koutsodendris et al., 2008; Ioakeimidis et al., 2014) classify land-based sources (up to 69% of litter) and vessel-based sources (up to 26%) as the two predominant litter sources, depending on the area. In addition, litter items have variable floatability and hence variable dispersal potential.

4.1 ECAP indicator 16 (beaches)

Strandline surveys, cleaning and regular surveys at sea are gradually being organized in many Mediterranean countries in the aim of providing information on temporal and spatial distribution. The various strategies based on the measurement of quantities or fluxes have been adopted for data collection purposes. However, most surveys are conducted by NGOs with a focus on cleaning and public awareness. Standing stock evaluations of beach litter reflect the long-term balance between inputs, land-based sources or stranding, and outputs from export, burial, degradation and cleanups. Recording the rate at which litter accumulates on beaches through regular surveys is currently the most commonly-used approach for assessing long-term accumulation patterns and cycles.

The majority of studies performed to date have demonstrated densities in the 1 item/m2 range (Table 3) but showing a high variability in the density of litter depending the use or characteristics of each beach. Plastic accounts for a large proportion of the litter found on beaches in many areas, although other specific types of plastic are widely-found in certain areas, according to type (Styrofoam) or use (fishing gear).

Four categories of items seem to be most prominent on the beaches in the northern part of the Mediterranean: Sanitary items (mostly cotton bud sticks: foremost item found in ARCADIS 2014), cigarette butts and cigar tips (29-37% of items found; Öko-Institut 2012, UNEP 2009 and UNEP/MAP 2008), packaging items and bottles/caps (third category in ARCADIS 2014, around 20-25% in Öko-Institut 2012, UNEP 2009 and UNEP/MAP 2008) and Fishing gears (UNEP/MAP 2013), must be considered to be of importance as well.

Table 1: Composition/ sources of marine litter in the Mediterranean (After Interwies et al., 2013)

Source (Literature)	**Items/Consistency (beaches; top five)**	**Type of material**	**Sources**
ARCADIS 2014; Barcelona)	- Cotton bud sticks - Plastic/polystyrene pieces - Crisp/sweets/chips - Other sanitary items - Charcoal (201 items) Ports: 1: Crisp/sweets packets and lolly sticks 2: cigarette butts 3: cotton bud sticks	Beaches: Plastics: 50% by volume: 80% (Barcelona Provincial Government, cited in ARCADIS) Ports: 29% plastics, 22% wood, 21% organic matter	Recreational & tourism:40% Households(combined):40% Coastal tourism: 32,3% Toilet/sanitary: 26,2% household: 11,2% Waste collection: 6% Recreational: 5,6%
Öko-Institut (2012; figures mainly from UNEP 2009)	-Cigarette butts: 29,1% - Caps/lids: 6,7% - Beverage cans: 6,3% - Beverage bottles (glass): 5,5% - Cigarette lighters: 5,2%	Beaches: 37-80% plastics Floating: 60-83% plastics Sea-floor: 36-90% plastics	Recreational/shoreline activities: >50% , Increase in tourism season
UNEP/MAP (cited in ARCADIS 2014)	-Cigarette butts/filters: 27% -Cigar Tips: 10% -Plastic bottles: 9,8% Plastic - bags: 8,5% - Aluminum cans: 7,6%	Floating: 83% plastics	
Ocean Conservancy/ICC 2002-2006 (cited in UNEP/MAP 2008)			Beach litter: recreational activities: 52% Smoking-related activities: 40% waterways activities: 5%
JRC IES (2011)		Beach:83% plastics/polystyrene	

For ICC (2014) , cigarette butts, plastic bags, fishing equipment and food & beverage packaging are the most commonly-found items, accounting for over 80% of litter stranded on beaches (Ocean Conservancy).

Table 2: Top ten items by country (International Coastal Cleanup, ICC, 2014) Total number is the number of items collected on 59.1 miles of cleaned beaches from 8 different countries using the same methodology.

country	Surveyed miles	Cigarette butts	Food wrappers	bottles (plastic)	caps (plastic)	Straws Stirrers	grocery bags (plastic)	bottles (glass)	Other plastic bags	Paper bags	Beverage cans
Croatia	0,1	2478	156	34	139	0	133	55	119	58	36
Egypt	0,1	1	3	64	29	1	24	53	10	0	9
Greece	34,5	64473	3479	6373	8398	7364	2083	1535	1845	1285	3652
Italy	0,2	0	0	7	1	0	13	46	1	0	15
Malta	0,1	0	24	36	64	21	0	11	5	0	0
Slovenia	5,5	1857	408	272	493	504	92	60	141	13	188
Spain	18,1	22995	2614	4276	6780	16661	3795	1541	2551	1046	2295
Turkey	0,5	6313	112	233	586	173	210	142	34	34	210
Total	59,1	98117	6796	11295	16490	24724	6350	3443	4706	2436	6405

	Number of items per 100 m									
COUNTRY	Cigarette butts	Food wrappers	Beverage bottles (plastic)	Bottle caps (plastic)	StrawsStirrers	Grocery bags (plastic)	Beverage bottles (glass)	Other plastic bags	Paper bags	Beverage cans
Croatia	1540	97	21	86	0	83	34	74	36	22
Egypt	1	2	40	18	1	15	33	6	0	6
Greece	116	6	11	15	13	4	3	3	2	5
Italy	0	0	2	0	0	4	14	0	0	7
Malta	0	15	22	40	13	0	7	3	0	0
Slovenia	21	5	3	6	6	1	1	2	0	2
Spain	79	9	15	23	57	13	5	9	4	8
Turquey	786	14	29	73	22	26	18	4	4	26
Nb/100m (mean)	175	12	20	29	44	11	6	4	4	11

Items found indicate a predominance of land-based litter, stemming mostly from recreational/tourism activities (40% in ARCADIS, 2014, >50% in Öko-Institut, 2012 and Ocean Conservancy/ICC 2002-2006). Household-related waste, including sanitary waste, is also of great relevance (40% in ARCADIS 2014); the amount of litter originating from recreational/tourism activities greatly increases during and after the tourism season. Smoking related wastes in general seems to be a significant problem in the Mediterranean, as several surveys suggest (UNEP 2009; UNEP/MAP 2008). Also, the fishing industry is of significance (UNEP/MAP 2013), as well as shipping (the latter especially off the African coast).

Small fragments measuring less than 2.5 cm (Galgani et al., 2011), also referred to as meso particles or meso debris (versus macro debris), are often buried and may not be targeted by cleanup campaigns or monitoring surveys. Stranding fluxes are therefore difficult to assess and a decrease in litter amounts at sea will only serve to slow stranding rates. Small items can comprise a large proportion of the debris found on beaches and very high densities have been found in some areas.

4.2 ECAP indicator 17

4.2.1 Floating litter

Floating debris comprises the mobile fraction of debris in the marine environment as it is less dense than seawater. However, the buoyancy and density of plastics may change during their stay in the sea due to weathering and biofouling (Barnes et al., 2009). Synthetic polymers comprise the majority of floating marine debris, with figures reaching up to 100%. Although polymers are resistant to biological or chemical degradation processes, they can be physically degraded into smaller fragments and hence turn into micro litter, defined as measuring less than 5 mm.

They can also be transported by currents until they sink to the sea floor, be deposited on the shore or degraded over time. Although anthropogenic debris floating in worldwide oceans was reported decades ago, the existence of Floating Marine Debris accumulation zones in oceanic gyres has now gained worldwide attention. However, there are no permanent gyres in the Mediterranean Sea and local drivers may largely affect litter distribution (CIESM, Workshop N°46, 2014).

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, as for beaches, few datasets are available for the comparable assessment of debris abundance and monitoring is only performed occasionally (Table 3).

The reported quantities of floating marine debris items larger than 2 cm range from 0 to over 600 per square kilometer. Floating debris was quantified during marine mammal observation cruises in the northern Mediterranean Sea, in a 100 x 200 km offshore area between Marseille and Nice and in the Corsican channel. A maximum density of 55 items/km² was found, with a clearly-discernible spatial variability relating to residual circulation and a Liguro-Provencal current vein routing debris to the West (Gerigny et al., 2012).

In the Ligurian Sea, data was collected through ship-based visual observations in 1997 and 2000. 15-25 items/km² were found in 1997, with a decrease to 1.5 – 3 items in 2000 (Aliani and Molcard, 2003). Voluntary observations in the Mediterranean Sea reported litter concentrations of 2.1 items/km², with plastic materials representing 83% and higher concentrations in coastal areas (Helmepa, in UNEP, 2011). Finally, high debris densities were found locally such as in the Adriatic Sea or in the Algerian basin, at up to 195 items/km2 (for 25 in the Mediterranean sea, Suaria and Aliani, 2014, Zambianchi et al., 2014).

Modelling oceanographic currents using input scenarios based on population densities and major shipping lines can help identify pathways and accumulation areas, thus enabling source attribution and the localization of areas harboring high litter concentrations (Maximenko et al., 2012). 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 (Lebreton et al., 2012). Modelling is also used to predict the pathways and impacts of large debris quantities introduced through natural extreme events, runoffs (e.g. the discharge located in Saida, Lebanon) and trans border transportation (Zambianchi et al.,2014).

4.2.2 Sea floor

Deep sea surveys are of major importance, as most litter comprises high-density materials and hence sinks. Even low-density polymers, such as polyethylene and polypropylene, may sink under the weight of fouling. General strategies for the investigation of seabed debris are similar to those used to assess the abundance and type of benthic species. Although floating debris, such as that found in the highly publicized ‘‘gyres’’ and/or convergence zones, has attracted public attention, debris accumulating on the sea floor can potentially impact benthic habitats and organisms. 47 studies were conducted between 2000 and 2013, but, until recently, very few covered extensive geographic areas or considerable depths. 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. The geographical distribution of plastic debris is highly impacted by hydrodynamics, geomorphology and human factors. Continental shelves are proven accumulation zones, but they often gather smaller concentrations of debris than canyons: debris is washed offshore by currents associated with offshore winds and river plumes.

Only few studies have focused on debris located at depths of over 500 m in the Mediterranean (Galil, 1995; Galgani et al., 1996, 2000, 2004; Pham et al., 2014; Ramirez-Llodra et al., 2013) (table 3).
Galgani et al. (2000) observed decreasing trends in deep sea pollution over time off the European coast, with extremely variable distribution and debris aggregation in submarine canyons. Using a deep sea remote operated vehicle (ROV), video surveys in submarine canyons (Galgani et al., 1996, Pham et al., 2014) concluded that submarine canyons may act as a conduit for the transport of marine debris into the deep sea. Higher bottom densities are also found in particular areas, such as around rocks and wrecks, and in depressions and channels. In some areas, local water movements carry debris away from the coast to accumulate in high sedimentation zones. The distal deltas of rivers may also fan out into deeper waters, creating high accumulation areas.

A wide variety of human activities, such as fishing, urban development and tourism, contribute to the patterns of seabed debris distribution. Fishing debris, including ghost nets, prevails in commercial fishing zones and can constitute high percentages of total litter. More generally, accumulation trends in the deep sea are of particular concern, as plastic longevity increases in deep waters as most polymers degrade slowly in areas devoid of light and with lower oxygen content.

The abundance of plastic debris is very location-dependent, with mean values ranging from 0 to over 7,700 items per km² (table 3). Mediterranean sites tend to show the highest densities, due to the combination of a populated coastline, coastal shipping, limited tidal flows and a closed basin, with exchanges limited to the Gibraltar strait. In general, bottom debris tends to become trapped in areas with low circulation, where sediments accumulate.

Counts from 7 surveys and 295 samples in the Mediterranean Sea (2,500,000 km², worldatlas.com) indicate an average density of 179 plastic items/km2 for all compartments, including shelves, slopes, canyons and deep sea plains, in line with trawl data on 3 sites described by Pham et al., 2014. On the basis of this data, we can assume that 525,615,958 (# 0.5 billion) litter items are currently lying on the sea floor.

4.2.3 Microplastics

In addition to large debris, there is growing concern with regards to micro particles measuring less than 5 mm and particles measuring as little as 1 μm have already been identified (Thompson et al., 2004). Most, but not all micro particles consist of micro plastics. The abundance and global distribution of micro plastics in oceans has increased steadily in recent decades (Cole et al., 2011). Micro plastics comprise a very heterogeneous group, varying in size, shape, color, chemical composition, density and other characteristics. They can be subdivided by use and source as (i) ‘primary’ micro plastics, produced either for indirect use as precursors (virgin resin pellets) for the production of polymer consumer products, or for direct use, such as in cosmetics, scrubs and abrasives and (ii) ‘secondary’ micro plastics, resulting from the breakdown of larger plastic materials into increasingly small fragments. This is the result of a combination of mechanisms, including photo, biological, mechanical and chemical degradation.

To date, only a limited number of global surveys have been performed in the aim of quantifying micro plastic distribution. The majority of existing surveys is localized and concentrated on specific areas around the world, such as regional seas, gyres or the poles. Most of these studies focus on sampling the sea surface and/or water column and intertidal sediments (Hidalgo-Ruz et al. 2012). Mean sea surface plastic were found in concentrations up to 330,000 particles / km^2 in the California current system, with 334,000 particles / km^2 in some stations in the North Pacific and 115,000 particles / km^2 in the NW Mediterranean Sea (maximum 890,000 particles) (Collignon et al., 2012; Moore et al. 2001; Cole et al. 2011). The highest micro plastic concentrations in sediment (Claessens et al., 2011) were found in beach and harbour sediments, with concentrations of up to 391 micro plastics/kg of dry sediment in a harbor sediment sample from the southern North Sea (Belgium). Similarly, a beach survey on the Mediterranean island of Malta revealed an abundance of pellets on all of the studied beaches (Turner and Holmes, in Cole et al. 2011), with the highest concentrations reaching 1,000 pellets/m2 along the high-tide mark. Finally, on Kea Island in the South Aegean Sea, microplastics abundance reached the 977 items/m^2 with a highly variable abundance of virgin pellets (7-560 pellets/m^2) (Kaberi et al., 2013). Micro plastic pollution has also spread throughout the world’s seas and oceans, into sediment and even the deep Mediterranean Sea (Van Cauwenberghe et al., 2013).

Time trends relating to the composition and abundance of micro plastics are scarce. However, available long-term trend data suggests various patterns in micro plastic concentrations. A decade ago, Thompson (2004) revealed a significant increase in plastic particle abundance over time. More recent evidence indicates that micro plastic concentrations in the North Pacific Subtropical Gyre have increased in the last four decades (Goldstein et al. 2012), whereas no changes have been observed on the surface of the North Atlantic gyre over a 20-year period (Lavender Law et al., 2010).

Table 3: Comparison of mean litter densities from recent data (from 2000) in the Mediterranean Sea. Intervals of values are given in parentheses.

Location	**Environmental compartment**	**Date**	**Sampling**	**Depth**	**Density (min-max)**	**% plastics**	**References**
Slovenia	Beaches	2007	3 beaches, 150 m-2 per transect	0	12158/km	64	Palatinus, 2009
Balearic	Beaches	2005	32 beaches	0	36000/ km (high season)	75 (46% cigarette butts)	Martinez et al., 2009
France /Marseille	Beaches	2011-2012	10 beaches (30 in winter)	0	0,076 m-3/day/100m (stranding rates)	80-94	MerTerre 2013 - (www.mer-terre.org)
Turkey	Beaches	2008-2009	10 beaches	0	0.085 to 5.058 items m2	91	Topçu et al., 2013
Spain	Beaches	2013-2015	12 beaches, 100m transects, 4 surveys/year	0	11-2263 items/100 m (2013) 27-1955 items/100 m (2014) 33-2209 items/100 m (2015 winter)	66% (2013) 62% (2014) 67% (2015, winter)	Ministerio de Agricultura, Alimentación y Medio Ambiente (http://www.magrama.gob.es/es/costas/temas/proteccion-medio-marino/actividades-humanas/basuras-marinas/)
Spain-Mediterranean Sea	Beaches	2013-2014	27 beaches	0	11-2273 items / 100 m	48.6%	MARNOBA Project (http://vertidoscero.com/Marnoba_AVC/result.htm)
Croatia (Mjet island)	Beaches	2007	NA	0	NA	80	Cukrov & Kwokal, 2010
Mediterranean sea (15 countries)	Beaches	2002-2006	Beaches	0	NA	>60	ICC, in UNEP, 2011
Greece	Beaches	2006-2007	80 Beaches	0	NA	43% (2006) 51% (2007)	Kordella et al., 2013
Greece (Ionian sea)	Beaches	2014-2015	4	0	208 /100m (35-405) 175 / 15 days/ 100m		Defishgear (2015), in prep.
Med Countries (10)	Beaches	2014	95 km	0	680 items/ 100m		ICC report (2014)
Spain (Murcia)	Micro plastics Beach	2012	1 Beach	0	2245 microplastics/m2	100	http://surf-and-clean.com/microplasticos/
Spain (Malaga)	Micro plastics Beach	2014	1 Beach	0	123-308 microplastics/100 ml 847-2071 microplastics/kg	100	CEDEX, 2014
France	Micro plastics Beach	2011	15 beaches	0	2920 microplastics/m2 (10cmm layer, 0-8000)	100	Klosterman et al., 2012

Location	Environmental compartment	Date	Sampling	Depth	Density (min-max)	% plastics	References
Greece	Micro plastics Beach	2012	12 beaches	0	10-977 items/m2 (2-4 mm) 20-1218 items/m2 (1-2 mm)	100	Kaberi et al., 2013
Ligurian coast	Floating	1997-2000	Visual	surface	1.5-25/ km²	nd	Aliani and Molcart, 2011
North western	Floating	2013	Waveglider	0-4,5m	40,5/ km²	100	Galgani et al., 2013 (CIESM)
Slovenia	Floating	2011	Visual	Surface	1.98 /km2	90	Vlachogianni & Kalampokis, 2014
Adriatic/ Greek waters	Floating	Since 2008	Visual	Surface	5.66 /km2		Vlachogianni & Kalampokis, 2014
North western	Floating	2006-2008	Visual	surface	3,13 / km²	85	Gerigny et al., 2012 and Unpublished data (Ecoocean.org)
Greece	Floating		Visual	Surface	2.1 items/km²	83	HELMEPA (Greece) in UNEP, 2011
Western, Ionian and Adriatic seas	floating	2013	Visual	Surface	6.9 items/km² (0-117)	95.6	Suaria and Aliani (2015)
NW Mediterranean	Floating /Micro plastics	2010	40 samples/Manta/330µm mesh	Surface	115000 / km²	> 90%	Collignon et al., 2012
West Sardinia	Floating /Micro plastics	2012	30 samples/Manta/500µm mesh	Surface	150 000 items/ km² (extrapolated from volumes)		Andrea /Lucia et al., 2014
Malta	Shelf	2005	Trawl (44 hauls, 20 mm mesh)	50-700	102	47	Misfud et al., 2013
Sicily/ Tunisian channel	Shelf	1995	Trawl (fishermen)	0-200 m	401/km²	75	Cannizarro et al. (1995)
Adriatic Sea	Shelf	1997	12 hauls (trawling, 20 mm mesh)	0-200 m	378 +/- 251 / km²	69,5	Galgani et al., 2000
Northern & central Adriatic	Shelf	2005-2010	trawl trawling	0-200m	5-34 kg/ km²	NA	From Vlachogianni & Kalampokis, 2014
Montenegro	Shelf/ slopes	2009	trawling	48 - 746 m	6-59% of total catches	NA	Petrovic & marcovic, 2013
Slovenia	Shallow waters	2013	diving	0-25m	Na	55	From Vlachogianni & Kalampokis, 2014
France-Mediterranean	Seabed, slopes	2009	17 canyons, 101 ROV dives,	80-700m	3.01 /km survey (0-12)	12 (0-100)	Fabri et al., 2013

Location	Environmental compartment	Date	Sampling	Depth	Density (min-max)	% plastics	References
Tyrrhenian sea	Seabed, Fishing grounds	2009	6 x 1.5 ha samples , trawl, 10mm mesh	40-80m	5960±3023/ km²	76	Sanchez et al., 2013
Spain-Mediterranean	Seabed, Fishing grounds	2009	Trawling (fishermen)	40-80m	4424±3743/ km²	NA	Sanchez et al., 2013
Mediterranean sea	Seabed, Bathyal/abyssal	2007-2010	292 tows, Otter/Agassiz trawl, 12 mm mesh	900-3000m	0.02- 3264.6 kg/ ·km² (including clinkers)	nd	Eva-Ramirez 2013
Turkey/ Levantine basin,	Seabed, Bottom/Bathyal	2012	32 hauls (trawl, 24 mm mesh)	200-800m	290 litter (3264.6 kg·) /km²	81.1	Güven et al., 2013
Turkey/ North eastern basin,	Shelf	2010-2012	132 hauls (2.5kts)	20-180	72(1-585 kg)/ hour	73	Eryasar et al., 2014
Mediterranean, Southern France	Shelves & canyons	1994-2009 (16 years study)	90 sites (trawls, 0.045 km2/tow)	0-800 m	76-146/ km² (0-2540)	29.5 -74	Galgani et al. 2000 & unpublished data
Greece	Shelf	Before 2004	59 sites	30-200	4900 /km²	55.5	Katsanevakis & Katsarou (2004)
Greece	Shelf	2000-2003	54 hauls (trawl, 1,5 mm mesh)	30-200	72–437 / km²	55,9	Koutsodendris et al. (2008)
Greece	Seabed (fishing ground)	2013	69 hauls (50mm mesh)	50-350	1211±594 items/km2 (Saronikos Gulf)	95,0±11,9 (Saronikos Gulf)	Ioakeimidis et al., 2014
Levantine basin (Cyprus)	Seabed (fishing ground)	2013	9 hauls (50mm mesh)	60-420	24±28 items/km2	67,4±7,7	Ioakeimidis et al., 2014
Black sea (Constanta bay)	Seabed (fishing ground)	2013	16 hauls (20mm mesh)	30-60	291±237 items/km2	45,2±4,8	Ioakeimidis et al., 2014
Italy (North Thyrrenian)	Shelf	2010-2011	69 dives (26 areas, 6.03 km2)	30-300	90 debris items/ km² (0- 160)	92% (89% from fishing)	Angiolillo et al. (2015)

4.3 ECAP indicator 18

Marine litter can affect marine organisms in a multitude of ways, either through physical damage such as entanglement or through indirect health effects such as after ingestion. Direct damage and entanglement pose serious threats to wildlife such as sea turtles, marine mammals, fish and invertebrates, as well as birds, which can be trapped or strangled in the debris (Gregory, 2009). In 2012, 663 species have been identified as possibly affected by marine litter (CBD, 2012).

"Ghost fishing", whereby lost or abandoned fishing gear continues to catch fish and cause direct harm and mortality to marine organisms (Brown and Macfayden, 2007). Moreover, "Ghost gear" can persist in the environment for a long time because they are usually made of synthetic fibers that are not bio-degradable.
Debris can come into the Mediterranean Sea from the Atlantic Ocean floating via the Strait of Gibraltar, but the majority of litter is of terrestrial origin (MSFD TS-ML, 2011; Galgani et al. 2013). The most lightweight (mainly plastics) float on the sea surface and are driven by the convergence of currents and eventually accumulate in gyres, while heavier (glass, metal, hard plastic items, etc.) collect on the bottom (Galgani et al. 2000, Barnes et al. 2009, Mifsud et al. 2013). More than 62 millions of debris items are estimated floating in the Mediterranean (Suaria and Aliani, 2014).

Biota indicators play an important role, as they provide indications of possible harm. At the same time, current protocols and methods have varying degrees of maturity. Pilot-scale monitoring is therefore an important step towards monitoring litter harm in terms of determining baselines and/or adapting the strategy to local areas. Litter affects marine life at various organizational levels and its impact varies according to the target species or population, environmental conditions and the considered region or country.

The concept of harm itself is not obvious, as no acceptable units of measure have been defined. Moreover, proven harm may not be useful for monitoring purposes. For example, entanglement has been highlighted as having one of the most harmful impacts on marine organisms. Organisms may however continue to travel over considerable distances after becoming entangled in ropes, net and lines, hence transforming active fishing gear into marine debris. As a consequence, monitoring criteria only refer to ingested litter, due to difficulties in distinguishing between entanglement in litter and active fishing gear. The current difficulties in interpreting data, together with the low reported numbers of entangled beached animals and problems associated with large-scale harm assessment due to the rarity of stranding, mean this approach can only usefully be applied to specific areas and on the basis of national decisions (Galgani et al., 2013). Research may contribute to the development of new, more specific entanglement indicators. For example, seabird nests can be used to facilitate litter-related entanglement monitoring, as the litter found there cannot originate from active fishing gear (Votier et al., 2011).

Beyond the direct impact on survival, debris ingestion causes sub-lethal effects related, for example, to the decrease of natural food inside stomach and therefore the amount of absorbed nutrients, or the ingestion of toxic substances adsorbed on or released directly from the plastic (Gregory 2009).They may act as endocrine disruptors and therefore can compromise the fitness of individuals (Teuten et al., 2009; Rochman et al., 2013; 2014).

More than 180 marine species have been documented to absorb plastic debris, among these different species of sea birds (Van Franeker et al. 2011), fish (Boerger et al., 2010) and marine mammals (de Stefanis et al. 2013), including plankton species (Fossi et al., 2012, de Lucia et al., 2014). Species that can be considered for monitoring of marine litter, must meet a number of basic requirements, like (i) sample availability (adequate numbers of individuals over a wider span of time and space, without dedicated killing of individuals but beached animals, by-catch victims or harvested species) , (ii) Regular plastic consumption (high frequency and amounts of plastic over time in stomachs), and (iii) feeding habits (stomach contents should only reflect the marine environment). Six of the world's 7 species of sea turtles have been found to ingest debris, with the exception of the flatback sea turtle (Natator depressus)

(Schuyler et al. 2014). All six are listed as globally vulnerable or endangered (IUCN 2013). Few single species can actually provide full coverage of all Mediterranean sea and the sea turtle *Caretta caretta* has been shown to be the best candidate species.

4.3.1 Sea turtles

The loggerhead sea turtle (*Caretta caretta*, Linnaeus, 1758) is the most abundant chelonian in the Mediterranean (Camedda et al., 2014; Casale and Margaritoulis, 2010; Margaritoulis et al., 2003). Sea turtles may ingest plastic bags mistaken for jellyfishes (Mrosovsky,1981; Mrosovsky et al., 2009; Plotkin et al., 1993) when they feed in neritic and oceanic habitats. Plastic fragments and other anthropogenic materials may be directly responsible for the obstruction of digestive tracts (Bugoni et al., 2001; Di Bello et al., 2006) and the death of sea turtles (Bjorndal et al., 1994). Furthermore, long retention times of plastic debris in the intestine may cause the releasing of toxic chemicals (e.g. phthalates, PCBs) that may act as endocrine disruptors and therefore can compromise the fitness of individuals (Teuten et al., 2009).
The loggerhead turtle is adopted worldwide as bio-indicator of environmental conditions as the pollution contamination (Foti et al., 2009; Keller et al., 2006). This species, which is listed on the Convention on International Trade in Endangered Species (CITES), has been classified worldwide as “endangered” (IUCN, 2013) and considered as a “priority” species according to the Habitat Directive of the European Union.

During 2012, an Italian task group (ISPRA, IAMC-CNR Oristano, SZN “Anton Dohrn” Napoli, University of Siena, University of Padova, ARPA Toscana) proposed the loggerhead turtle as a target-indicator species for the evaluation of ingested macro litter in an experimental protocol specific for the Mediterranean Sea (Matiddi et al., 2011; MSFD TS-ML, 2013).

Litter in Biota protocol, implemented and adapted to the Mediterranean sea, has been included in “Monitoring Guidance for Marine Litter in European Seas”, reference report by the Joint Research Centre of the European Commission (MSFD TS-ML, 2013).

Its extended spatial distribution in the Mediterranean Sea (Casale and Margaritoulis, 2010, Oliver, 2014; Darmon et al., 2014), and the regular occurrence of human waste in the stomach contents (Tomas et al., 2002; Lazar and Gracan 2011; De Lucia et al., 2012; Bentivegna et al., 2013; Travaglini et al., 2013; Camedda et al. 2013; 2014) are interesting criteria for the use of this species as assessment and monitoring tool for marine litter in biota.

Sea turtle species have different lifestyles at various stages of their lives; they can frequent disparate areas feeding on epipelagic or benthic prey in oceanic and neritic zones.
At the early stage of their life individuals probably are mainly inactive, driven by the currents in the oceanic area, after this they gradually begin to swim against the tide reaching shallow water , then adults start to use the sea bottom and the water column as feeding compartment (Casale et al. 2008, Lazar et al. 2010). Adult loggerheads have been found to show fidelity to their neritic feeding grounds which may be the same ones they recruited to as juveniles (Casale et al., 2012), for these reasons they are likely to ingest waste in different habitat types during their lives.

The transition to the pelagic stage to the neritic one, occurs at different range sizes, but below 40 cm Curved Carapace Length (CCL) are usually considered juveniles (Cardona et al., 2005; Casale et al., 2008; Lazar et al., 2008; Campani et al., 2013) and the neritic area is probably selected depending on the proximity to the oceanic area frequented before (Casale et al. 2007).
Some studies in which stranded turtles were analyzed report that smaller oceanic turtles are more likely to ingest debris than larger turtles (Plotkin & Amos 1990; Schuyler et al. 2012). This means young oceanic turtles may be more at risk from debris ingestion than older benthic-feeding turtles, not only, they are more likely to ingest debris, but their relatively small, thinner digestive systems will be more vulnerable to impaction by and perforation from the debris (Schuyler et al. 2012).

Different result has been found in Mediterranean Sea where adult specimens of loggerhead showed higher values of marine litter if compared with the juvenile (Campani et., al., 2013).

Even though loggerhead sea turtles, in particular adult individuals, are able to discriminate colors to find food (Bartol and Musick, 2003), and avoid biting non-preferred preys (Swimmer et al., 2005), Camedda et al., (2014) showed that both, adults and juveniles of *C. caretta* ingested plastic materials “preyed” on the sea surface and in the water column.

The hypothesis that loggerheads have a low feeding discrimination also received support from Hoarau et al., 2014, they demonstrated that loggerhead collects heterogeneous types of materials in terms of shape and colors, some of which debris was not similar to any prey species.

Sea turtles are a migratory species and have an average swimming speed of about 1,2Km per hour, below 0.5km per hour at foraging sites, satellite telemetry studies indicated that sea turtles are able to travel long distances, quantified in dozens kilometers per day (Bentivegna, 2002; Bentivegna et al., 2007; Luschi et al., 2006; Schofield et al., 2010; Tucker, 2010; Varo-Cruz et al., 2013).

Seasonal migrations (north/south) probably due to temperature change are known from the north-western Atlantic (Musick and Limpus 1997), but do not seem to be a general pattern for all populations (Limpus and Limpus 2001). Hochscheid et al. (2005, 2007) observed that loggerhead turtles in the Mediterranean can undergo a state of dormancy to overcome the cold season, without the need of migrating to warmer areas.

Large quantities of debris can remain in the gut for months (Lutz, 1990) and pass through their entire digestive tract without causing any lethal damage.
The loggerhead sea turtle, *Caretta caretta*, demonstrates great tolerance of anthropogenic debris ingestion and the species is generally able to defecate these items (Balazs, 1985; Casale et al., 2008; Frick et al., 2009)

Camedda et al., 2014 observed that sea turtles in the Sardinia rescue centre, released anthropogenic materials in the feces for longer than a month of hospitalization, even if most of the litter was expelled within the first 2 weeks. Studies about transit time of substances in gastro-intestinal tracts of loggerhead sea turtles demonstrated that materials (as polyethylene spheres) are expelled in about 10 days (Valente et al., 2008). Therefore, they conclude that considering the mean distance covered in 10 days by *C. caretta*, the litter defecated during the hospitalization into the tanks is likely to be a sample of debris present around Sardinia (Camedda et al., 2014).

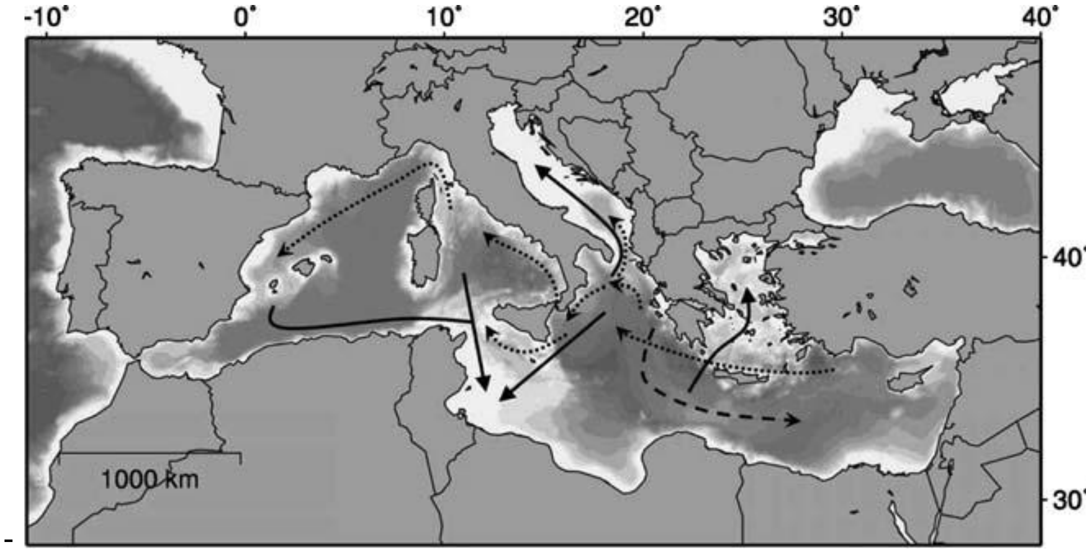

Fig. 2: A hypothetical pattern of frequented areas and movements of *Caretta caretta*. *Dashed lines* link natal sites and oceanic habitats (the *bold dashed line* considers a hypothetical oceanic habitat in the eastern Mediterranean). *Continuous lines* link oceanic and neritic habitats. *Lines* just link different areas and should not be necessarily considered as specific routes (Casale et al., 2007).

Despite loggerhead is able to ingest any kind of waste, plastic items seems to be significant more than other kind of marine litter. Different studies in the Mediterranean Sea (Tomas et al., 2002; Casale et al., 2008; Lazar and Grac ̌an,2011; Campani et al., 2013, Camedda et al., 2014), in the Atlantic Ocean (Plotkin et al.,1993; Bugoni et al., 2001; Frick et al., 2009) in the Pacific Ocean (Parker et al., 2005; Boyle and Limpus, 2008) and in the Indian Oceans (Hoarau et al., 2014), demonstrated that plastic is the most frequently ingested anthropogenic debris. Schuyler et al. (2013) recently showed that plastic was the most widely reported debris item ingested by all sea turtles in analyzing 37 studies published on debris ingestion by sea turtles.

It is common idea that more plastic items are ingested by loggerheads because of their resemblance of natural preys in oceanic waters and their opportunistic habit of feeding on items floating at or near the surface but it is also well known that plastic is the main waste at sea all around the world. Plastic is the primary type of debris found in marine and coastal environments (Derraik 2002), and plastics are the most common form of debris ingested by wildlife (Mrosovsky et al. 2009; van Franeker et al. 2011; Schuyler et al. 2012). In the OSPAR Fulmar EcoQO indicator only plastic items are considered, but all the categories of marine litter are recorded.

In Camedda et al., (2014) litter found in the stranded sea turtles was compared with those excreted by hospitalized ones, analysis of categories showed homogeneity in relation of the total abundance, weight and composition among alive and dead turtles. Hoarau et al., 2014 found that the number, weight, volume and mean length of debris were higher in gut content of deceased loggerheads than in fecal samples of live turtles, but not significantly.
According to Scuyler et al., (2013) lavage or fecal analyses underestimate debris ingestion because only a small subset of the gastrointestinal tract is sampled. Seminoff et al. (2002) found 1.9% of 101 lavaged turtles had ingested debris: 41 of these turtles were kept in a tank and their feces collected. Of these, 19% excreted debris, 10 times the amount found through lavage. Seven turtles from the same population died and their stomach contents were analyzed; 2 had ingested debris.

4.3.2 Other species

There is a potential for using litter Ingested by other species as indicator of harm. 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). However alternative tools are needed for the Mediterranean Sea. On the basis of available information, bird species of interest for monitoring such as shearwaters have limited distribution indicating local interest. The protocol proposed by TSG-ML which can be used for seabirds in general, may be then applied in parts of the Mediterranean.

Alternative species may also be considered. This may be the case for some fish species (Boops sp. for example, Deudero et al., in CIESM, 2014) or invertebrates such as echinoderms of mollusks. Such indicators need however more research and interpretation may be restricted to the effects of micro plastics only. Ingestion of litter by a wide range of whales and dolphins or deep sea species e.g. Galeus melastomus (Anastasopoulou et al, 2013) is also known. However, the known rates of incidences of ingested litter are generally low to justify a standard ECAP monitoring recommendation at this point.

Table 4: Ingestion rate of Litter in Mediterranean Sea turtles. Size is given in shell length.

Sardinia(E&W)	2008-2012	21-73	30	20	91	12	121	14,04	Camedda et al., 2013
Tuscany	2010-2011	29-73	31	71			31	71	Campani et al., 2013
Adriatic	2011-2004	25-79	54	35,2			54	35,2	Lazar & Gracan, 2011
Spain	nd	34-69	54	79,6			54	79,6	Tomas et al., 2012
Lampedusa	2001-2005	25-80	47	51,5	33	44,7	79	48,1	Casale et al., 2008
Malta	1988	20-69			99	20,2	99	20,2	Grammentz, 1988
France	2011-2012	Nc	2	0	54	24	56	19,6	Dell'Amico & Gambaiani, 2012
France	2003-2008		20	36			20	36	Claro & Hubert, 2011
Balearic islands	2002-2004	36-57	19	37,5			19	37,5	Revelles et al., 2007
Linosa	2006-2007	26,7-69					32	93,5	Botteon et al., 2012
Italy/Spain (Murcia)	2001-2011				155	50	155	50	Casini et al., 2012

5) MONITORING and ASSESSMENT CRITERIA

Monitoring is an important part of any management strategy as no strategy can be evaluated without monitoring data. When defining the aims and objectives of monitoring, ECAP will address measurements as an assessment of whether GES has been achieved or maintained, whether environmental status is improving, and what progress has been made towards achieving environmental targets. Without some degree of information on trends and amounts across all compartments, a risk-based approach to litter monitoring and measures is impossible. In the Mediterranean Sea, Contracting parties must draw up their monitoring programmes in a coherent manner by ensuring monitoring methods are consistent across the region. This will facilitate the comparison of monitoring results and take into account relevant trans-boundary impacts and features.

As major future decisions within the Mediterranean Action Plan on ML will be based on measures, monitoring efforts should be shouldered by quality control/quality assurance (training, inter-comparisons, use of reference material for microplastics, etc.) to assist survey teams. Protocols have been defined for the three ECAP indicators, considering standard list of categories of litter items in order to enable the comparison of results between countries and environmental compartments. Items may be attributed to a given source e.g. fisheries, shipping etc., or a given form of interaction (ingestion), hence facilitating identification of the main sources of marine litter pollution and the potential harm caused by litter. This will enable a more target-orientated implementation of measures. Site selection strategies will focus on both sites with specific characteristics and sites chosen randomly in order to facilitate extrapolations. Sampling/analysis/reporting will need to be coordinated on a sub basin scale, e.g. Northwestern Mediterranean, Adriatic, Ionian, Aegean and Levantine seas. Data handling and reporting for the ECAP must be considered however at regional (Mediterranean) level and based on an online, Mediterranean-wide data collection system.

For the specific case of sampling the stranded turtles that are widely distributed and may migrate over long distances, taking into account the characteristics of the sampling area, locally but also on a basin/sub basin level, will assist in creating a large-scale monitoring network and database enabling the understanding of Tran boundary issues.

Both UNEP/ MEDPOL and MSFD have produced monitoring guidelines of interest for the Mediterranean, focusing on beach, sea floor and floating litter, microplastics, litter in biota and micro-litter in biota. Beach litter is the most detailed indicator for marine litter inflow and therefore the most mature indicator and the one for which most data is available.

There is currently no accepted Mediterranean or sub regional baseline against which to measure progress towards Good Environmental Status. The monitoring programmes required by MLRP to be implemented should thus provide such a comprehensive baseline.
Due to the poor differences between the Mediterranean sub regions in terms of litter densities, the unequal spread of available data-sets, and because some countries belong to two or more sub regions (Italy, Greece), the online expert group recommends that common baselines for the various EIs (beaches, sea surface, sea floor, microplastics, ingested litter) must be considered at the level of the entire basin (Mediterranean Sea) rather than at the sub regional level.

It must be recognized that accumulation of beach litter may occur, and that beach litter will be more representative of land-based sources than that which is deposited far offshore. By monitoring, some indications on litter inflow can be established, in particular for urban beaches and those geographically under the influence of specific activities and discharges such as around river mouths.
For beaches, protocols may favor the description and quantification of marine litter in a very detailed way in terms of material and nature of items present. They can then provide information on sources and the effectiveness of management and reduction measures. Wherever a single litter type is sufficiently present in the observed marine litter composition, anti-littering measures dedicated to this specific litter

item will have some effect, ranging from a couple of percentage points or more on the total number of beach litter items found.

This shows that beyond taking general policy measures on waste recycling (e.g. general recycling targets for some materials) a significant effect can be expected from specific measures on specific items. Then, the option of considering top items (top 15 for example, figure 3), especially on beaches, for baselines, targets and measures appears as the most efficient strategy.

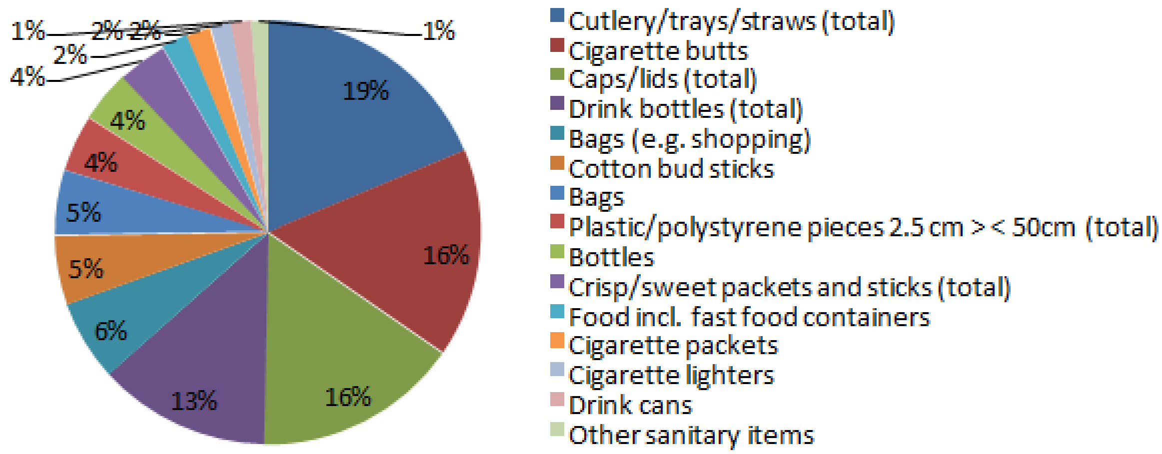

Figure 3: Top 15 items by percentage found on Mediterranean beaches (after Arcadis, 2014)

Nevertheless, in terms of management, litter specific items stranded on beaches that are individually targeted by reduction plans (cigarette butts, plastic bags, cotton buds, etc.) will need specific baselines and targets to be defined in order to prevent loss of information and to better evaluate the effectiveness of the reduction measures.

Local, countries or sub regional differences regarding some items (Cotton bud sticks, cigarette butts, etc.) are frequently found as marine litter distribution varies from one area to another. This is in large part due to the differences in behavior and waste collection/treatment systems between different regions/countries. The outcome of general waste policy measures and the outcome of specific marine litter item measures are then difficult to add up.

However, advantages of this approach are (i) the regional baseline, (ii) the possible targeting of specific items that will facilitate consideration of more robust statistical baselines, (iii) the connection with well-established indicators, (iv) the possible consideration of operational targets to address the specific sources, linked directly to measures, and (v) the possible consideration of operational targets that reflect prevention.

For other ECAP indicators than beaches (surface, sea floor, microplastics), and because mixing has occurred at sea before they are deposited, ingested of floating, the relation with sources will be more difficult to understand. More general trends will be of interest when following changes in the environment and the consideration of main categories of litter only may be sufficient to monitor the state of the environment. Except for micro-plastics, some specific sources however will have to be considered, such as those corresponding to fishing activities, tourism or health related debris as this type of debris may relate to specific sources, specific targets and specific reduction measures.

Regarding sea turtles, more studies are needed to better understand biological constraints (table 8) and some questions are still to be precised before defining a GES and a target for marine debris ingested by sea turtles. Trend seems to be more convenient than a target value. Beside, rate of decrease will have to be considered more "in depth" and discussed in relation with local specificities. Additional questions will also have to be considered (size classes, stranded/live, etc.). Then, the basic question for defining a baseline will be to consider minimum, mean or a maximum value. We understand that data must be considered at sub regional level only because of stranding rates of sea turtles and local migrations meaning significance at a larger scale than just a beach only. Then, the baseline and targets may be defined at a regional level (Mediterranean) but reporting should be at a sub-regional level (western basin, Adriatic…) to address the sub regional differences.

6) SUMMARY OF PROPOSED BASELINES

Following scientific and technical considerations cited above, The CORMON group propose the following baselines levels

Table 5: Proposed baselines for monitoring marine litter in the Mediterranean Sea

Indicator	minimum value	maximum value	mean value	Proposed baseline
16. beaches (items/100 m)	11	3600	920	450-1400
17. Floating litter(items/km2)	0	195	3.9	3-5
17. sea floor(items/km2)	0	7700	179	130-230
17 Microplastics (items/km2)	0	892000	115000	80000-130000
18 (Sea Turtles)				
Affected turtles (%)	14%	92.5%	45.9%	40-60%
Ingested litter(g)	0	14	1.37	1-3

It must be noted however that the amount of existing information is limited to set definitive baselines that may be adjusted once the national monitoring programs could provide additional data. Moreover, Average values over large areas are difficult to harmonize, in particular for beach litter. Then, the setting or derivation of baselines should take the local conditions into account and may follow a more localized approach. Finally, additional specific baselines may be decided by CPs on specific litter categories especially when they may represent an important part of litter found or a specific interest (targeted measures, etc.).

7) LITTER CATEGORIES IN THE MEDITERRANEAN SEA

Taking into account that some of the litter found in the Mediterranean should be generated in other seas, it is quite important to harmonize as far as possible the monitoring programs with other Regional Seas Conventions (e.g. OSPAR).

Taking as basis the Master List produced by the TSG-ML, each Region should adapt the whole list including the more frequent items in order to produce a shorter list, more useful and practical for the field work.

For the case of the beach litter monitoring, the Master List contains a total number of 165 different items (with associate code), distributed in the following categories:

- Artificial polymer materials (plastics/polystyrene).
- Rubber.
- Cloth/Textile.
- Paper/Cardboard.
- Processed/worked wood.
- Metal.
- Glass/Ceramics.

This high number could elevate the time consumed in the field work. In the case of the OSPAR Convention and after revision in 2009, the list contains only 115 different items.

The online expert group suggests that the CORMON working group should agree on a reduced list (desirably close to that in use in the others RSC), which would include the items more frequently found on the Mediterranean beaches, avoiding those that are found rarely. Moreover, the lists of litter categories considered in countries having monitoring programs dedicated to two RSC (e.g. Turkey, France or Spain) would need harmonization. For this, the MSFD derived MEDPOL list is now compatible with other RSC lists of beach litter categories. Minor changes have been suggested by the online expert group (Table 6). With regards to the MSFD form, it is proposed to merge some types of beach litter (e.g. different types of 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 MED monitoring programs (e.g. Spanish Monitoring Program on beach marine litter, implemented from 2013 in the Mediterranean).

Table 6: Main changes in the MSFD form for the MEDPOL harmonization with others RSC

Item ID	Changes proposed	Rational
G7/G8	Merge both categories	Same source, similar impact
G21/G24	Merge the 4 categories	Similar impact. Very difficult to distinguish in the field
G27	Included in the paper/cardboard class	In coherence with others RSC
G30/G31	Merge both categories	Same source
G34/G35	Merge both categories	Same source
G45	Include also plastic stoppers	Same source (mariculture)
G57/G58	Merge both categories	Same source
G62/G63	Merge both categories	Similar source. Difficult to distinguish
G91	Not included in others RSC but interesting	Specific problems related with the water treatment plants.
G95	Included in the sanitary class	In coherence with others RSC
G96	Included in the sanitary class	In coherence with others RSC
G97	Included in the sanitary class	In coherence with others RSC
G99	Included in the medical waste class	In coherence with others RSC
G100	Included in the medical waste class	In coherence with others RSC
G 101	Included in a specific class	In coherence with others RSC
Some artificial polymer items	Not included as specific items. It should to be counted in the other plastic items category	Very scarce in the existing MED monitoring programs and in coherence with others RSC
G133	Included in the sanitary class	In coherence with others RSC
Several rubber items	Not included as specific items. It should to be counted in the other	Very scarce in the existing MED monitoring programs and in

	rubber items category	coherence with others RSC
G144	Included in the sanitary class	In coherence with others RSC
Several textile items	Not included as specific items. It should to be counted in the other textile items category	Very scarce in the existing MED monitoring programs and in coherence with others RSC
Several paper/cardboard items	Not included as specific items. It should to be counted in the other paper/cardboard items category	Very scarce in the existing MED monitoring programs and in coherence with others RSC
G160/G161	Merge both categories	Similar source. Difficult to distinguish
Several wood items	Not included as specific items. It should to be counted in the other wood items categories according its size	Very scarce in the existing MED monitoring programs and in coherence with others RSC
Several metallic items	Not included as specific items. It should to be counted in the other metal items categories according its size	Very scarce in the existing MED monitoring programs and in coherence with others RSC
Items on glass/ceramic classes	Distinguish	Different source
G208	Not included in others RSC but interesting	Specific problems related with the use of the beach
G98	Not included in others RSC but interesting	Very slow degradation time

Annex 2 includes the MEDPOL Form (MSFD derived and OSPAR compatible) for 100 m stretches to be considered for beach monitoring in the Mediterranean Sea.

Other different issue to be discussed regards the Lower size Limit of litter items, If lower size limits are not set, the lower limit will be determined by the possibility of detection by the naked eye and depends on the visual perception (eyesight) of the individual surveyors and on the conspicuousness of the litter items, which in turn depends on their size, color and form. As some identifiable items included in the Master List are smaller than 2.5 cm (e.g. some caps and lids and cigarette filters) and as the protocol includes a size class <2.5cm for plastic and polystyrene pieces (item ID G 75), beside a minimum lower limit at 0.5 cm (upper size of microlitter), the on line group proposes to use for surveys a minimum lower limit at 0.5 cm.

8) CONSIDERATIONS FOR THE PROPOSITION OF TARGETS

Environmental targets are qualitative or quantitative statement on the desired condition of the different components of marine waters. They are important for management and, within ECAP, they will enable to (i) link the aim of achieving Good Environmental Status (GES) to the measures and effort needed to achieve GES, (ii) measure progress towards achieving the objective by means of associated indicator(s) , (iii) to assess the success or failure of measures to prevent marine litter from entering the seas and to support management and stakeholder awareness (Interwies et al., 2013).

The definition of targets is a political choice that can be based on levels of acceptance and levels of ambition in the transition towards a good environmental status in the marine environment. As discussed during the conference of Berlin (2013, http://www.marine-litter-conference-berlin.info/) target setting undergoes an iterative process, starting from a conceptual understanding of the desired condition and the change that is required to achieve it. Broad based targets (maintain level of Marine litter, reduce the amount of litter at sea, etc.) and "trend-based" targets (e.g. reduce the amount of litter transported by rivers, decrease the number of visible litter items on beaches) are possible options. Typically broad targets will have many advantages such as a common concern enabling harmonized actions, political commitment, coordinated actions and cooperation. Another approach would be to provide some flexibility in the extent of reductions towards a common goal. For example, for a target to reduce the amount of litter per square meter of beach, contracting parties and possibly Regional Seas might have different quantitative goals. This could reflect their different starting points on this. Our current lack of knowledge with regards to metrics to be used is such that absolute targets are difficult to set; as a result, many Contracting Parties are formulating trend targets instead. The design of most protocols enables regional adaptation and the discrimination of litter items; they are therefore likely to detect changes in litter types and enable a proper assessment of the various measures implemented.

Table 7: Overview of potential aspects to set targets on marine litter (derived from Interwies et al., 2013)

	Examples
Location of marine litter	• Beach - washed ashore, or deposited through human activity (e.g. tourism) • Water column • Floating (water surface) • Sea bed • Marine life (plastic ingested, entanglements)
Composition/ Type	• Plastic bags • Cigarette butts • Caps/lids • Plastic bottles • Consumption packaging • Sanitary waste • Cotton buds • Ghost nets and abandoned traps • Micro-particles
Sources & pathways of marine litter	• Sewers and rivers • Beach and shoreline • Landfills • Ship-based litter
Sectors	• Fisheries • Recreation and Tourism • Waste producers • Industry (e.g. virgin pellets)
Measures	• Reduce urban waste production (the "4R" measures) • Improved waste collection of land-based sources/sectors • Improved collection of ship-based waste in the port reception facilities • Improved waste water treatment • Behavioural change (reduce consumer littering) • Inspection at sea

These kinds of knowledge gaps lead to problems when trying to determine the relative importance of different sources and pathways globally and regionally, which are important for devising management strategies and tactics. The old dictum states that what can't be measured can't be managed (CMS, 2014).

Subsequently they lead to difficulties in setting quantitative targets on marine litter at any level, whether global, regional or by sector.

It may be possible to circumvent some of these issues by using trend targets and ‘operational’ measures. In December 2013, the Contracting Parties of the Barcelona Convention adopted the Regional Action Plan on Marine Litter Management in the Mediterranean. No specific quantitative targets are defined in the document, except the general objectives of the Plan, which are:

a) Prevent and reduce to the minimum marine litter pollution in the Mediterranean and its impact on ecosystem services, habitats, species in particular the endangered species, public health and safety;

b) Remove to the extent possible already existent marine litter by using environmentally respectful methods;

c) Enhance knowledge on marine litter; and

d) Achieve that the management of marine litter in the Mediterranean is performed in accordance with accepted international standards and approaches as well as those of relevant regional organizations and as appropriate in harmony with programmes and measures applied in other seas.

The Action Plan describes also some strategic, operational objectives and lists a series of prevention measures (following the Waste Hierarchy) and remediation measures that should be considered and implemented by the CPs to the extent possible and within a specific time-frame.

It may be adequate to encourage the establishment of both “state” and “pressure” targets and indicators, as complementary in defining and monitoring the presence of marine litter and the impact of policy responses. Well-formulated “pressure” targets and indicators can better reflect the effectiveness of specific operational objectives.

The lack of consistent and harmonized data is mentioned by some Contracting Parties to be able to define adequate and appropriate targets. It is clear that there is more data on beach debris than for debris in the water column, even though there is not so much information available in Mediterranean marine waters to set quantitative thresholds related to the reduction of marine litter stranded on beaches.
Quantitative reduction targets for beach/floating/ seabed litter and microplastics should nevertheless be considered. It may be proposed that the goal of a general measurable and significant reduction of marine litter by 2020 be adopted in the first instance. It must be noted, in this respect, that if higher targets are set, and appropriate measures are instituted to meet the targets, it will be easier to determine, through monitoring, that a change has indeed occurred, than if weak targets had been set. For example, It may not be technically possible to measure a slight (few %) change that could just reflect a “background noise”. The extent of the monitoring that would be required to have sufficient confidence that such a modest target had been met would make it more expensive to determine than would be the case for a more ambitious target.

Moreover, an apparent failure to achieve a modest target may be cited by some as evidence that more ambitious targets are not feasible, and should not be pursued (CMS 2014).
Within the context of various management schemes, some contracting parties have proposed or plan to set targets as follow (See Arcadis, 2014):

- To reduce litter from beaches based on a five year moving average;
- Negative annual trend in beach litter;
- Reduction in litter on sea surface, water column and seabed;
- Litter proved to be harmful to marine organisms reduced towards zero over the long term;
- Entanglement and strangulation reduced towards a minimum;

- Less than X% of sea turtles having more than Xg of plastic in their stomachs;
- Various targets regarding better waste collection in coastal regions;
- Reduced inflow from rivers and sewers;
- Targets dedicated to education, as related to changes in behaviour (littering, etc.).

There is quite a wide diversity of targets that may be defined by CPs, in terms of nature, ambition and measurability, even between neighboring countries. Most countries involved in reduction plans have defined targets as a reduction in the overall amount of litter present in the marine environment or in any of its compartments (coast, seafloor, water column) or biota. In the Mediterranean, France opted for a "Significantly reduce the amount of waste in the marine environment" for instance when Spain established targets regarding the special category of marine litter originating from fisheries on both beaches and the sea floor. With regards to the implementation of actions, Italy and Spain, for example, are supporting respectively "an increasing effort in collecting waste on the sea-bed" and "the Improvement of knowledge on the characteristics and impacts of marine litter, including their origin and dispersion". Concerning time frames, few countries are considering deadlines, such as Achievement by 2020 (Spain) , Reduction or no increase in marine litter originating from fisheries in relation to the reference levels established in 2012 (Spain), Reduction of waste in coast, water column and seafloor between 2012 and 2020 (Slovenia) and reduction of Microplastics beyond the levels of 2011/2012 (Slovenia).

Where CPs are hesitant about establishing quantitative state targets, pressure/operational-oriented targets can complement their efforts, as they refer to human processes and activities which are easier to monitor and influence. As some CPs have done in other management plans, formulating a sub-set of targets for specific sources of marine litter (e.g. litter generated by fisheries) or even particular types of items (e.g. reduce the average occurrence of the top identifiable items found on reference beaches) should facilitate breaking down such a complex issue into more quantifiable and complementary elements.

Most Contracting Parties may use beach litter as an indicator to assess the reduction of marine litter or directly relate beach litter to a target formulated. This is quite positive, as it reflects the intention to implement beach litter monitoring programmes widely in the Mediterranean. If done in line with the common MEDPOL protocol, it will constitute a cost-effective methodology and a critical step towards a harmonized and comparable monitoring approach across the region. CPs should look for further specification and harmonization in terms of how trends and reductions are to be determined (time scales for example) and have comparable reference periods. This may enable comparability and for this reason, the remaining countries should be encouraged to consider beach litter as a common indicator to be adopted.

The setting of marine debris targets will encourage the implementation of monitoring programs. Different types of targets are relevant to different types of information gaps: at-sea targets for improving the state of information about abundance, operational targets such as estuarine monitoring for improving information on pathway, source and regional differences; and targets related to impacts on wildlife improving information in that regard. There are quite a large set of factors affecting the quantities and distribution of marine litter in a certain area and variables that affect its transport, accumulation and fragmentation processes are yet to be fully understood. It can be therefore very challenging to detect clear reduction trends in the amount of litter present in the sea that can be associated to the implementation of measures in a particular area.

A proposal of a headline reduction target for marine litter on beaches was proposed by Arcadis (2014), based on (i) the targets already in use at the level of Europe, Contracting Parties or UNEP/regional seas, (ii) the expectations of the general public and the stakeholders concerning an effective marine litter policy, (iii) the analyzed occurrence of key marine litter types, loopholes and pathways retrieved from 343 recent beach screenings in the four European regional seas, (iv) the modelled impact on marine litter of the different policy options, and (v) the assessed impact on marine litter that dedicated policy measures for specific litter items could have.

In September 2014, the European Commission in their Communication 2014/398 "*Towards a circular economy: A zero waste programme for Europe*", adopted this proposal, formulated as follows:

- An aspirational target of reducing marine litter by 30 % by 2020 for the ten most common types of litter found on beaches, as well as for fishing gear found at sea, with the list adapted to each of the four marine regions in the EU.
- It is formulated for 2020, compared to 2015, applying the screening method from the technical guidance documents on monitoring of marine Litter and excluding fragmented or undefinable litter items.

As stated by Arcadis (2014) for European regional seas, measures targeting cigarette butts have resulted in reductions of total number of beach litter items of up to 18%, reductions in plastic carrier bags of up to 13%, bottle caps up to 7%, cotton buds up to 2% and deposit refund systems for beverage packaging up to 12%, depending on the specificities of the regional sea concerned. The level of ambition of the proposed target remains high as depending on the litter management policies from Contracting Parties and may not fit for indicator EI 17. Floating litter may be transported from one country/ sub basin to another, and sea bed litter is accumulating for long period, with low degradation rates. Moreover, sources of microplastics cannot be distinguished by uses, etc., and it will be difficult to relate targets with measures.

We propose then more accessible targets, considering however the proposed baselines (see chapter 5 and 6) that may be optimized after 2015 first results from monitoring to be started in 2015. Targets may focus on the total amount of marine litter first with some specific targets on individual items when impacts of reduction measures must be evaluated. For floating and sea floor litter, a significant decrease will enable to overcome the constraints of diffuses and uncontrolled sources (Tran boundary movements, influence of currents) and permanent accumulation processes on sea floor. Ingested litter in sea turtles will then focus on the number of affected animals and the amount of ingested debris by number or weight.

Finally, with regards to strategy and technical or scientific considerations, the propositions for practical environmental targets in the context of ECAP may be summarized in the following table 8:

Table 8: propositions for practical environmental targets in the context of ECAP

ECAP INDICATORS	TYPE OF TARGET	MINIMUM	MAXIMUM	RECOMMENDATION	REMARK
BEACHES (EI16)	% decrease	significant	30	20% by (2024 or 2030)	Not 100% marine pollution
FLOATING LITTER (EI 17)	% decrease	-	-	Statistically Significant	sources are difficult to control (trans border movements)
SEA FLOOR LITTER (EI 17)	% decrease	stable	10% in 5 years	Statistically Significant	15% in 15 years is possible
MICROPLASTICS (EI 17)	% decrease	-	-	Statistically Significant	sources are difficult to control (trans border movements)
INGESTED LITTER (EI 18)					Movements of litter and Animals to be considered
Number of turtles with ingested litter (%)	% decrease in the rate of affected animals	-	-	Statistically Significant	
Amount of ingested litter	% decrease in quantity of	-	-	Statistically Significant	

	ingested weight(g)				

9) **KNOWLEDGE GAPS & RESEARCH NEEDS (with regards to assessment criteria)**

Accumulation rates vary widely in the Mediterranean Sea and are subject to factors such as adjacent urban activities, shore and coastal uses, winds and currents, leading to floating, beach and sea floor accumulation areas. Additional basic information is still required on sources, inputs, degradation processes and fluxes before a correct global debris assessment can be provided. Furthermore, anthropogenic inputs may change and sources may shift between tourism, fishing, shipping and marine industry, etc. More research towards a clear evidence base is necessary to ensure efficient policy decisions. For this purpose, and in view of the considerable variations in methodologies across regions and investigators, more valuable and comparable data could be obtained by standardizing our approaches. In terms of distribution and quantities, the overall balance between increased waste and plastic production, reduction measures and quantities found on the surface and shorelines has not been assessed to date, hence indicating the possible accumulation of large quantities, the locations of which have yet to be discovered. We clearly need to understand litter distribution better in order to accurately assess its impact.

An important aspect of litter research to be established is the evaluation of links between hydrodynamic factors. This will give a better understanding of transport dynamics and accumulation zones. Further development and improvement of modelling tools must be considered for the evaluation and identification of both the sources and fate of litter in the marine environment. Comprehensive models should define source regions of interest and accumulation zones. Likewise, backtrack simulations should be initiated at those locations where monitoring data are collected.

The project STAGES (http://www.stagesproject.eu) stated that a better understanding about rates of degradation of litter in the environment is needed. At present the lower limit of detection for plastic particles is around 1µm. It seems likely that even smaller particles of litter (nanoparticles) may exist, however we need to develop appropriate methodology to quantify these. We also need a better understanding of the potential sink/types and habitat where this material is most likely to accumulate as the knowledge of the accumulation and environmental consequence of microplastic/nanoplastics particles is relatively limited. For monitoring of microparticles, lower limits for collection is recommended from the group at 330µm and must be agreed by CPs.

Repeatability, optimization, robustness and reliability of monitoring methods will require further research to develop rapid interpretation of litter data. The present methods applied are a good tool for mapping litter distribution as a way of identifying litter sources, but need to be further developed before they can be used for monitoring purposes.

Interwies et al., (2013) listed the following gaps as the most important in the Mediterranean Sea:

- Amounts and composition, and transport, origin and impacts of marine litter on the sea floor (especially in the deep sea) and in the water column (floating litter).
- Impacts and amounts of micro-particles.
- Socio-economic impacts of marine litter.
- Amounts and impact of abandoned/lost fishing gear.
- Importance of shipping activities for the generation of marine litter.
- Evaluation of riverine inputs to support reduction measures.

For ingestion of litter by sea turtles, a more precise definition of target (GES) and the identification of Parameters/biological constraints and possible bias sources (see table 9) when defining GES are the priority research needs. Work on other "sentinel" species is also important as it may provide additional protocols supporting the measurement of impacts, especially for microplastics. Finally, the use of new approaches and the development of new metrics to assess entanglement of marine organisms specifically by Marine Litter may open new perspectives in the context of monitoring. As an example, guidelines are currently being developed for litter in seabird nest structures and the associated entanglement in litter in nest structures. Some species tend to incorporate marine litter in their nests, which may result in entanglement. (Votier et al., 2011). Even with some research needed to define behaviours, breeding seasons and the types of litter brought into seabird nests, species such as shags (*Phalacrocorax aristotelis*) is promising with regards to monitoring of the Mediterranean Sea. The species is very common throughout the Mediterranean and nests on coastal areas in most European and North African countries, together with the Black Sea coast.

Table 9: Parameters/biological constraints and possible bias sources to be considered when defining a GES target on marine debris ingested by sea turtles, and knowledge gaps identified (Claro et al., Workshop on GES for sea turtles, Marseille, 13 October 2014).

Parameter/ biological constraints	considerations	Possible bias	Possible solutions
Sex	Possible differences in ingestion level between individuals depending on their sex and reproductive status (e.g. before or after nesting in females / etc.)	Influence of sex on level of debris ingestion not identified in the literature	Evaluate impact of sex on litter ingestion
size (CCL)/ stage of development/ population	According to their population of origin (Atlantic/Mediterranean), size at which individuals are benthic/pelagic feeders may differ (differences in growth features) as well as the level of ingestion (feeding needs growing with size, debris less abundant at the sea bottom)	The value of the indicator may be biased by the structure and origin of the "population" sampled in a given region	Interpretation of data must consider juveniles (CCL<40cm)* and adults separately
Habitat	Depending on their developmental stage, habitat use and resources availability, individuals may use neritic, oceanic foraging habitats or both (debris less abundant at the sea bottom)	The value of the indicator may be biased by the habitat used by the turtles sampled in a given region	Interpretation of data must consider juveniles (CCL<40cm)* and adults separately
health status	Possible differences in ingestion between individuals which died suddenly (collision or bycatch), and stranded turtles	Possible biased values for beached turtles which have been ill for a long time before stranding and have excreted all their digestive content	Samples with empty digestive tract not to be considered
movement capacity/ duration of digestive transit	Since turtles have a high movement capacity and duration of digestive transit may vary according to several factors, debris could have been ingested outside Mediterranean waters; however sea turtles may stay one month or more in a same developmental/ foraging area	Possible bias of interpretation if analysis performed at a wrong scale	More data needed

**CCL= Curved Carapace Length*

10) RECOMMENDATIONS

The following table 10 is providing the recommendations as agreed by the expert group on marine litter

TOPIC	DRAFT RECOMMENDATIONS
SCIENTIFIC and TECHNICAL BASIS OF MONITORING	
SCALE	**Common baselines** for the various EI (16, 17, 18) must be considered at the level of the entire basin (Mediterranean) rather than sub regional level
RESEARCH	Need to **define an adapted protocol for microplastics in sediments**
RESEARCH	Research to **support the development of an indicator dedicated to entanglement**
BASELINES/TARGETS	**Consider specific baselines and targets** for Litter categories that are individually targeted by reduction plans or measures by contracting parties (cigarette butts, plastic bags, cotton buds, etc)
CATEGORIES	**Consider the reduction of the number of categories** in MEDPOL monitoring protocol
CATEGORIES	**Adapt MEDPOL master list**, MSFD derived, to harmonize with other RSC
MONITORING	**Needs for adjustement of the monitoring guidance** (more compatible definitions and wording , list of items/categories)
MONITORING	**Harmonization** of the CORMON Report (this report) with the ECAP monitoring guidance for Marine Litter
SUPPORT	
MONITORING	**Consider the relevance of ML for monitoring marine pollution** (lower costs, possible harmonization, easy protocols) , especially on beaches, when compared with other approaches (e.g. analysis of contaminants)
MONITORING	**Support evaluation/adjustments of baselines/targets** on the basis of the first monitoring results
MONITORING	Improve knowledge on experimental indicator EI 18, **Support capacity building and monitoring experiment on sea turtles at a pilot scale**
QUALITY ASSURANCE	As the Mediterranean Action Plan on ML is based on measures and monitoring **efforts should be shouldered by quality control/quality assurance** (training, inter-comparisons, use of reference material for microplastics, etc.) to assist survey teams.
DATA MANAGEMENT	**Data base is to be organised** for the collection of data
CORMON	Support a **specific expert group** for long term developments of activities dedicated to Marine Litter, trends analysis and analysis of data from countries (art 11 of the MLRP)
CORMON	Consider **capacity building** in long term, in support of the MLRP (training, intercalibrations, etc.)

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ANNEX I
Acronyms

CP(s)

Contracting Party (Parties).

EcoQO

Ecological Quality Objectives.

GES

Good Environmental Status.

IUU fishing

Illegal, unreported and unregulated fishing activities.

MEDPOL

Program for the Assessment and Control of Pollution in the Mediterranean Region

MSFD

Marine Strategy Framework Directive.

RAP(s)

Regional Actions Plan(s).

RSC(s)

Regional Sea Convention(s).

TSG ML

Technical Subgroup on Marine Litter.

UNEP/MAP

UNEP Mediterranean Action Plan.

ANNEX II. MEDPOL Form for 100 m beach monitoring

Mediterranean Action Plan

MARINE LITTER BEACH MONITORING PROGRAM
100 metres stretch survey form

ID	PLASTIC/POLYSTYRENE	Nº units
G1	4/6-pack yokes, six-pack rings	
G3	Shopping bags incl. pieces	
G4	Small plastic bags, e.g. freezer bags incl. pieces	
G5	Plastic bag collective role; what remains from rip-off plastic bags	
G7/G8	Drink bottles	
G9	Cleaner bottles & containers	
G10	Food containers incl. fast food containers	
G11	Beach use related cosmetic bottles and containers, e.g. Sunblocks	
G13	Other bottles & containers	
G14	Engine oil bottles & containers <50 cm	
G15	Engine oil bottles & containers >50 cm	
G16	Jerry cans (square plastic containers with handle)	
G17	Injection gun containers (including nozzles)	
G18	Crates and containers / baskets	
G19	Car parts	
G21/24	Plastic caps and lids (including rings from bottle caps/lids)	
G26	Cigarette lighters	
G28	Pens and pen lids	
G29	Combs/hair brushes/sunglasses	
G30/31	Crisps packets/sweets wrappers/ Lolly sticks	
G32	Toys and party poppers	
G33	Cups and cup lids	
G34/35	Cutlery and trays/Straws and stirrers	
G36	Fertiliser/animal feed bags	
G37	Mesh vegetable bags	
G40	Gloves (washing up)	
G41	Gloves (industrial/professional rubber gloves)	
G42	Crab/lobster pots and tops	
G43	Tags (fishing and industry)	
G44	Octopus pots	
G45	Mussels nets, Oyster nets including plastic stoppers	
G46	Oyster trays (round from oyster cultures)	

G47	Plastic sheeting from mussel culture (Tahitians)	
G49	Rope (diameter more than 1cm)	
G50	String and cord (diameter less than 1 cm)	
G53	Nets and pieces of net < 50 cm	
G54	Nets and pieces of net > 50 cm	
G56	Tangled nets/cord	
G57/58	Fish boxes - plastic or polystyrene	
G59	Fishing line/monofilament (angling)	
G60	Light sticks (tubes with fluid) incl. Packaging	
G62/63	Floats for fishing nets/ Buoys	
G65	Buckets	
G66	Strapping bands	
G67	Sheets, industrial packaging, plastic sheeting	
G68	Fibre glass/fragments	
G69	Hard hats/Helmets	
G70	Shotgun cartridges	
G71	Shoes/sandals	
G73	Foam sponge	
G75	Plastic/polystyrene pieces 0 - 2.5 cm	
G76	Plastic/polystyrene pieces 2.5 cm - 50 cm	
G77	Plastic/polystyrene pieces > 50 cm	
G91	Biomass holder from sewage treatment plants	
G124	Other plastic/polystyrene items (identifiable) including fragments	
Please specify the items included in G124		

ID	RUBBER	Nº units
G125	Balloons and balloon sticks	
G127	Rubber boots	
G128	Tyres and belts	
G134	Other rubber pieces	
Please specify the items included in G134		

ID	CLOTH	Nº units
G137	Clothing / rags (clothing, hats, towels)	
G138	Shoes and sandals (e.g. Leather, cloth)	
G141	Carpet & Furnishing	

G140	Sacking (hessian)	
G145	Other textiles (incl. rags)	
Please specify the items included in G145		

ID	**PAPER / CARDBOARD**	Nº units
G147	Paper bags	
G148	Cardboard (boxes & fragments)	
G150	Cartons/Tetrapack Milk	
G151	Cartons/Tetrapack (others)	
G152	Cigarette packets	
G27	Cigarette butts and filters	
G153	Cups, food trays, food wrappers, drink containers	
G154	Newspapers & magazines	
G158	Other paper items,including fragments	
Please specify the items included in G158		

ID	**PROCESSED / WORKED WOOD**	Nº units
G159	Corks	
G160/161	Pallets / Processed timber	
G162	Crates	
G163	Crab/lobster pots	
G164	Fish boxes	
G165	Ice-cream sticks, chip forks, chopsticks, toothpicks	
G166	Paint brushes	
G171	Other wood < 50 cm	
Please specify the items included in G171		
G172	Other wood > 50 cm	
Please specify the items included in G172		

ID	**METAL**	Nº units
G174	Aerosol/Spray cans industry	
G175	Cans (beverage)	
G176	Cans (food)	

G177	Foil wrappers, aluminium foil	
G178	Bottle caps, lids & pull tabs	
G179	Disposable BBQ's	
G180	Appliances (refrigerators, washers, etc.)	
G182	Fishing related (weights, sinkers, lures, hooks)	
G184	Lobster/crab pots	
G186	Industrial scrap	
G187	Drums, e.g. oil	
G190	Paint tins	
G191	Wire, wire mesh, barbed wire	
G198	Other metal pieces < 50 cm	
Please specify the items included in G198		
G199	Other metal pieces > 50 cm	
Please specify the items included in G199		

ID	**GLASS**	Nº units
G200	Bottles incl. pieces	
G202	Light bulbs	
G208	Glass fragments >2.5cm	
G210a	Other glass items	
Please specify the items included in G210a		

ID	**CERAMICS**	Nº units
G204	Construction material (brick, cement, pipes)	
G207	Octopus pots	
G208	Ceramic fragments >2.5cm	
G210b	Other ceramics items	
Please specify the items included in G210b		

ID	**SANITARY WASTE**	Nº units
G95	Cotton bud sticks	
G96	Sanitary towels/panty liners/backing strips	
G97	Toilet fresheners	
G98	Diapers/nappies	
G133	Condoms (incl. packaging)	
G144	Tampons and tampon applicators	

	Other sanitary waste	
Please specify the other sanitary items		

ID	**MEDICAL WASTE**	Nº units
G99	Syringes/needles	
G100	Medical/Pharmaceuticals containers/tubes	
G211	Other medical items (swabs, bandaging, adhesive plaster etc.)	
Please specify the items included in G211		

ID	**FAECES**	Nº units
G101	Dog faeces bag	

ID	**PARAFFIN/WAX PIECES**	Nº units
G213	Paraffin/Wax	

Presence of industrial pellets?	YES ☐ NO ☐

Presence of oil tars?	YES ☐ NO ☐

ADDITIONAL COMMENTS

1st Report of the Informal Online Working Group on Contaminants

1. Introduction

In the framework of the gradual application of the ecosystem approach (EcAp) for the management of human activities in the Mediterranean region, it is necessary to assess the environmental status of marine areas using well defined methodological criteria. In order to decide if a marine area is in "Good Environmental Status" (GES), it is necessary to establish threshold values (which could be also defined as Environmental Assessment Criteria (EAC) for key contaminants in order to distinguish between acceptable (good) and unacceptable (not good) environmental conditions.

To date UNEP/MAP-MED POL work in this direction has resulted in background information on the methodology to be followed for the definition of EAC for the Mediterranean and first estimates have been made of background concentrations for trace metals in sediments and biota and PAHs in sediments. In accordance with the relevant decisions of COP 18, it was identified a need to advance this important work in order to finalize the development of well-defined methodological criteria.

More specifically there is a need to obtain eco-toxicological information on the key species to be used for the establishment of transition points of biological effects and to carry out further examination of the MED POL database in order to obtain more reliable background values as well as statistical tests to evaluate the precision of the MED POL monitoring programmes.

The CorrGEST meeting held in February 2014 in Athens agreed on the following common indicators:

Contaminant common indicators (ecological objective 9)

Common Indicator 11	Concentration of key harmful contaminants measured in the relevant matrix (biota, sediment, seawater)
Common Indicator 12	Level of pollution effects of key contaminants where a cause and effect relationship has been established.
Common Indicator 13	Occurrence, origin (where possible) extent of acute pollution events (e.g. slicks from oil, oil products and hazardous substances) and their impact on biota affected by this pollution
Common Indicator 14	Actual levels of contaminants that have been detected and number of contaminants which have exceeded maximum regulatory levels in commonly consumed seafood
Common Indicator 15	Percentage of intestinal enterococci concentration measurements within established standards

2. Objective and composition of the informal online working group on contaminants

The main objective of the work of the informal online working group on contaminants (**Contaminants Working Group**) was to deliver environmental and background assessment criteria based on data availability for some contaminants. Therefore, the work has been focusing on the evaluation of available data to determine EAC, BAC and baseline values.

The Contaminants Working Group is expected to provide advice to the Secretariat regarding the monitoring guidance based on the recommendations of ECAP Coordination group held in Athens in October 2014.

This report is intended to be a living-document drafted by co-chairs during the life time of the Contaminants Working Group.. It is being periodically circulated by the co-chairs to the rest of experts for comments and discussion with the aim to input into the relevant upcoming monitoring related meetings (Integrated Correspondence Group Meeting on Monitoring, Focal Points Meeting of MED POL, EcAp Coordination Group Meeting respectively). . The Contaminants Working Group members have experience in providing practical scientific advice and the range of expertise applicable to the task were nominated by the Contracting Parties to the Barcelona Convention. The nominated experts have scientific background and experience on statistical interpretation of field data. The work of the Contaminants Working Group was co-chaired by Ms. Nevenka Bihari (Croatia) and Ms. C. Martínez-Gómez (Spain). The list of experts is given in Annex I.

The experts of the Contaminants Working Group have exchanged views on various levels and formats, with the following key topics of discussion:

- **Specific recommendations on the Draft Integrated Monitoring and Assessment Guidance**

-Definition of common indicator 12

Experts consider that common indicator 12 should be improved in their definition, with “Level of pollution effects of key contaminants where a cause and effect relationship has been established”.

It is recommended to slightly revise the common indicator 12 in order to take into account several and complex aspects of toxic actions. [One alternative indicator would be for example "Levels of pollution effects on the concerned ecosystem components, having regard to the selected biological processes and taxonomic groups where a cause/effect relationship has been established and needs to be monitored”.

Any chemical will not has a single mode of toxic action or a single target organ in the organism. Even at the level of individual cellular enzymes, many environmental contaminants are known to inhibit or stimulate several endogenous enzymes/receptors, although some are more sensitive than others to a given compound.

Most contaminant-related biomarker responses are sensitive to a wide variety of chemical compounds and they are, therefore, particularly useful as integrative indicators of organism health than as indicators of specific exposure to single chemical compounds/class of contaminants. Given the complexity of biological responses and environmental system it is unlikely that a single biological effect response (named biomarkers) would be able to provide measurements of the health status of organisms and therefore the necessity of measure a suite of biomarkers at different levels of biological organizations, as it has been proposed in the two-tier approach.

Experts stressed the importance of understanding that all biomarkers responses established as mandatory or recommended by Regional Conventions have a cause/effect established after validation in laboratory and field studies. Definition of the indicator 12 should not be understood just for the application of specific and exposure effect biomarkers.

- Table 3.1.

Transitions point T0 and T1 for assessing pesticides (dieldrin, HCB, lindane, pp-DDE and α-HCH) should be added for clarity.

Assessing Biological Effects

The Contaminants Working Group discussed the utility of developing a multidisciplinary integrated approach, combining chemical analyses in abiotic matrices, with those reflecting contaminant levels in biota and biological effects (biomarkers), thus fulfilling the EcAp approach.

Different models are becoming available in the Mediterranean region to elaborate various typologies of data with the 5 classes approach, and to aggregate them in a final evaluation, still based on the 5 classes discrimination (Benedetti et al., 2012)

The Contaminants Working Group on contaminants confirmed the importance of the following biomarkers to be analysed in mussels (wild populations or caged), and recognize the importance of corresponding BC and BACs: Lysosomal membrane stability, Stress on Stress, micronucleus frequencyand acetylcholinesterase. In addition, they recommend that biomarkers are analysed also in representative key fish species, i.e. the red mullet (*Mullus barbatus*). For these organisms, priority responses are identified in EROD activity, bile metabolites, micronucleus frequency and acetylcholinesterase. For these biomarkers several mediterranean countries (Greece, Spain, France, Italy and Croatia) have been monitoring in the past years and first BACs can be expected to be obtained within the framework of expert groups on Contaminants along 2015-2016.

Other biomarkers, widely investigated by the scientific community, might be considered for their usefulness within the EcAp approach based on their different biological and ecological characteristics. Future evaluation will involve the possibility to assess BC, BAC or thresholds values for such responses like lipid peroxidation processes (lipofuscin, malondialdehyde), peroxisomal proliferation, antioxidants and total antioxidant capacity, loss of DNA integrity (others than micronucleus frequency), hormonal/ reproductive dysfunction (i.e. vitellogenin in fish/intersex). The overall elaboration of such different responses in synthetic indices can be actually performed by several integrative approaches, which normally consider the sensitivity and toxicological relevance of the responses (Marigómezet al., 2013). The possibility to test or implement similar approaches to develop a specific model for Mediterranean countries needs to be further studied and evaluated on expert level.

On the other hand, experts consider that evaluation of the use of bioassays to assess environmental quality in water and sediments should be also addressed in future.

<u>Development of assessment criteria for the definition of threshold limit values for chemical environmental status monitoring of contaminants in order to be able to determine the achievement of GES.</u>

Experts agreed that although it is biologically inappropriate to evaluate absolute BC, BAC and Environmental Assessment Criteria (EAC) contaminant levels in one species from the parallel levels of even a close relative species new, BCs and BACs levels will be calculated / assessed in the coming month/years using data from the Mediterranean Region. However, the approach of derive EAC levels for the MEDPOL areas from the ratio EAC/BAC levels in compatible OSPAR sentinel species it is found absent of scientific sounds. That was discussed by the working group and it was agreed that would be more convenient to use current established EACs from other regional Conventions until more data are available from specific Mediterranean species.

<u>Reference methods and guidelines for marine pollution monitoring under UNEP/MAP- MEDPOL</u>

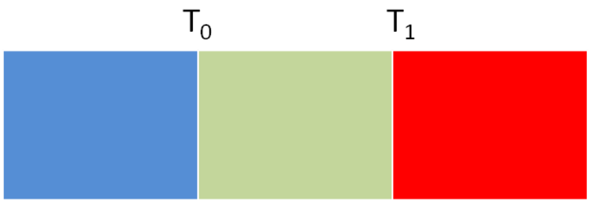
Experts underlined that in coming years the Reference Methods listed in the Annex XI should be revised and if necessary updated. The reference method on Sediment sampling strategy should be discussed in future in a targeted manner in the Contaminants Working Group with the overall aim to be finalized before the EcAp Coordination Group in September.

Comment on Annex on Contaminants Monitoring Fact Sheets (Indicators Monitoring Fact Sheets on Ecological Objective 9: Contaminants)

- PAHs concentration in mussels should be also included as parameters but not in fish
- Aluminium content and Aluminum (Al) and Organic Carbon(OC) measurements should be considered mandatory in sediment for testing normalization purposes
- Change from the 2-tier to the 1-tier the biomarker Stress on Stress in the table of the Annex.
- Indicate that the assessment method of contaminant concentrations in fish (red mullet) should be conducted during the non-spawning period taking into account the future integrated and coordinated sampling to analyses biological effects in red mullet.

- **Addressing and agreeing on common definitions on thresholds, baseline and assessment criteria.**

After consultation between expert members on the report UNEP(DEPI)/MED WG. 365/Inf.8 on Development of Assessment Criteria for Hazardous Substances In the Mediterranean (Athens 2011) it was agreed to follow the OSPAR approach of a “traffic light” system for both contaminant concentrations and biological responses, where there are two “thresholds” T_0 and T_1 to be defined (OSPAR, 2008; Davies et al., 2012).



This is wise from a presentational perspective, as it can give the reader a clear and immediate picture of where environmental conditions are acceptable or not and prompt appropriate environmental management options. That approach involves to specifically assess each chemical and biological determinant against its “threshold” values and to obtain its corresponding synthetic classification or category, allowing therefore an easy comparison and aggregation with other determinants from different regional/sub-regional areas.

The establishment of the transition points T_0 and T_1, requires the definition of a series of reference concentrations, particularly of Background Assessment Concentrations (BACs), derived from the Background Concentrations (BCs), Baseline Assessment responses (BACs) and the Environmental Assessment Criteria (EACs). This needs to be explained where it is a relevant factor in data interpretation.

Common definition of thresholds for contaminants

In the case of contaminants T_0 will be defined in sediments and biota, as the concentration of a contaminant at a “pristine” or “remote” site, where no deterioration of the environment can be expected. In turn, T_1 is the concentration above which significant adverse effects to the environment or to human health are most likely to occur. Between T_0 and T_1, no chronic effects are expected to occur in marine biota species, including the most sensitive, as well as the levels do not pose significant risk to the environment or to human health.

Common definition of thresholds for biological parameters

In the case of biological parameters, T_0 will be defined as the baseline biological response in target species of healthy organism responses. Biological responses $\leq T_0$ will be interpret as the levels of environmental contaminants are not causing deleterious biological effects. In turn, biological responses $>T_1$ will be defined as the in target species above which significant acute and long-term adverse biological effects are most likely to occur. In the case of biomarkers of exposure, only T_0 can be estimated, whereas for biomarkers of effects T_0 and T_1 can be established. Between T_0 and T_1, the biological responses indicate deleterious biological effects are possible although not likely to occur.

Background concentrations (BCs)

BCs are assessment tools intended to represent the concentrations of certain hazardous substances that would be expected in such “pristine” or “remote” sites, based on contemporary or historical data (such as core samples of sediments). For a man-made compound (e.g. PCBs) the background concentration (BC) in environmental matrices should be taken as zero.

Therefore, in order to facilitate precautionary assessments of data against BCs, and following the OSPAR approach (OSPAR Publication 2008/379) it is necessary to develop Background Assessment Concentrations (BACs) for contaminants in the Mediterranean region.

➔ In sediments, two different approaches were agreed to calculate BCs of contaminants:

i) Data from the analysis of pre-industrial layers of dated sediment cores. These data can be obtained from the scientific literature and if possible, organized per Mediterranean geographical areas.

ii) Median value of the median contaminant concentration in sediment samples from sites/areas that contracting parties have considered reference stations/areas (i.e. no known local sources of contamination or those areas which were not considered unequivocally as reference sites but as those less influenced from human and industrial activity).

The second approach differs with the previous approach used to calculate BCs of contaminants in sediments (UNEP(DEPI)/MED WG. 365/Inf. 8), in which BCs were calculated taking the median of the lower 5% of all data available in the MED POL database, excluding well known polluted sites. Experts considered that data from reference sites can be a better approach to calculate BCs of no man-made contaminants in the Mediterranean Region. The reasoning is that has been recognized that natural processes such as geological variability or upwelling may lead to significant variations in background concentrations of contaminants, particularly for trace metals, in certain subregions of the Mediterranean Sea. The natural variability of background concentrations should be taken into account in the interpretation of data, and local conditions should be taken into account when assessing the significance of any exceddance.

Metal concentration in sediments are usually normalized to 5% aluminium content meanwhile organic contaminants are usually normalized to 2.5% organic carbon content (OSPAR, 2008). However, there are already evidences from certain regions of the NW Mediterranean indicating that normalization is not convenient, as these environmental factors are not well correlated with contaminant concentrations (León et al. et al, 2014). The low sedimentation rate in certain subregions of the Mediterranean Sea will partially explain the lack of correlations beween contaminant concentrations and the mentioned factors. However, experts of the Contaminants Working Group recognized that in order to further test if normalization is convenient for sediment particle variability, aluminum (Al) and organic carbon (OC), such parameters should be considered as mandatory ones in the new MAP integrated monitoring programme. It will be also necessary to further investigate subregional differences on sedimentation rate and geocomposition of the sediments. At this stage was therefore agreed by experts to consider and establish preliminary not normalized BCs and BACs of contaminants in sediments from the Mediterranean region, as it is currently established for Spanish sediments within OSPAR area.

- ➔ Similarly as for sediments, the following approach to calculate BCs in biota (fish and mussels) was considered

1) Median value of the median concentration from organisms sampled at sites/areas which contracting parties consider being reference stations/areas (i.e. no known local sources of contamination or those areas which were not considered unequivocally as reference sites but as those less influenced from human and industrial activity). It should be underlined that selection of reference stations/areas can be different in relation to the contaminant under study (ie. organisms can be sampled in a place where contamination by PAHs is absent but contamination by Hg exists). As mentioned above, this approach differs with the previous used to calculate BCs of contaminants in biota (UNEP(DEPI)/MED WG. 365/Inf. 8), in which BCs in biota were calculated taking the median of the lower 5% of data available in the MED POL database, excluding well known polluted sites.

<u>Background concentrations and baseline assessment criteria (BACs)</u>

i) Concerning contaminants, background assessment criteria (BACs) are statistical tools defined in relation to the background concentrations (BCs), which enable statistical testing of whether observed concentrations can be considered to be near background concentrations. BACs are therefore derived from the BCs, taking into account the analytical precision of the monitoring programme. Observed concentrations are said to be ‘near background’ if the mean concentration is statistically significantly below the corresponding BAC.

BACs of contaminants can be calculated according to the method set out in Section 4 of the CEMP Assessment Manual (OSPAR Publication 2008/379). The outcome of this method is that, on the basis of what is known about variability in observations, there is a 90% probability that the observed mean concentration will be below the BAC when the true mean concentration is at the BC. Where this is the case, the true concentrations can be regarded as “near background” (for naturally occurring substances) or “close to zero” (for man-made substances). The BAC value for certain contaminants (e.g. PAHs, metals) will depend on the BC and the residual variance in temporal trend series at the BC. The BC for man-made substances is zero, and in this case the variance used to derive BACs is the variance at a low concentration that is small but detectable by common analytical methods.

Up to date, a statistical test to know the analytical precision of the monitoring programme using IAEA and MED POL database has not been performed (scarcity of available data). Therefore it was agreed by experts to use the following relationships between BC and BAC for metals in sediments, fish and shellfish to assess the BACs levels, as it is being used in OSPAR (OSPAR, 2008).

Thus, for sediments and shellfish BAC=1.5xBC, for fish BAC=2xBC.

ii) Concerning background responses of biological measurements (biomarkers), BACs can be calculated following different approaches described by ICES/OSPAR experts (Davies and Vethaak, 2012). These different approaches are linked to the nature of the biological responses under measurement (such as inhibition, deleterious effects, activation, etc.). Mediterranean experts consider adequate these approaches and adopted them.

Similarly as for BCs in sediments and biota, Mediterranean experts agreed that BACs of biomarker responses should be calculate using data from organisms sampled at sites/areas which contracting parties consider being reference stations/areas or kept under control conditions in the laboratory (particularly for those biomarkers of general stress, such as SoS and LMS).

1) Using the 90th percentile of averages/medians values from references sites or control conditions in the laboratory (case of activation or increased responses after exposure to contaminants)

2) Using the 10th percentile of averages/medians values from references sites or control conditions in the laboratory (case of inhibition o decreased responses after exposure to contaminants)

For BACs of biomarker responses, assessment criteria should be defined on regional basis, using available long-term data. However, a scarcity of biomarker data exists in the Mediterranean region in comparison to chemical data.

Unlike contaminant concentrations in sediments, contaminant concentrations and biomarker responses in biota cannot be assessed against BACs in most of cases without consideration of certain biological and environmental factors (such as species, gender, size, maturation state, season or ambient temperature). Therefore it was agreed by experts to consider such factors (whenever possible and necessary) for establishing BACs in organisms from the Mediterranean region.

- **List, identify and review and analyze available data on contaminants and biological effects in the Mediterranean (common indicators).**

The Contaminants Working Group experts were uploading in the InfoMAP groupware MED POL library:

- *relevant national available data and or*
- *available national, sub regional and regional reports, and or*
- *relevant web-site links.*

At the time of the drafting of the current First Report of the Contaminants Working Group(March 2015), experts from several countries made available data on contaminants in sediment and biota and biological effects in biota, most of them from reference areas. These data are listed above and were carefully revised. Only those from reference areas and from specimens sampled from natural populations were used to calculate contaminant BCs and BACs.

Country	TM in sediments	TM in mussels	TM in fish	PAHs in sediments	PAHs in mussels	Biomarker responses in mussels	Biomarker responses in fish
Greece	x	x	x	x	x	x	x
Croatia	x	x	x	-	-	x	x
Italy	x	x	x	x	x	x	x
France	x	x	-	x	x	-	-
Spain	x	x	x	x	x	x	x
Lebanon	x	x	-	x*	x*	-	-
Egypt	x*	x*	x*	x*	x*	-	-
Turkey	x	x	x	x	x	x	x

* No data available from reference sites

During the work of the Contaminants Working Group, experts revised and prepare common excel files with existing data available from reference areas from several countries.

A suite of criteria were adopted to harmonized and facilitate further processing of the data:

- All data from contaminants in sediments and biota were introduced on dry weight basis.

- Contaminant concentrations in sediments were not normalized.

- Trace metal and PAH concentration units were µg/Kg

- Half of the detection limit value was introduced in those cases were measured valued was below detection limit.

- Sampling date were introduced whenever possible

-Supporting environmental (ambient water temperature and salinity, sampling depth, etc) and biological supporting parameters (length, weight, sex) were introduced whenever possible

The work was conducted by the following expert subgroups.

Expert sub-groups	Common excel files created
Martínez-Gómez C. Hatzianestis, I.* Fanfandel, M.*	Trace metal concentration in Sediments
Chiffoleau, J.F. * Hatzianestis, I. Fanfandel, M.*	PAHs concentration in Sediments
Martínez-Gómez, C. * Bihari, N. Fanfandel, M.*	Trace metal concentration in mussels
León V.M.* Hatzianestis, I. Chiffoleau, J.F.	PAHs concentration in mussels
Kukuksezgin, F.* Regoli F. León V.M.	Trace metal concentration in fish
Fernández B Campillo J.A.* Regoli F. Bihari, N. *	Biomarker responses in mussel and fish

*Nominated experts developing interseasonally further work on excel files.

At the time of the drafting of the First Report of the Contaminants Workging Group, 6 common excel files were obtained. Data from these common excel files are now available and were load in the Infomap Groupware by co-chairmans. These files will be used inter-seasonally by nominated experts to analyse and calculate contaminant BCs and BACs (contaminants and biological responses). At this stage, this work has been initiated but still is far from being finished.

To better illustrate of how the work is being conducted is described below an example related with the assessment of trace metals BCs in wild mussels from reference areas of the Mediterranean Region

<u>Assessment of trace metals BCs in wild mussels from reference areas of the Mediterranean Region</u>

Using database created during the discussions of the Contaminants Working Group, and before to calculate BCs, an exploratory study was first performed to find out potential differences on trace metals concentrations caused by environmental and biological factors. Results of this exploratory study showed that data submitted by different Mediterranean countries differs in relation to sampling season, size range of the individuals, number of reference sites considered. Furthermore, two mussel species have to be considered form the Mediterranean region (*Mytilus galloprovincialis* and *Brachiodontes variabilis*$^{\Psi}$).

Country	Sampling season	Number of subregions	Size range of mussels(cm)
Croatia	Spring	Middle A Northern	5.4±0.1 4.5±0.1
France	Winter	Single	Unknown
Italy	Spring, Summer, Autumn, Winter	Adriatic	[5-6]
Turkey	Winter	Izmir Bay	5.8±0.1
Spain	Spring	Levantino-Balear/Estrecho-Alborán	3.5±0.4
Greece	Spring, Winter	Subregion 1 Subregion 3 Subregion 9	3.5 6.1±0.2 Unknown
Lebanon$^{\Psi}$	Unknown	North Lebanon	Unknown

Once the differences, inconsistencies and gaps have been identified, further work will be conducted by experts to fill the gaps and clarify potential inconsistencies with data whenever possible. For each sub-region, the median of the median concentrations from each station within the same subregion will be calculated. The values obtained will be considered species specific BCs at each subregion, sampling season and size range.

Experts agreed that although it is biologically inappropriate to evaluate absolute BC and BAC contaminant levels in one species from the parallel levels of even from a close relative species, Mediterranean experts consider that some of the current contaminant BCs and BACs used in the OSPAR area for areas (OSPAR Commission, Agreement number 2009-2) can be adopted until the new BCs and BACs levels from the Mediterranean Region are calculated. In the case of organic contaminant in sediments, experts considered that BC and BAC established to assess concentrations in sediments from Spain within OSPAR area (not normalized) should be adopted for the Mediterranean region, until strong evidences of normalization requirements are demonstrated. Concerning BC and BACs for metal concentrations in Mediterranean experts agreed that BC and BACs calculated from core sediment samples from the Mediterranean region (UNEP/MAP (2011)) can be adopted until more new data are available. Concerning mussels, expert agreed to adopt the preliminary BACs established for metals and PAHs in *Mytlilus galloprovincialis* from the NW Mediterranean region (Benedicto et al., 2102) and the reference concentrations of metals in *Brachiodontes variabilis* that Lebanon was made available (expert communication) until new BACs are established. Similarly, expert agreed to adopt the preliminary BACs established for metals in *Mullus barbatus* from the NW Mediterranean region (Benedicto et al., 2102) until new BACs are established (see table 1).

Similarly than for contaminants, the Contaminants Working Group experts consider that BACs of biomarker responses in mussels currently established in the OSPAR area (Davies and Vethaak, 2012) can be adopted for mussels from the Mediterranean region until the new BCs and BACs levels species specific from the Mediterranean Region are calculated (see table 2).

Table 1. Background Assessment Criteria recommended to be used to assess concentrations in Mediterranean sediments, mussels (¥ *Mytilus galloprovincialis*, [Ψ] *Brachidontes variabilis*) and fish ([×] Mullus barbatus) from the Mediterranean region.

Trace metals	Sediments BAC (1) µg/kg d.w.	Mussels BAC (2) mg/kg d.w.	Fish BAC(2) mg/kg d.w.
Cd	150	1.088 [¥]/1.0 [Ψ]	0.008 [×]
Hg	45	0.188 [¥]/0.17 [Ψ]	0.600 [×]
Pb	30000	3.80 [¥]/1.0 [Ψ]	0.558 [×]
Polycyclic aromatic hydrocarbon	BAC (3) µg/kg d.w.	BAC(2) µg/kg d.w.	
Phenantrene	7.3	24.3 [¥]	
Anthracene	1.8	4.1 [¥]	
Fluorantene	14.4	6.8 [¥]	
Pyrene	11.3	6.1 [¥]	
Benzo[a]anthracene	7.1	1.3 [¥]	
Chrysene	8.0	2.4 [¥]	
Benzo[k]fluoranthene	-	1.8 [¥]	
Benzo[a]pyrene	8.2	1.3 [¥]	
Benzo[ghi]perylene	6.9	1.3 [¥]	
Indene[123-c,d]pyrene	8.3	0.8 [¥]	
Organochlorinated contaminants	BAC (3) µg/kg d.w.	BAC (3) µg/kg d.w.	BAC (3) µg/kg w.w.
CB28	-	0.75	0.10
CB52	-	0.75	0.08
CB101	-	0.70	0.08
CB105	-	0.75	0.08
CB118	-	0.60	0.10
CB138	-	0.60	0.09
CB153	-	0.60	0.10
CB156	-	0.60	0.08
CB180	-	0.60	0.11
Σ7CBS ICES	0.46	-	-
Lindane	0.13	0.19	-
α-HCH	-	0.13	-
pp´DDE	0.09	0.13	0.10
HCB	0.16	0.13	0.09
Dieldrin	0.19	-	-

(1) UNEP/MAP, 2011.
(2) Benedicto et al., 2012
(3) OSPAR Commission, 2009-2

Table 2. Background Assessment Criteria recommended to be used to assess biomarker responses in Mediterranean mussels (¥ *Mytilus galloprovincialis)*

Biomarkers / Bioassays	Mussels BAC (1)
Stress on Stress (days)	10
Lysosomal membrane stability Neutral Red Retention Assay (minutes)	120
Lysosomal membrane stability Cytochemical method (minutes)	20
AChE activity (nmol min-1 mg-1 protein)	
in gills (French Mediterranean waters)	29¥
in gills (Spanish Mediterranean waters)	15¥
Micronuclei frequency ($^{0}/_{00}$)	
in haemocytes	3,9

(1) Davies et al., 2012.

- **Addressing how to gather eco-toxicological information on key marine species on a sub-regional level, compile this information in a report on the determination of EAC for CBs, PAHs and trace metals (Cd, Hg, Pb) in biota.**

At the time of drafting the First Report of the Contaminants Working Group(March 2015), it was not possible to face up this task, and experts agreed that continuous work it will be necessary along the years to gather the required eco-toxicological information on key marine species on a Mediterranean sub-regional levels. The development of Mediterranean EACs is a difficult task because it requires together with concentrations in biota and sediments of the priority subtsances, ecotoxicological data for autochthonous marine species, which is largely lacking. To this end, Mediterranean and international data should be used to:

• Find out the most appropriate key sensitive species in the Mediterranean that can serve as a proxy for assessment, and

• Propose ecotoxicological studies to fill the gaps.

The approach of derive EAC levels for the MEDPOL areas from the ratio EAC/BAC levels in compatible OSPAR sentinel species proposed previously for the Mediterranean region (UNEP(DEPI)/MED WG. 365/Inf. 8), it was found absent of scientific sounds. That was discussed by the Contaminants Working Group and it was agreed that would be more convenient to use current established EACs from other regional Conventions until more data are available from specific Mediterranean species, deriving from the work of OSPAR, assuming that the EACs defined for one species in the OSPAR region can be used in the Mediterranean (see Table 3 and 4). Specifically:

Mytilus edulis (OSPAR) vs *Mytilus galloprovincialis* (MAP)

A benthic fish (OSPAR) vs *Mullus barbatus* (MAP)

Table 3. Environmental Assessment Criteria recommended to be used to assess concentrations in Mediterranean sediments, mussels (¥ *Mytilus galloprovincialis*, Ψ *Brachidontes variabilis*) and fish (× Mullus barbatus) from the Mediterranean region.

	Mussels (1)	Fish (1)	Sediments (1)
Trace metals	EC mg/kg d.w.	EC mg/kg d.w.	ERL mg/kg d.w.
Cd	5	0.207	1.2
Hg	2.5	4.150	0.15
Pb	7.5	1.245	46.7
PAHs	EAC µg/kg d.w.		EAC µg/kg d.w.
Phenantrene	1700		240
Anthracene	290		85
Fluorantene	110		600
Pyrene	100		665
Benzo[a]anthracene	80		261
Chrysene	-		384
Benzo[k]fluoranthene	260		-
Benzo[a]pyrene	600		430
Benzo[ghi]perylene	110		85
Indene[123-c,d]pyrene	-		240
Organochlorinated contaminants	EAC (1) µg/kg w.w.	EAC (1) µg/kg lipid	ERL(1) µg/kg d.w.
CB28	0.64	64	
CB52	1.08	108	
CB101	1.20	120	
CB105	-	-	
CB118	0.24	24	
CB138	3.16	316	
CB153	16.00	1600	
CB156	-	-	
CB180	4.80	480	
Σ7CBS ICES	-	-	11.5
Lindane	0.29	11Y	3.0
α-HCH	-	-	-
pp´DDE	10(2)	-	2.2
HCB	-	-	20.0
Dieldrin	10(2)	-	2.0

(1) OSPAR Commission, 2009-2

(2) OSPAR Commission, 2000

Table 4. Environmental Assessment Criteria for biomarker responses in *Mytilus galloprovincialis* deriving from the work of ICES/OSPAR (Davies et al., 2012)

Biomarkers / Bioassays	*Mytilus galloprovincilais* EAC
Stress on Stress (days)	5
Lysosomal membrane stability Neutral Red Retention Assay (minutes)	50
Lysosomal membrane stability Cytochemical method (minutes)	10
AChE activity (nmol min-1 mg-1 protein)	
in gills (French Mediterranean waters)	20
in gills (Spanish Mediterranean waters)	10

- **Perform a statistical test to evaluate the precision of MED POL Monitoring Programmes (per country) in order to define the relationship between Background Concentration (BC) and Background Assessment Concentration (BAC) taking into consideration the variability of reported data on Certified Reference Materials (sediments and biota) used by Mediterranean Laboratories in proficiency tests and in inter-calibration exercises.**

At the time of the drafting the First Report of the Contaminants Working Group(March 2015), a statistical test to evaluate the precision of MED POL Monitoring Programmes was not possible as variability of reported data on Certified Reference Materials (sediments and biota) used by Mediterranean Laboratories in proficiency tests and in inter-calibration exercises was very limited. This task has to be afforded in future.

- **Perform a quality control examination of the datasets in the MED POL database in order to better assess BAC values**

At the time of the drafting the First Report of the Contaminants Working Group (March 2015), a quality control examination of the datasets in the MED POL database was not possible as such MED POL database was not made available to the experts.

- **To check if there is a significant trace metal concentration/size statistical dependency using the trend monitoring data in order to decide if normalization to organism size (age) is required.**

At the time of the drafting the First Report of the Contaminants Working Group(March 2015), the statistical test to investigate if significant trace metal concentration/size statistical dependency exists was not possible as MED POL trend monitoring data was not made available to the experts.

Concluding remarks

A draft report and joint work on proposed environmental BACs and EACs for selected toxic metals in sediment and biota as well for selected biological responses in target species was initiated during the discussions of the Contaminants Working Group .

Furthermore, experts agreed to conduct further on line seasonal work in order to send a Final report to EcAp Coordination Group before September 2015.

In addition, the Contaminants Working Group agreed on some specific recommendations to be brought to the attention of the Integrated Correspondence Group Meeting on Monitoring, as refected in the "Recommendations of the online informal working groups" (UNEP(DEPI)/MED WG 401/5).

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ANNEX I

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