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Nice, France, 27-28 April 2017

Agenda item 4. Regional Assessment of the Mediterranean Marine and Coastal Environment: the development of the Quality Status Report

Quality Status Report (QSR) Assessment Factsheets on Pollution

UNEP/MAP
Athens, 2017

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Introduction

1. The Integrated Monitoring and Assessment Programme (IMAP) including 23 Common Indicators and 4 Candidate Indicators was adopted at the 19th Meeting of the Parties to the Barcelona Convention (COP 19) in February 2016[1]. The 2017 Quality Status Report (QSR2017) will be the first report on the IMAP-based Ecological Objectives and related common indicators. The UNEP/MAP Programme of Work adopted at COP 19 has a specific Output 1.4.1 *"Periodic assessments based on DPSIR approach and published addressing inter alia status quality of marine and coastal environment, interaction between environment and development as well as scenarios and prospective development analysis in the long run. These assessments include climate change-related vulnerabilities and risks on the marine and coastal zone in their analysis, as well as knowledge gaps on marine pollution, ecosystem services, coastal degradation, cumulative impacts and impacts of consumption and production."* The specific activity for 2016-2017 is to "*Prepare and publish Quality Status Report (QSR) based on MAP EcAp-based EO and related common indicators"*

2. Since the adoption of the IMAP decision at COP19, and given the IMAP implementation is still at an early phase, the approach for the QSR2017 accommodates the short time availably for preparation of this report and data gaps on some of the IMAP indicators, and also considers the approach taken by other Regional Seas (such as OSPAR), and global work such as ongoing work of the Regional Process on a second World Ocean Assessment(s) and the process on implementing the 2030 Agenda, especially in relation to oceans related Sustainable Development Goals (SDGs). As countries are still in the process of revising their national monitoring programmes, it will not be possible to compile a full set of data for all IMAP indicators for the QSR2017. Therefore the approach for the QSR2017 is to use all indicator data available and to complement and address gaps with inputs from numerous sources. In the initial steps additional sources of information are identified and mapped, from other partners, the NAP reports, etc.

3. The QSR2017 report will be prepared as an online interactive report so that the report can be made widely available, be visually appealing, include graphics and animations (such as time series maps of concentrations), and in addition to the main section, can have links to case studies, from Contracting Parties and also partners), or links to other databases and information sources. A Summary Report will also be prepared and published. The QSR2017 will be presented to 20th Meeting of Contracting Parties to the Barcelona Convention in December 2017, with a recommendation for future assessments.

4. The current document presents a first draft of the indicators for Ecological Objective 9 (EO9): Contaminants cause no significant impact on coastal and marine ecosystems and human health. This assessment is based predominantly on the MED POL database and on a number of recent reports and results from several projects and initiatives in the Mediterranean. Following review by the EcAp Coordination Group, factsheets will be shared with Pollution CORMON experts and the Pollution online working group for further technical review.

5. Contracting Parties and participants are invited to contribute to this initial draft of the assessment factsheets through the following:

   i. To review and comments for the further revision of the assessment factsheets
   ii. To provide to the Secretariat any information, assessments and publications that can be included in the further revision of the assessment factsheets

[1] UNEP(DEPI)/MED IG.22/28. Decision IG.22/7: Integrated Monitoring and Assessment Programme of the Mediterranean Sea and Coast and Related Assessment Criteria

iii. To propose, in addition to the regional level assessment factsheets proposals for case studies at the local, national or regional level for one or more indicator that can also be included in the QSR2017.

Ecological Objective EO9. Contaminants cause no significant impact on coastal and marine ecosystems and human health.

EO9: Common Indicator 17. Concentration of key harmful contaminants measured in the relevant matrix (EO9, related to biota, sediment, seawater).

Content	Actions	Guidance
General		
Reporter	Underline appropriate	**UNEP/MAP/MED POL** SPA/RAC REMPEC PAP/RAC Plan Bleu (BP)
Geographical scale of the assessment	Select as appropriate	Regional: **Mediterranean Sea** Eco-regional: NWM (North Western Mediterranean); ADR (Adriatic Sea); CEN (Ionian and Central Mediterranean Seas); AEL (Aegean and Levantine Sea) Sub-regional: Please, provide appropriate information
Contributing countries	Text	**Croatia, Cyprus, Egypt, France, Greece, Israel, Italy, Morocco, Slovenia, Spain, Syria, Tunisia, Turkey**
Core Theme	Select as appropriate	**1-Land and Sea Based Pollution** 2-Biodiversity and Ecosystems 3-Land and Sea Interaction and Processes
Ecological Objective	Write the exact text, number	**EO9. Contaminants cause no significant impact on coastal and marine ecosystems and human health**
IMAP Common Indicator	Write the exact text, number	**CI17. Concentration of key harmful contaminants measured in the relevant matrix (EO9, related to biota, sediment, seawater)**
Indicator Assessment Factsheet Code	Text	**EO9CI17**
Rationale/ Methods		
Background (short)	Text (250 words)	The status of the chemical contamination in the marine environment is linked with the human activities (drivers and pressures) that take place all around the coastal and marine areas of the Mediterranean Sea. For example, from small recreational marinas up to major commercial ports, which count thousands, have created a number of different pressures in terms of chemical pollution. At present, there are still old threats and new pressures, although the trends and levels of the so called legacy pollutants (e.g. heavy metals), have decreased significantly in the most impacted areas in the Mediterranean Sea after the implementation of environmental measures (e.g. leaded-fuels ban,

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		mercury regulations, anti-fouling paints ban), as observed in the NW Mediterranean Sea. However, there are still point and diffuse pollution sources entering both priority and emerging chemical contaminants (e.g. pharmaceuticals, personal care products, flame retardants) in the Mediterranean Sea. Land-based sources (LBS) of these groups of contaminants impact the coastal environment both via treated (or non-treated) wastewater discharges and represent a major input. In term of diffuse pollution sources, land based run-off and atmospheric deposition are also two major contributors to the coastal areas, and recently sea-based sources themselves are accounted as well in the budget (direct inputs from maritime and industrial activities, such as shipping, fishing, oil refining oil and gas exploration and exploitation are permanent chronic sources of pollution in the marine environment, including the potential for acute pollution events). In the Mediterranean Sea, the Barcelona Convention adopted in 1976 was the first legally-binding instrument for its environmental protection and included a number of protocols, such as the pollution land-based sources (LBS) Protocol. Since 2000, other international and national policies, such as the European Water Framework Directive and the European Marine Strategy Framework Directive are developing programmes which sums to its environmental protection at sub regional levels and collaborate with UNEP/MAP.  **Image provided: Mudsedimentsample_CGuitart.jpg** Description: Muddy sediment sample taken with a large grab sampler. The top 1 cm layer is collected for chemical pollution analyses. The oxic and anoxic layers can be clearly observed.
Assessment methods	Text (200-300 words), images, formulae, URLs	The method for the assessment of Common Indicator 17 has been undertaken by evaluating the levels of toxic metals contamination (Cadmium, Mercury and Lead) reported in different marine matrices by stations (at a regional scale). Three different matrices have been evaluated, bivalves, fish and sediments, against their available assessment criteria. That is, the percentage of stations (units) with levels above the BAC or EAC criteria. The species of bivalves were (*Mytilus galloprovincialis, Ruditapes decussates, Mactra corralina and Donax trunculus*). The fish species was *Mullus barbatus*. The calculation and details of the assessment can be found in the following files: **Bivalves_assessment_file.xlsx** **Fish_assessment_file.xlsx** **Sediments_assessment_file.xlsx** The datasets from the MED POL Database (see below) were employed for the assessment. The latest relevant years of data allowing the maximum spatial coverage were selected for each matrix and country. Datasets from countries

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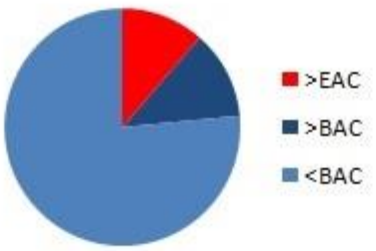
		reporting consecutive years were examined to evaluate consistence before the selection of the latest dataset. Alternatively, datasets were mixed to provide spatial coverage. A detailed evaluation of the datasets was undertaken and then averaged when necessary by stations with replicate samples. For sediments, the data by stations were also averaged (or by area when many close stations were reported) when necessary to allow coherence with the scale of the assessment and the volume of data available. The datasets obtained from the MED POL Database for each matrix and country were as follows: Mussel: Croatia (2009, 2011-2014), Egypt (2009-10), France (2012), Israel (2012-13, including 2010 and 2011 for Pb), Italy (2009), Slovenia (2015), Spain (2011), Tunisia (2010-13), Turkey (2009, 2011) Fish: Cyprus (2014-2015), Greece (2005), Israel (2013), Spain (2006-08), Turkey (2013) Sediments: Croatia (2011, 2013), Egypt (2006, 2009, 2010), France (2009-2012), Greece (2005), Israel (2013), Italy (2009), Morocco (2007), Spain (2007-08, 2011), Syria (2007), Tunisia (2012), Turkey (2013) **Image provided: Assessment plot.jpg** Description: Plot showing the percentage of evaluated stations around the Mediterranean Sea with pollutant concentrations below and above Background Assessment Criteria (BACs), and above Environmental Assessment Criteria (EACs). 
Background (*extended*)	Text (no limit), images, tables, references	The status of the chemical contamination in the marine environment is linked with the human activities (drivers and pressures) that take place all around the coastal and marine areas of the Mediterranean Sea. This results in different kinds of chemical pollution entering the marine environment due to different socio-economic related activities such as tourism, urban and social development, industrialization, resources exploitation and maritime transport to mention few. For example, starting with small recreational marinas up to major commercial ports, which count thousands, have created a number of different pressures in terms of chemical pollution. At present, there are still old threats and new pressures, although the trends and levels of the so called legacy pollution (eg. heavy metals), have decreased significantly in the most impacted areas in the Mediterranean Sea after the implementation of environmental measures (e.g. leaded-fuels ban, anti-fouling paints ban), as observed in the NW Mediterranean Sea. However, there are still point and diffuse pollution sources entering both priority and emerging chemical contaminants (e.g. pharmaceuticals, personal care products, flame retardants) in the Mediterranean Sea. Land-based sources (LBS) of these groups of contaminants impact the coastal environment both via treated (or non-treated) wastewater discharges and represent a major input. In term of diffuse

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		pollution sources, land based run-off and atmospheric deposition are also two major contributors to the coastal areas, and recently sea-based sources themselves are accounted as well in the budget (direct inputs from maritime and industrial activities, such as shipping, fishing, oil refining oil and gas exploration and exploitation are permanent chronic sources of pollution in the marine environment, including the potential for acute pollution events). Once these different groups of chemical pollutants have entered the marine environment different processes such as transport, transformation, accumulation and toxicity of contaminants will occur within the ecosystem. The fate of these substances and their potential degradation products are known to be the accumulated in the seawater column, marine organisms or sediments, in accordance with their known physicochemical properties and environmental processes. In the Mediterranean Sea, the Barcelona Convention adopted in 1976 was the first legally-binding instrument for its environmental protection and included a number of protocols, such as the pollution land-based sources (LBS) Protocol. Within the Mediterranean Action Plan (MAP) system, the MED POL Programme was established in order to control the inputs, to monitor and to assess the status and trends of the marine pollution in the Mediterranean Sea. This system has been and still a major framework for cooperation towards the protection of the Mediterranean Sea. Since 2000, other international and national policies, such as the European Water Framework Directive and European Marine Strategy Framework Directive are developing programmes which sums to its environmental protection at sub regional level and collaborate with UNEP/MAP. The 19th Ordinary Meeting of the Contracting Parties to the Convention for the Protection of the Marine Environment and the Coastal Region of the Mediterranean and its Protocols (the Barcelona Convention) adopted in 2016 the Integrated Monitoring and Assessment Programme (IMAP) of the Mediterranean Coast and Sea and Related Assessment Criteria, which includes the targets to achieve the Good Environmental Status (GES). The initial targets of GES under Common Indicator 17 will be based upon data of a relatively small number of chemicals, reflecting the scope of the current MED POL Programme and the availability of suitable agreed assessment criteria.
Results		NOTE: If the assessment has been performed at different geographical scales, include the results and conclusions accordingly.
Results and Status, including trends (brief)	Text (500 words), images	The latest available datasets of contaminants reported in the MED POL Database continues to indicate decreasing inputs of legacy pollutants and contaminants in the Mediterranean Sea, whilst show their fate and persistence in the coastal sediments. The monitored chemical contaminants in different matrices, namely mussel, fish and sediments and their assessment against Background Assessment Criteria (BACs) and Environmental Assessment Criteria (EACs) point to this conclusion. In general terms, between 21% and 32% of the stations assessed at a regional scale shows levels above the BACs or EACs for biota (mussel and fish), and therefore, acceptable marine environmental conditions (ca. below or above BACs) for the 90% of the MED POL monitored stations. On the contrary, the monitored levels of contaminants in coastal sediments are mostly above the BACs or EACs (23%-91%), such as toxic mercury with a 51% of the monitored stations above the EACs in the coastal Mediterranean Sea. The quality status of the major contaminant groups with known behavior as persistent, toxic and bioaccumulable (PBTs) substances were considered. These groups, typically, heavy metals (to refer to the anthropogenic inputs of toxic metals and elements), organochlorinated compounds and petroleum hydrocarbon compounds were assessed against the environmental criteria (Background Assessment Criteria and Environmental Assessment Criteria, BACs and EACs, respectively), recently established and adopted for the Mediterranean

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		Sea by the COP19 decision (UNEP/MAP, 2016). The operational objectives seek to reduce and maintain the levels at healthy conditions for the marine ecosystems with regard the concentrations of these chemical substances; therefore, toward natural background concentrations and zero concentrations, for occurring and synthetic substances, respectively (pre-industrial conditions). Concentrations of hazardous substances need to be maintained at background environmental levels, therefore, should not overpass the Environmental Assessment Criteria (EACs) established for each individual substance based on monitoring data and toxicology studies. A second criterion towards a good environment status (GES) is when temporal trends are either maintained or decreased (downward trends), if the current situation is not at natural (or zero) levels. At this point, these would reflect a situation where the pressures on the coastal environment are under control and the environmental measures and remediation actions are taken (UNEP/MAP, 2015). The BACs and EACs allow monitoring the targets to achieve the Good Environmental Status (GES). The initial targets and assessment of GES under Common Indicator 17 are based upon data of a relatively small number of chemicals, reflecting the scope of the monitoring activities performing in the Mediterranean Sea. The spatial scale of the assessment has been performed at regional scale for the whole Mediterranean basin. The major assessments were performed for coastal population of marine bivalves (such as *Mytilus galloprovincialis*), fish (such as *Mullus barbatus*) and sediments. The datasets for cadmium, mercury and lead in biota species can be used for comparisons purposes at a regional scale, including sediment information (Figures 1-9). Overall, the elaboration of the assessment reflected environmental issues with Pb in mussels and Pb and HgT in coastal sediments, whilst for the rest of matrices and toxic metals evaluated the levels are classified as acceptable. To guarantee the maintenance of the quality status (for example, with regard Cd and HgT for biota), and avoid future deteriorations of the current environmental conditions the measures implemented and the control of potential inputs from land, atmospheric and sea based sources to the coastal marine environment need to be continuously monitored.
Results and Status, including trends (extended)	Text(no limit), figures, tables	**Cadmium, mercury and lead in Mediterranean bivalves** The Figures 1 to 3 shows the distribution of the assessment performed for toxic metals in the Mediterranean Sea. The stations are located in the Western Mediterranean Sea and the Adriatic Sea eco-regions. The assessment shows that Cd levels are not above the Environmental Assessment Criteria (EACs) for any of the stations and HgT only for one station, thus indicating acceptable environmental conditions, which is an improvement of the earlier situation reported (UNEP/MAP/MEDPOL 2011a). A 79% and 68% of the monitored data for Cd and HgT in mussel, respectively, is below the Background Assessment Criteria (BACs). Similarly, the Pb assessment shows an improvement of the quality in the environmental situation in the Western Mediterranean which is significant in the Italian coast from the Tyrrhenian Sea; despite major mining and industrial activities with levels above the EACs in the coasts of Spain, Italy and Croatia still known hotspots. A 90% of the stations have Pb levels below the EAC value (72% below BAC and 18% above BAC), whilst a 10% is above EAC and indicates that the environmental situation should improve in these areas. **Cadmium, mercury and lead in Mediterranean fish** The new assessment for the pilot project implemented by some Contracting Parties in the Mediterranean Sea, with regard the monitoring of levels of contaminants in fish, shows an acceptable environmental situation (Figures 3-6). The assessment of the three toxic metals indicates an acceptable environmental status with very few stations above the BACs and none above the EACs. Particularly, 9%, 17% and 6% of the evaluated stations in these

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		Western and Eastern geographical areas shows values above BAC for Cd, HgT and Pb. Although this is the first reported data and assessment for fish the situation in absolute concentrations found in this matrix (*Mullus barbatus*) shows that levels are acceptable and both Cd and Pb are almost non-detectable in fish fillet samples. **Cadmium, mercury and lead in Mediterranean coastal sediments** The Figures 6 to 9 show the assessment for coastal sediments against BACs and EACs for latest information available in the Mediterranean Sea. The concentrations of toxic metals in coastal sediments shows a different picture with respect the environmental information obtained from biota samples, in particular for HgT and Pb. The number of samples over the EACs values is higher in this matrix, which responds to the known environmental processes for chemical substances in the environment were the final compartment for chemical pollutants is known to be the coastal sediment. Cd shows a 2% and 55% of the evaluated stations above the EAC and BAC, respectively. Few of these few stations are known to be impacted by anthropogenic sources, whilst others respond to different natural input processes, such as the input of Cd from the Atlantic waters in the Gibraltar Strait, upwelling inputs in the Gulf of Lions and atmospheric deposition processes in the Mediterranean islands of Corsica. HgT concentrations in coastal sediments reflect a situation far from a good ecological status (GES) with respect to the benthic marine ecosystems in terms of chemical pollution, particularly in the Northwestern Mediterranean, the Adriatic Sea, the Aegean Sea and the Levantine Sea. All the data assessed in the different eco-regions shows a 51% of the stations above the EAC and a 40% above the BAC. As a result only less than the 9% of the stations assessed provided levels below BAC in the coastal sediment. The main sources of this mercury in the marine environment are due to the industrial exploitation of mines of the Hg-rich natural land resources in the area. It should be pointed out that the reference values agreed are based on information from core sediments collected in the Mediterranean Sea and the revision of the values has been proposed (UNEP/MAP MED POL, 2016a). Pb is another toxic metal (within the group of the legacy pollutants) with known sources into the marine environment. However, the situation compared to HgT is somehow different due to the fact that Pb is an ubiquitous major element in the Mediterranean Sea crust with different geographical composition. In the Western Mediterranean data shows a 11% of the stations above the EAC and a 12% above the BAC. However, none of the stations evaluated in the Eastern Mediterranean coasts show values above the EAC, and for the Levantine Sea none of the stations show even values above the BAC. As mentioned above, these situation might reflect that different background values for Pb at sub-regional (eco-regional) scales in the Mediterranean Sea needs to be considered, thus some known hotspots for Pb inputs are known in the Eastern Mediterranean Sea. As for the case of HgT, the Pb criteria, BACs and EACs, for sediments are under proposal to refine the assessments at a sub-regional scales (UNEP/MAP MED POL, 2016a). **Persistent Organic Pollutants (POPs) and Non-halogenated compounds** Persistent organic pollutants (POPs) include certain legacy chlorinated pesticides and industrial chemicals, such as the so called polychlorinated biphenyls (PCBs), most of which have already been prohibited in Mediterranean countries and at a global scale (under the Stockholm Convention). These chemical substances are resistant to environmental degradation processes, and therefore persistent and prone to long-range transport. In the marine environment the bioaccumulation and biomagnification in organisms have been scientifically documented, as well as their implications for human health. Despite the implementation of the MED POL monitoring of chlorinated compounds during almost two decades, the availability of data with sufficient spatial geographical coverage and quality assured impedes to further assess their occurrence in the Mediterranean Sea region, beyond known sources and hotspots in coastal

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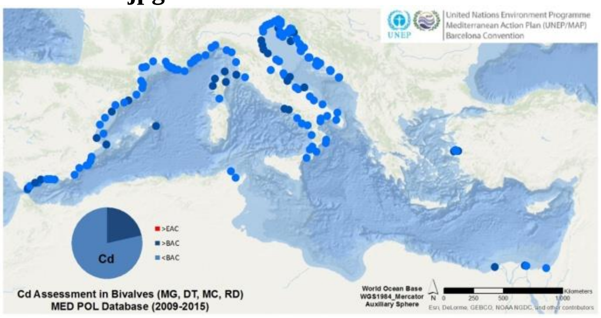
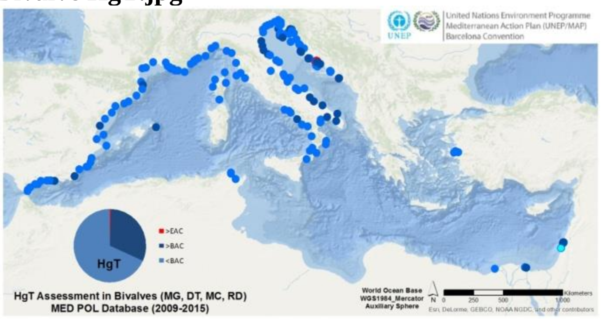
		areas. On the other hand, most of the recent datasets show non-detectable levels, mainly in biota matrices, which is in accordance with the earlier decreasing trends observed (UNEP/MAP/MED POL 2011a, 2011b, 2012). Similarly, the sources of petroleum hydrocarbons from a number of urban, industrial and sea activities in the marine environment have been reduced, probably the most significant example is the reduction of spills (acute pollution) compared to previous decades. However, chronic petroleum pollution continues associated to main harbors and sea-based sources. Oil is composed of thousands of compounds and includes the group of the Polycyclic Aromatic Hydrocarbons (PAHs). Additional, to land and sea based sources; different petroleum related chemicals also enter the marine environment through atmospheric deposition. Further, it is interesting to point out the overlooked importance of inputs from particular marine operations, such as oil exploitation, not only due to the introduction of PAHs in the marine environment, thus also for the introduction of other chemicals (e.g. phenols) with the produced-water from these installations. **Emerging chemical compounds** The occurrence of emerging compounds in the Mediterranean Sea has gained relevance over the last decade both in the northern and southern coasts. Different groups of chemicals, such as pharmaceutical compounds, personal care products, polycyclic fragrances and many others are currently under investigation. It is worth to mention the occurrence of synthetic litter from nano to macro sizes in the marine environment a new major treat for the Mediterranean Sea. Images provided (x9): **Bivalve Cd.jpg; Bivalve HgT.jpg; Bivalve Pb.jpg; Mullus Cd.jpg; Mullus HgT.jpg; Mullus Pb.jpg; Sediment Cd.jpg; Sediment HgT.jpg; Sediment Pb.jpg** Description: Images shows the plot of the assessment for toxic metals in the different marine matrices at a Mediterranean Sea scale. **Bivalve Cd.jpg**  **Bivalve HgT.jpg**  **Bivalve Pb.jpg**

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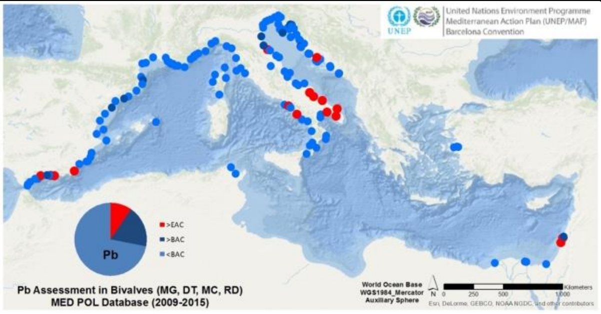
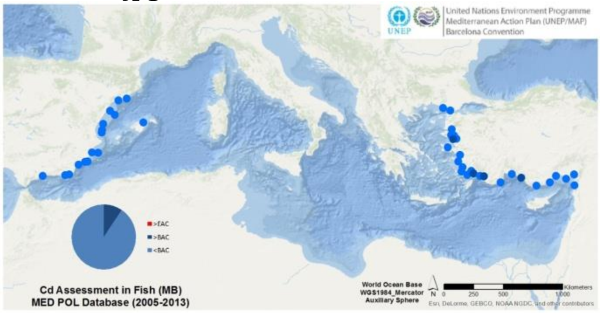
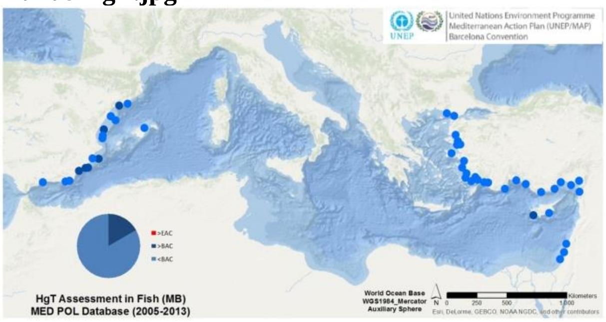


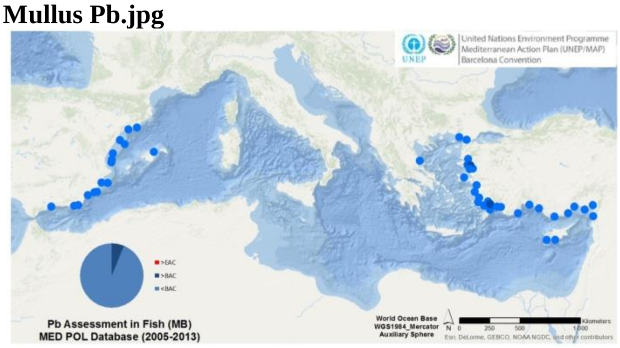
Mullus Cd.jpg



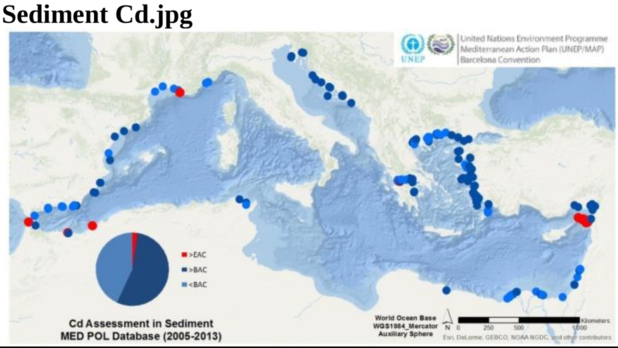
Mullus HgT.jpg



Mullus Pb.jpg



Sediment Cd.jpg



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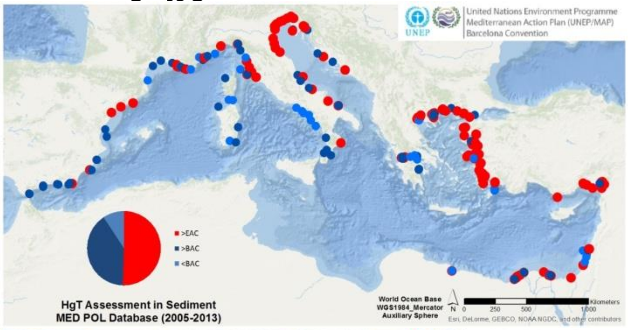
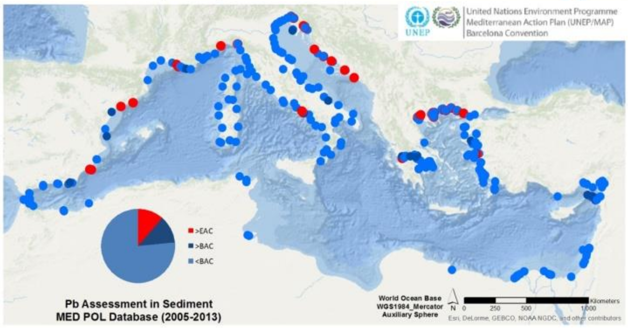
		Sediment HgT.jpg   **Sediment Pb.jpg** **Figure Captations:** Figure 1. Regional Cadmium assessment against BAC/EAC criteria in bivalve sp. (*Mytilusgalloprovincialis, Donaxtrunculus, Mactracorralina and RuditapesDecussatus*) for the Mediterranean Sea Figure 2. Regional Mercury assessment against BAC/EAC criteria in bivalve sp. (*Mytilusgalloprovincialis, Donaxtrunculus, Mactracorralina and RuditapesDecussatus*) for the Mediterranean Sea Figure 3. Regional Lead assessment against BAC/EAC criteria in bivalve sp. (*Mytilusgalloprovincialis, Donaxtrunculus, Mactracorralina and RuditapesDecussatus*) for the Mediterranean Sea Figure 4. Regional Cadmium assessment against BAC/EAC criteria in fish sp. (*Mullusbarbatus*) for the Mediterranean Sea Figure 5.Regional Mercury assessment against BAC/EAC criteria in fish sp. (*Mullusbarbatus*) for the Mediterranean Sea. Figure 6.Regional Lead assessment against BAC/EAC criteria in fish sp. (*Mullusbarbatus*) for the Mediterranean Sea**.** Figure 7. Regional Cadmium assessment against BAC/EAC criteria in sediment for the Mediterranean Sea Figure 8. Regional Mercury assessment against BAC/EAC criteria in sediment for the Mediterranean Sea Figure 9.Regional Lead assessment against BAC/EAC criteria in sediment for the Mediterranean Sea.
Conclusions		
Conclusions (brief)	Text (200 words)	A main conclusion from the pollution assessment by metals and organic contaminants in the Mediterranean Sea is that levels differ between biota and coastal sediments. This new situation, in terms of environmental protection from chemical pollution indicates that the inputs in the coastal surface waters (or atmospheric sources) from both urban or industrial activities are decreasing (ca. under control measures) and the already existing chemicals find their fate in the sediment compartment. Thus, the elevated levels observed in the coastal sediments are not correlated with the few impacted

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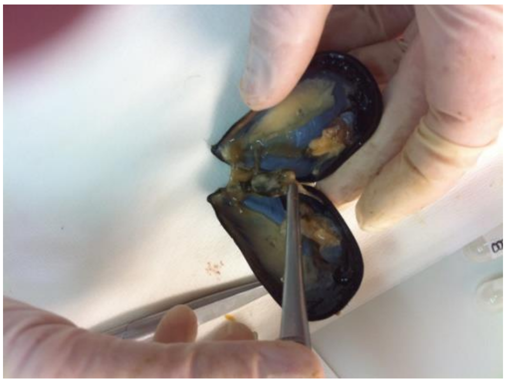
		observations coastal locations due to run-off, sewage discharges or other routes of inputs in the marine environment by means of biota monitoring. Therefore, in terms of GES achievement, the biota (mussel and fish) show a situation where the acceptable levels should be maintained. The levels of toxic metals and organic pollutants in few coastal areas continue to be localized in known hotspots were measures and actions should be considered to improve the environmental quality.
Conclusions (extended)	Text (no limit)	A main conclusion from the pollution assessment by metals and organic contaminants in the Mediterranean Sea is that levels differ between biota and coastal sediments. This new situation, in terms of environmental protection from chemical pollution indicates that the inputs in the coastal surface waters (or atmospheric sources) from both urban or industrial activities are decreasing (ca. under control measures) and the already existing chemicals find their fate in the sediment compartment. Thus, the elevated levels observed in the coastal sediments are not correlated with the few impacted observations coastal locations due to run-off, sewage discharges or other routes of inputs in the marine environment by means of biota monitoring. Therefore, in terms of GES achievement, the biota (mussel and fish) show a situation where the acceptable levels should be maintained. The levels of toxic metals and organic pollutants in few coastal areas continue to be localized in known hotspots were measures and actions should be considered to improve the environmental quality.
Key messages	Text (2-3 sentences or maximum 200 words)	• Levels of chemical legacy pollutants are decreasing whilst the concern is pointing to emerging chemical threats in the Mediterranean Sea. • Toxic metals budgets are found almost entirely in the coastal sediment compartment indicating a clear reduction of inputs from legacy pollutants in surface waters. • Organic chlorinated compounds are almost non-detectable in the monitored biota, although hotspot stations remain a threat. • Chronic petroleum sources into the marine environment (sea-based) are the principal target for pollution reduction, as the trends for acute pollution are controlled, maintained and decreasing. • Emerging pollution in both the northern and southern Mediterranean coasts is a raising topic of concern, including their relevant processes and interactions in the ecosystem. • Measures and actions should focus on known hotspots associated to urban and industrial areas along the coast of the Mediterranean Sea, and include sea-based sources, as these are the primary inputs of the pollutants. • Background and Environmental Assessment Criteria (BACs and EACs) should be further improved to take in consideration sub-regional specificities for occurring natural compounds.
Knowledge gaps	Text (200-300 words)	There are no new gaps identified in the Mediterranean Sea concerning the assessment of the Common Indicator 17. The limited spatial coverage, temporally consistent and quality assured datasets from monitoring activities hinders to some extent the regional and sub-regional assessments, as previously observed (UNEP/MA/MED POL, 2011a and 2011b). There is a lack of sufficient synchronized datasets for the assessment of the quality

Content	Actions	Guidance
		status in a coherent and timely manner which should be improved. To this regard, the criteria to undertake the assessment have also shown some gaps such as the necessity to explore the criteria at sub-regional scale for the determination of background concentrations of those chemicals occurring also naturally, such a Pb in sediments. Two recent published reports (UNEP/MAP MED POL, 2016a and 2016b) reviewed and proposed the background and environmental assessment criteria (BACs and EACs) for the Mediterranean Sea, as well as updated the temporal trend evaluation by countries with the MED POL datasets received up to the end of 2015. These reports were built in line with the 2011 reports (UNEP/MAP MED POL, 2011a and 2011b). Therefore the assessment period covered span for different periods including the most recent data, despite the number of datasets did not increased significantly nor the potential evaluation of temporal trends. The major studies are performed in the coastal population of marine bivalves (such as *Mytilus galloprovincialis*), fish (such as *Mullus barbatus*) and sediments. As early mentioned the distribution of information in the Mediterranean is not ideal as the southern Ionian, Aegean and Levantine basins lack of abundance of datasets to assess levels and temporal trends.
List of references	Text	UNEP/MAP/BP/RAC (2009). The State of the Environment and Development in the Mediterranean 2009. United Nations Environment Programme, Mediterranean Action Plan, Blue Plan Regional Activity Centre, Vallbone. UNEP/MAP/MED POL (2011a). Hazardous substances in the Mediterranean: a spatial and temporal assessment. United Nations Environment Programme, Mediterranean Action Plan, Athens. UNEP/MAP/MED POL (2011b). Analysis of trend monitoring activities and data for the MED POL Phase III and IV (1999-2010). United Nations Environment Programme, Mediterranean Action Plan, Athens. UNEP/MAP/MED POL, WHO (2008). Assessment of the state of microbial pollution in the Mediterranean Sea. United Nations Environment Programme, Mediterranean Action Plan, Athens. UNEP/MAP (2012). Initial integrated assessment of the Mediterranean Sea: Fulfilling step 3 of the ecosystem approach process. United Nations Environment Programme, Mediterranean Action Plan, Athens. UNEP/MAP (2012). State of the Mediterranean Marine and Coastal Environment. United Nations Environment Programme, Mediterranean Action Plan, Athens. UNEP/MAP (2013). Decision IG.21/3 - Ecosystems Approach including adopting definitions of Good Environmental Status (GES) and Targets. COP 18, Istanbul, Turkey. United Nations Environment Programme, Mediterranean Action Plan, Athens. UNEP/MAP (2015). Initial Analysis on existing measures under the Barcelona Convention relevant to achieving or maintaining good environmental status of the Mediterranean Sea, in line with the Ecosystem Approach. United Nations Environment Programme, Mediterranean Action Plan, Athens. UNEP/MAP/MED POL (2016a). Background to Assessment Criteria for Hazardous Substances and Biological Markers in the Mediterranean Sea Basin and its Regional Scales. United Nations Environment Programme, Mediterranean Action Plan, Athens. UNEP/MAP/MED POL (2016b). Temporal Trend and Levels Analysis for Chemical Contaminants from the MED POL Database. United Nations Environment Programme, Mediterranean Action Plan, Athens. UNEP/MAP (2016). Decision IG.22/7 - Integrated Monitoring and Assessment Programme (IMAP) of the Mediterranean Sea and Coast and Related Assessment Criteria. COP19, Athens, Greece. United Nations Environment Programme, Mediterranean Action Plan, Athens.

Ecological Objective EO9. Contaminants cause no significant impact on coastal and marine ecosystems and human health.

EO9: Common Indicator 18. Level of pollution effects of key contaminants where a cause and effect relationship has been established

Content	Actions	Guidance
General		
Reporter	Underline appropriate	<u>**UNEP/MAP/MED POL**</u> SPA/RAC REMPEC PAP/RAC Plan Bleu (BP)
Geographical scale of the assessment	Select as appropriate	Regional: <u>**Mediterranean Sea**</u> Eco-regional: NWM (North Western Mediterranean); ADR (Adriatic Sea); CEN (Ionian and Central Mediterranean Seas); AEL (Aegean and Levantine Sea) Sub-regional: Please, provide appropriate information
Contributing countries	Text	**Contracting Parties by research studies**
Core Theme	Select as appropriate	<u>**1-Land and Sea Based Pollution**</u> 2-Biodiversity and Ecosystems 3-Land and Sea Interaction and Processes
Ecological Objective	Write the exact text, number	**EO9. Contaminants cause no significant impact on coastal and marine ecosystems and human health**
IMAP Common Indicator	Write the exact text, number	**CI18. Level of pollution effects of key contaminants where a cause and effect relationship has been established**
Indicator Assessment Factsheet Code	Text	**EO9CI18**
Rationale/ Methods		
Background (short)	Text (250 words)	In most Mediterranean countries, the costal monitoring of a range of chemicals and biological effects parameters in different marine ecosystem compartments and organisms are undertaken in response to the UNEP/MAP Barcelona Convention (1975) and its Land-Based Protocol. A considerable amount of founding actions from the past decades are available through the pollution monitoring and assessment component of the UNEP/MAP MED POL Programme, including monitoring pilot programmes such as the ecotoxicological effects of contaminants (UNEP/MAP MED POL, 1997a, 1997b). The environmental assessments have been used for the identification and confirmation of significant occurrence, distributions, levels, trends of contaminants and their effects; as well as, for the continuous development of

Content	Actions	Guidance
		monitoring strategies and guidance. With respect to the Ecosystem Approach Process and IMAP, their implementation will continue under the benefits gained from this past knowledge and the policy framework built in the Mediterranean Sea.  **Image provided:** **Musseldisentionforanalysis_CGuitart.jpg** Description: Preparation (dissection) of a fresh mussel for both chemical and biological effects analysis.
Assessment methods	Text (200-300 words), images, formulae, URLs	(The present assessment has been undertaken based on bibliographic references and scientific documents in the Mediterranean Sea, as no enough datasets at regional scale are available). The assessment of the Common Indicator 18 will be based on the integrated evaluation of the biomarkers selected for the Mediterranean, Acetylcholinesterase activity (AChE), Lysosomal membrane stability (LMS) and Micronuclei frequencies (MN) on first instance. For these parameters there have been environmental criteria developed in terms of Background Assessment Criteria (BACs) and Environmental Assessment Criteria (EACs). These will be followed by the combined evaluation of the chemical's occurrence and the observed biological effects in organisms monitored in reference, coastal and hotspot stations in the coastal environment (marine bivalves, such as *Mytilus galloprovinciali*, and fish, such as *Mullus barbatus*), which will lead to the assessment of Good Environmental Status (GES). Assessing biomarker responses against Background Assessment Criteria (BACs) and Environmental Assessment Criteria (EACs) will allow to establish if the responses measured belong to levels that are not causing deleterious biological effects, levels where deleterious biological effects are possible or levels where deleterious biological effects are likely to occur in the long-term (UNEP/MAP MED POL, 2016; UNEP/MAP, 2016). Further, complementary biomarkers, bioassays and histology techniques and methods are also recommended to be carried out on a country basis (such as, comet assay, hepatic pathologies assessment, etc).
Background (*extended*)	Text (no limit), images, tables, references	The marine organisms are exposed to the chemical substances occurring in the marine environment which cause harmful effects at subcellular and cellular organization levels of an individual, and therefore, have the potential to correlate with the disfunctioning of the ecosystem as a whole. Several pilot monitoring programmes were initiated developed by few Contracting Parties (Croatia, France, Greece, Italy and Spain) with the objective to implement biological effects monitoring onto the current national networks of sampling stations in the Mediterranean Sea for chemical monitoring under MED POL (UNEP, 1997a). The use of a number of biomarkers, bioassays and associated biological parameters in an integrated manner altogether with information on environmental chemicals should provide clearer information of the pollution

Content	Actions	Guidance
		effects in the marine environment, and therefore, through monitoring the biological effects elucidate the potential for marine chemical pollution (UNEP/RAMOGE, 1999). A number of toxicological tests have found consensus and were recommended by a number of contracting parties' laboratories, namely, Lysosomal Membrane Stability (LMS) as a method for general status screening, Acetylcholinesterase (AChE) assay as a method for assessing neurotoxic effects in aquatic organisms and Micronucleus assay (MN) as a tool for assessing cytogenetic/DNA damage in marine organisms. Additionally, the survival on air (or Stress on Stress, SoS), was also incorporated as a general method of physiological condition. In the latest decade, scientific research has been intensified towards alternative biological effect-based tools for integrated pollution monitoring, thus the integrative assessment revealed a more complex panorama with real samples exposed to environmental concentrations. A number of confounding factors are hindering the cost-effective and reliable use of these methods to determine the biological effects at cellular and sub-cellular levels (ICES, 2012). As a consequence, most of these methods (biomarkers), based on the chemical exposure to biological effects cause relationships, are envisaged to be applied to monitor hotpots stations, dredging materials and local damage evaluations rather than for long-term environmental monitoring (surveillance). Ongoing research (biomarkers, bioassays) and future research trends, such as 'omics' developments, will further define the methodologies for these common indicator for toxicological effects (EU, 2014). In most Mediterranean countries, the costal monitoring of a range of chemicals and biological effects parameters in different marine ecosystem compartments and organisms are undertaken in response to the UNEP/MAP Barcelona Convention (1975) and its Land-Based Protocol. A considerable amount of founding actions from the past decades are available through the pollution monitoring and assessment component of the UNEP/MAP MED POL Programme, including monitoring pilot programmes such as the ecotoxicological effects of contaminants (UNEP/MAP MED POL, 1997a, 1997b). The environmental assessments have been used for the identification and confirmation of significant occurrence, distributions, levels, trends of contaminants and their effects; as well as, for the continuous development of monitoring strategies and guidance. With respect to the Ecosystem Approach Process and IMAP, their implementation will continue under the benefits gained from this past knowledge and the policy framework built in the Mediterranean Sea.
Results		NOTE: If the assessment has been performed at different geographical scales, include the results and conclusions accordingly.
Results and Status, including trends (brief)	Text (500 words), images	Idem
Results and Status, including trends (extended)	Text(no limit), figures, tables	In the Mediterranean Sea, the biological effects have recently been extended to studies in mussels exposed to outfall effluents and complex mixtures of pollutants using a battery of biomarkers (de los Ríos et al., 2012), including pelagic fish (Fossi et al., 2002; Tomasello et al., 2012) and combining wild and caged mussels (Marigómez et al., 2013), as well as in acute pollution accidental episodes such as oil spills (Marigómez et al., 2013b, Capó et al., 2015). In the Eastern Mediterranean, the LMS (neutral red retention method, NRR) and AChE levels have been evaluated on mussels *Mytilus galloprovincialis* collected from Thermaikos and Strymonikos gulfs in the northern Greece (Dailanis, et al., 2003) and more recently including the Eastern Mediterranean and the Black Sea in a number of marine species (Tsangaris et al., 2016). In the Adriatic Sea, the use of biomarkers has found applications in the monitoring of the anthropogenic impact due to the explotaition of gas fields (Gomiero et al. 2015) and studies of the genetic stability caused by pollution have been also

Content	Actions	Guidance
		investigated in Croatian laboratories (Stambuk et al. 2013). In the southern Mediterranean Sea, trials have been undertaken on the integrated use of biomarkers, and the development of biomarker indexes to study the spatial and temporal variations in locations with different levels of pollution in Algeria (Benali, et al., 2015) and in the Lagoon of Bizerte in Tunisia (Ben Ameur et al., 2015; Louiz et al., 2016). In the northwestern Mediterranean, investigations of benthic fish associated to the continental platform, *Solea solea*, *Mullus barbatus* have been investigated for hepatic and branchial biomarkers, as well as a battery of biomarker responses for biological effects monitoring in order to elucidate the sentinel species in pollution monitoring (Siscar, et al., 2015, Martinez-Gómez et al., 2012). High value commercial species, such as tuna (*Thunnus thynnus*) have also been investigated in Mediterranean Sea (Maisano et al. 2016). In the coastal environment, the rivers flowing into the Mediterranean such as Llobregat river (Spain), have also been used as locations to investigate the biological effects in invertebrate communities (Prat, et al., 2013; de Castro-Català, 2015). Recently, metabolomic responses and differences in metabolite profiles were observed in clams (*Ruditapes decussatus*) between control and polluted sites in the Mar Menor Lagoon, in the Western Mediterranean (Campillo, et al. 2015). These biological effects based tools have been also tested for the direct effects of pharmaceuticals in laboratory experiments in the Mediterranean Sea (Mezzelani, et al., 2016).
Conclusions		
Conclusions (brief)	Text (200 words)	The ongoing research developments with regard biological effects and toxicological methods is one of the reasons for the slow implementation of these techniques in marine pollution monitoring in the Mediterranean Sea. At present, in many Mediterranean countries, different programmes and projects leaded universities, research centers and government agencies are undergoing and will be the providers of the future quality assured and reliable tools to guarantee the correct implementation of a biological effects programme to assess the Common Indicator 18 in the Mediterranean Sea.
Conclusions (extended)	Text (no limit)	The ongoing research developments with regard biological effects and toxicological methods is one of the reasons for the slow implementation of these techniques in marine pollution monitoring in the Mediterranean Sea. At present, in many Mediterranean countries, different programmes and projects leaded universities, research centers and government agencies are undergoing and will be the providers of the future quality assured and reliable tools to guarantee the correct implementation of a biological effects programme to assess the Common Indicator 18 in the Mediterranean Sea.
Key messages	Text (2-3 sentences or maximum 200 words)	• Biological effects monitoring tools still in a research phase which limits the implementation of these methodologies in the long-term marine monitoring networks. • Traditional biomarkers and bioassays exhibiting confounding factors are being replaced with new molecular targets and methods, including metabolomic techniques, for its reliable application in integrated marine assessments in a cost-effective manner. • Exposure tests to different combinations of xenobiotics are one the relevant advancements of the development of biological-effects based tools.
Knowledge gaps	Text (200-300 words)	Important development areas in the Mediterranean Sea over the next few years should include: confirmation of the added value of these batteries of biomarkers in long-term marine monitoring, test of new research-proved tools such as ‘omics’, analytical quality harmonization, development of suites of assessment

Content	Actions	Guidance
		criteria for the integrated chemical and biological assessment methods, and review of the scope of the monitoring programmes. Through these and other actions, it will be possible to develop targeted and effective monitoring programmes tailored to meet the needs and conditions within the GES assessment.
List of references	Text	UNEP/MAP/MED POL (2016). Background to Assessment Criteria for Hazardous Substances and Biological Markers in the Mediterranean Sea Basin and its Regional Scales. United Nations Environment Programme, Mediterranean Action Plan, Athens. UNEP/MAP (2016). Decision IG.22/7 - Integrated Monitoring and Assessment Programme (IMAP) of the Mediterranean Sea and Coast and Related Assessment Criteria. COP19, Athens, Greece. United Nations Environment Programme, Mediterranean Action Plan, Athens. EU, European Commission, 2014. Technical report on effect-based monitoring tools. Technical Report 2014 – 077. European Commission, 2014. UNEP/RAMOGE, 1999. Manual on the Biomarkers Recommended for the UNEP/MAP MED POL Biomonitoring Programme. UNEP, Athens, 1999. ICES Cooperative Research Report. No.315. Integrated marine environmental monitoring of chemicals and their effects. I.M. Davies and D. Vethaak Eds., November, 2012 UNEP (1997b) The MED POL Biomonitoring Programme Concerning the Effects of Pollutants on Marine Organisms Along the Mediterranean Coasts. UNEP(OCA)/MED WG.132/3, Athens, 15 p. UNEP (1997a) Report of the Meeting of Experts to Review the MED POL Biomonitoring Programme. UNEP(OCA)/MED WG.132/7, Athens, 19 p. Dailanis, S., Domouhtsidou, G.P., et al. 2003. Evaluation of neutral red retention assay, micronucleus test, acetylcholinesterase activity and a signal transduction molecule (cAMP) in tissues of Mytilus galloprovincialis (L.), in pollution monitoring. Mar. Env. Res. 56, 443-470. de los Ríos, A., Juanes, J.J., et al., 2012. Assessment of the effects of a marine urban outfall discharge on caged mussels using chemical and biomarker analysis. Mar. Poll. Bull., 64, 563-573. Tomasello, B, Copat, C., et al., 2012. Biochemical and bioaccumulation approaches for investigating marine pollution using Mediterranean rainbow wrasse, *Coris julis* (Linneaus 1798) Marigómez, I., Zorita, I., et al., 2013b. Combined use of native and caged mussels to assess biological effects of pollution through the integrative biomarker approach. Aquatic Toxicol. 136-137, 32-48. Marigómez, I., Garmendia, L., et al., 2013a. Marine ecosystem health status assessment through integrative biomarker indices: a comparative study after the Prestige oil spill ‘‘Mussel Watch’’. Ecotoxicology, 22, 486-505. Benali, I., Boutiba, Z., et al., 2015. Integrated use of biomarkers and condition indices in mussels (*Mytilus galloprovincialis*) for monitoring pollution and development of biomarker index to assess the potential toxic of coastal sites. Mar. Poll. Bull., 95, 385-394. Siscar, R, Varó, I, Solé, M., 2015. Hepatic and branchial xenobiotic biomarker responses in Solea spp. from several NW Mediterranean fishing grounds. Mar. Env. Res., 112, 35-43.

Content	Actions	Guidance
		Capó, X., Tejada, S., 2015. Oxidative status assessment of the endemic bivalve *Pinna nobilis* affected by the oil spill from the sinking of the Don Pedro. Mar. Env. Res., 110, 19-24. Campillo, J.A., Sevilla, A., et al., 2015. Metabolomic responses in caged clams, Ruditapes decussatus, exposed to agricultural and urban inputs in a Mediterranean coastal lagoon (Mar Menor, SE Spain). Sci. Tot. Environ., 524-525, 136-147. Ben Ameur, W., El Megdiche, Y., et al., 2015. Oxidative stress, genotoxicity and histopathology biomarker responses in Mugil cephalus and Dicentrarchus labrax gill exposed to persistent pollutants. A field study in the Bizerte Lagoon: Tunisia. Chemosphere, 135, 67-74. Tsangaris, C., Vanessa, M., et al., 2016. Biochemical biomarker responses to pollution in selected sentinel organisms across the Eastern Mediterranean and the Black Sea. Environ. Sci. Poll. Res., 23, 1789-1804. Maisano, M., Cappello, T., et al., 2016. PCB and OCP accumulation and evidence of hepatic alteration in the Atlantic bluefin tuna, T. thynnus, from the Mediterranean Sea. Mar. Env. Res., 121, 40-48. Mezzelani, M., Gorbi, S., et al., 2016. Ecotoxicological potential of non-steroidal anti-inflammatory drugs (NSAIDs) in marine organisms: Bioavailability, biomarkers and natural occurrence in *Mytilus galloprovincialis*. Mar. Env. Res., 121, 31-39. De Castro-Català, N., Muñoz, I., et al., 2015. Invertebrate community responses to emerging water pollutants in Iberian river basins. Sci. Tot. Environ. 503-504, 142-150. Louiz, I., Ben Hassine, O.K., et al., 2016. Spatial and temporal variation of biochemical biomarkers in Gobius niger (Gobiidae) from a southern Mediterranean lagoon (Bizerta lagoon,Tunisia): Influence of biotic and abiotic factors. Mar. Poll. Bull., 107, 305-314. Prat, N., Rieradevall, M., et al., 2013. The combined use of metrics of biological quality and biomarkers to detect the effects of reclaimed water on macroinvertebrate assemblages in the lower part of a polluted Mediterranean river (Llobregat River, NE Spain). Ecol. Ind., 24, 167-176. Fossi, M.C., Casini, S., et al. 2002. Biomarkers for endocrine disruptors in three species of Mediterranean large pelagic fish. Mar. Env. Res. 54, 667-671. Stambuk, A., Srut., M., 2013. Gene flow vs. pollution pressure: Genetic diversity of *Mytilus galloprovincialis* in eastern Adriatic. Aquatic Toxicol. 136-137, 22-31.

Ecological Objective EO9. Contaminants cause no significant impact on coastal and marine ecosystems and human health.

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

Content	Actions	Guidance
General		
Reporter	Underline appropriate	UNEP/MAP/MED POL SPA/RAC **REMPEC** PAP/RAC Plan Bleu (BP)
Geographical scale of the assessment	Select as appropriate	**Regional:** **Mediterranean Sea**
Contributing countries	Text	Mediterranean assessment based on existing regional surveys, research and publications.
Core Theme	Select as appropriate	**Land and Sea Based Pollution**
Ecological Objective	Write the exact text, number	Ecological Objective 9 (EO9) Pollution. Contaminants cause no significant impact on coastal and marine ecosystems and human health.
IMAP Common Indicator	Write the exact text, number	Common Indicator C119. Occurrence, origin (where possible), and extent of acute pollution events (e.g. slicks from oil, oil products and hazardous substances) and their impact on biota affected by this pollution (EO9).
Indicator Assessment Factsheet Code	Text	EO9CI19
Rationale/ Methods		
Background (short)	Text (250 words)	Pollution from ships has been one of the first issues addressed by the Mediterranean Coastal States when they decided to act collaboratively to protect the Mediterranean Sea environment in 1975. The 1967 Torrey Canyon oil spill accident, which resulted in a massive oil pollution, raised the public awareness on pollution from shipping activities. Concern was expressed regarding possible oil and other harmful substances that may be released in the Mediterranean Sea, a semi-closed marine area. This led to the establishment of the Mediterranean Action Plan (MAP)’s first regional activity centre (Regional Oil Combating Centre, now REMPEC) and to the adoption, under the Barcelona Convention, of the Protocol Concerning Cooperation in Combatting Pollution of the Mediterranean Sea by Oil and other Harmful Substances in Cases of Emergency. This Protocol was revised in 2002 to include prevention of pollution from ships to emergency situations and is today referred to as the Protocol concerning Co-operation in Preventing Pollution from Ships and, in Cases of Emergency, Combating Pollution of the Mediterranean Sea (Prevention and Emergency Protocol). The Protocol addresses pollution incidents, which includes both accidental pollution and illicit discharges. Pollution from oil and other hazardous substances were also addressed internationally in a number of conventions adopted under the aegis of International Maritime Organization (IMO),

Content	Actions	Guidance
		some of which provides for stricter regime in the Mediterranean Sea. Although action at regional and international level has resulted in a significant decrease of massive oil pollutions from ships, incidents and illegal discharges are still responsible for the release of oil, oily mixtures and other hazardous and noxious substances (HNS) at sea. It is on these grounds that the Contracting Parties to the Barcelona Convention have included a Common Indicator (CI 19) on "*occurrence, origin (where possible), and extent of acute pollution events (e.g. slicks from oil, oil products and hazardous substances) and their impact on biota affected by this pollution*" under Ecological Objective 9.
Assessment methods	Text (200-300 words), images, formulae, URLs	**Assessment of accidents** In the Mediterranean region, under the Prevention and Emergency Protocol, assessment of occurrences, origins and extends of oil and HNS pollution from ships is carried out based on pollution reports (POLREP) issued by the Contracting Parties to REMPEC and other affected States to notify a pollution or an event that could result in a pollution. These reports provide details on the incidents, including position; extent of pollution; characteristics of pollution; sources and cause of pollution, trajectory of pollution, forecast and likely impacts, as well as sea state and meteorological information. The reports sent to REMPEC are also used to feed the Alerts and Accidents Database maintained by the Centre. Records of oil spills and accidents likely to cause spillages of oil in the Mediterranean started in 1977, while accidents involving other HNS are reported since 1988. Another main source of information used to populate the Alert and Accident Database is the Lloyd's Casualty Reporting Services (LCRS). Accidents recorded in this database are accidents that caused or were likely to cause a pollution by oil or other HNS in the Mediterranean Sea area. Accidents included are: - accidents happening in the Mediterranean Sea as defined in the Barcelona Convention; - accidents involving any type of ship, which actually resulted in an oil spill, a spill or release of a hazardous and noxious substance, or in a loss or damage to a container containing HNS; - accidents on land (terminals, storage tanks, pipelines, industries, power plants, etc.) that resulted in entry into the sea of oil or HNS; - accident involving one or more oil tankers or chemical tankers (either laden or not); - collisions, groundings or other accidents causing serious damage to the ships involved, in particular if these carried or could carry significant quantities of fuel oil as bunkers; - accidents involving sinking of vessels that had on board any quantity of oil as bunkers; and - accidents involving sinking of vessels that carried HNS as cargo (either in bulk or in packaged form). **Assessment of illicit discharges:** Monitoring of illicit discharges is conducted to detect violations of requirements of the MARPOL Convention (International Convention for the Prevention of Pollution from Ships) and collect evidence for prosecuting ships offenders. The POLREP can also be used by a Contracting Party to report to REMPEC a deliberate discharge. Methods: The following methods are used to detect a pollution and assess its origin and extent:

<table>
<tr><th>Content</th><th>Actions</th><th>Guidance</th></tr>
<tr><td></td><td></td><td>• Oil:
- expert human eye observation,
- aerial observation (human eye observation and/or remote sensing equipment),
- satellite imagery analysis to assess the extent and fate of an oil slick,
- sampling and analysis to determine the nature of the substance at sea, on shore and on board vessels. The Bonn Agreement has developed an internationally recognized procedure for sampling at sea, analysis and interpretation of results.

The following can be identified:
- volume of oil: internationally recognized guidance is used based on oil type and appearance to assess thickness (mm) and volume of oil (m^3/km^2) at sea (Bonn Agreement Oil Appearance Code (BAOAC),
- location and coverage of slick at sea (latitude and longitude - GPS),
- characteristics of oil (persistent vs. non persistent / viscosity),
- origin of slick (if visible ship name and IMO number, offshore installations ID number). Backtracking oil using trajectory modelling methods help to identify ship source.

On-shore monitoring will be used to assess the extent of impacted shorelines, type and degree of contamination as well as impact on habitats and wildlife casualties.
• HNS:
Detection of HNS pollution events and assessment of impacts is primarily achieved on site by expert human eye observation, complemented with real time monitoring, sampling and analysis, as well as the use of modelling tools. Conclusions of any risk assessment for HNS will be based on a number of information including identification of incident circumstances and location; identification of chemical involved, its properties / toxicity, and its form (packaged / bulk) as well as identification of sensitive neighbouring areas and environment conditions.</td></tr>
<tr><td>Background (extended)</td><td>Text (no limit), images, tables, references</td><td>Increasing shipping and maritime activities are important drivers for anthropogenic pressure on the marine environment in the Mediterranean Sea. Pressure from maritime transport includes potential chemical pollution from oil and HNS; dumping of garbage at sea; release of sewage; biofouling and non-indigenous species introduction. As documented in a great number of scientific researches, chemical pollution by oil and other harmful substances have impact on water, seabed, fauna and flora. The level of risk of an accident occurring in the Mediterranean Sea is driven by two factors: traffic density and routes for oil and chemical tankers. In addition, illicit discharges of oil from ships remains a concern.

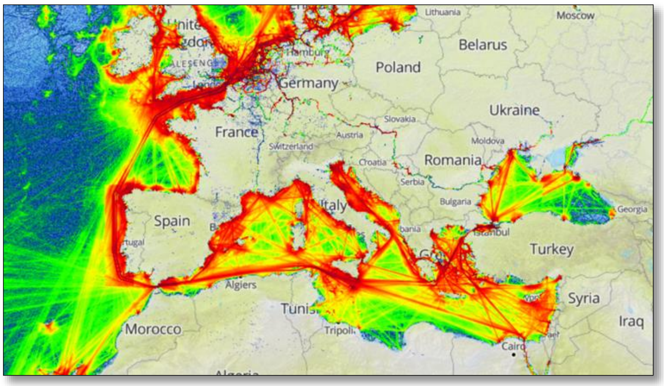
• Risk of accidents:

The Mediterranean is a major shipping lane. It is estimated that around 80 per cent of global trade by volume and over 70 per cent of global trade by value are carried by sea (UNCTAD, 2015), with approximately 15 % of global shipping activity by number of calls and 10 % by vessel deadweight tonnes (dwt) (REMPEC, 2008) taking place in the Mediterranean. The area is an important transit route for shipping, with two narrow busiest straits in the world: the strait of Gibraltar and the Bosphorus Strait. The Mediterranean is a major transit route. In 2006 around 10,000, mainly large, vessels transited the area en-route between non Mediterranean ports. In addition to hosting an important transit lane for international shipping, the Mediterranean Sea is also a busy traffic area due Mediterranean Sea born traffic (movement between a Mediterranean port and a port outside the Mediterranean), and short sea shipping activities. It is estimated that around</td></tr>
</table>

Content	Actions	Guidance
		18% of the shipping traffic in the Mediterranean Sea takes place between two Mediterranean ports (REMPEC, 2008). Figure 1 is a representation of the maritime traffic in the Mediterranean Sea.

Although several factors contribute to maritime casualties, the correlation between traffic density and accidents causing a pollution is confirmed by the fact that “collisions/ allisions” represent the first cause of accidents (26%) resulting in an oil spill as recorded by the International Tankers Oil Pollution Federation (ITOPF) between 1970 and 2016. In the Mediterranean, the “collision/contact” category accounts for 17% of accidents reported to REMPEC, after “grounding” (21%). Other accidents type contribution are as follows: “fire/explosion”:14%, “cargo transfer failure”: 11%, “sinking”: 9%, and “other accidents”: 28%. Several studies, based on the daily traffic crossing the Istanbul Strait and the Bosphorus, have identified the east Mediterranean /Black Sea area as one of the top areas presenting the greatest probability of a shipping accident occurring.

Figure 1: Density of maritime traffic in the Mediterranean Sea



Source: marinetraffic.com.

The Mediterranean is an important route for oil tankers’ shipments. The Mediterranean Sea is also a major route for tankers. The REMPEC study mentioned above shows that “The Mediterranean is both a major load and discharge centre for crude oil. Approximately 18 per cent, or 421 million tonnes, of global seaborne crude oil shipments which in 2006 amounted to approximately 2.3 billion tonnes, take place within or through the Mediterranean”. The following figures (Figure 2; Figure 3 and Figure 4) show the oil export areas and overseas destinations through the Mediterranean Sea.

Figure 2: Oil export source and destinations (North Africa)

Source: Tankers International website.

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<tr><th>Content</th><th>Actions</th><th>Guidance</th></tr>
<tr><td></td><td></td><td>Figure 3: Oil export source and destinations (Middle East)


Source: Tankers International website.

Figure 4: Oil export source and destinations (Black Sea)


Source: Tankers International website.

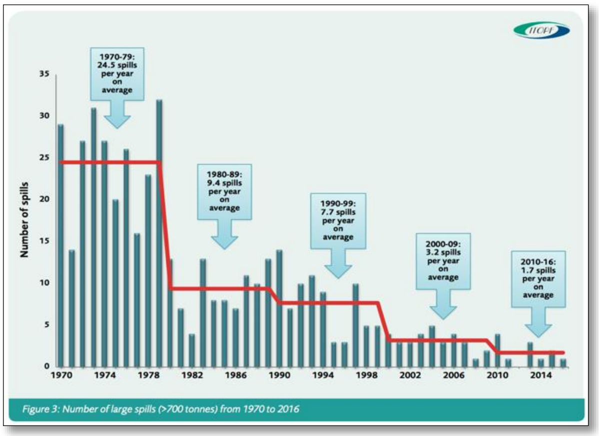
Figures 3 and 4 above emphasize that the East Mediterranean area is at risk: in addition to being an area where traffic is dense, it is also a hot spot because of tanker routes from the Black Sea and the Middle East.

• Deliberate discharges at sea
It has been demonstrated, with the use of satellite imagery and other observation tools, that deliberate oil pollution occurrences are high along busy traffic lanes. In the Mediterranean, there is evidence that the distribution of oil spills is correlated with the major shipping routes, along the major west-east axis connecting the Straits of Gibraltar through the Sicily Channel and the Ionian Sea with the different distribution branches of the Eastern Mediterranean, and along the routes toward the major discharge ports on the northern shore of the Adriatic Sea, east of Corsica, the Ligurian Sea and the Gulf of Lion (UNEP/MAP, 2012).</td></tr>
<tr><td>Results</td><td></td><td>NOTE: If the assessment has been performed at different geographical scales, include the results and conclusions accordingly.</td></tr>
<tr><td>Results and Status, including trends (brief)</td><td>Text (500 words), images</td><td>Statistical data analyses indicate a significant downward trend in accidental pollution from ships, for both oil and HNS. This decrease can also be seen both in the number of accidents causing these pollutions and in the volumes of pollutants discharged at sea. On the other hand, the same observation cannot be made with regard to illicit discharges from ships. We do not have sufficient data to identify an upward or downward trend, but based on the EMSA 2016 data, it can be argued that a significant number of illegal releases are still occurring.</td></tr>
</table>

<table>
<tr><th>Content</th><th>Actions</th><th>Guidance</th></tr>
<tr>
<td>Results and Status, including trends (extended)</td>
<td>Text (no limit), figures, tables</td>
<td>Key findings for accidents:

Decrease in the number of major oil spills worldwide
Maritime casualties involving oil have decreased substantially over the years, despite a growth in the volume of oil moved by ships. Today, according to ITOPF statistics, 99.99% of crude oil transported by sea arrives safely at its destination. As shown in Figure 5, the average number of large oil spills from tankers, i.e. greater than 700 tonnes, has progressively diminished over the years, to an average of 1.7 spills per year between 2010 and 2016.

Figure 5: Number of Oil Spills Greater than 700 Tonnes Between 1970 and 2016



Decrease in the frequency of accidents causing a pollution in the Mediterranean
• Oil:
The statistical analytical study prepared by REMPEC on the basis of its Alerts and Accidents database shows that major oil spills occurred frequently between 1977 and 1981 but have become rare events since then, with the last major accident being the MT “HAVEN” accident off Genoa in April 1991, with 144,000 tonnes of crude oil spilled.

In terms of volume of oil released at sea, the 2014 REMPEC Study indicates that between 1 January 1994 and 31 December 2013, approximately 32,000 tonnes of oil entered into the Mediterranean Sea as a result of accidents.

This includes approximately 15,000 tonnes originating from the 2006 Eastern Mediterranean incident which occurred in the power plant of Jieh, in Lebanon, between the 13^{th} and 15^{th} of July 2006. The fuel which did not burn was released in the marine environment. The exact quantity of the burnt quantity remains unknown but according to the estimate communicated by the Lebanese authorities, between 13,000 and 15,000 tonnes were released as a consequence of the spill.
The Lebanese spill is the fifth biggest spill reported since 1977 in the Mediterranean Sea, the largest spill being the spill related to the explosion of the MT HAVEN in 1991, which sunk with its cargo of 144,000 tonnes of crude oil in the Italian waters.

In terms of accidents causing a pollution, the number of accidents resulting in an oil spill dropped from 56% of the total number of accidents for the</td>
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</table>

Content	Actions	Guidance
		period 1977 – 1993, to 40% for the period 1994 – 2013. 61 % of the incidents resulted in a spillage inferior to 1 tonne.

- **HNS:**

In the Mediterranean, the quantities of HNS accidentally spilled have considerably decreased during the period 1994 - 2013. Since 2003, the release of HNS has become insignificant compared to the period 1994 – 2002.
The last two major accidents occurred in 1996 namely:
the sinking of Kaptan Manolis I in Tunisia, with 5,000 tonnes of phosphates on board; and
the sinking of Kira off Greece, releasing 7,600 tonnes of phosphoric acid.
The worst HNS spill in the Mediterranean was the sinking of the Continental Lotus in 1991 in the Eastern Mediterranean, with 51,600 tonnes of iron on board.

REMPEC's statistical analysis related to geographical location of accidents indicates that the majority of accidents occur in the Easter Mediterranean area (Cyprus, Egypt, Israel, Lebanon, Syria, Turkey) if we include Greece which is treated separately in REMPEC's findings, showing as Figure 6.

Figure 6: Geographical distribution of accidents

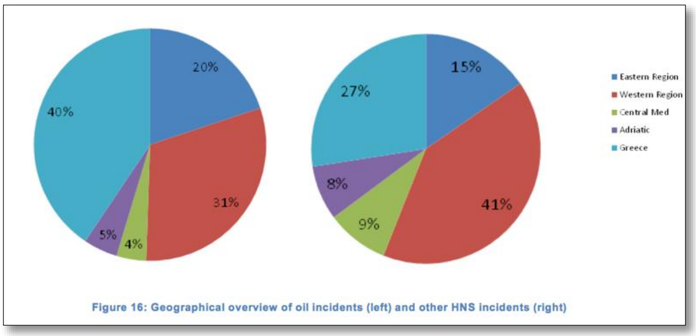


Figure 16: Geographical overview of oil incidents (left) and other HNS incidents (right)

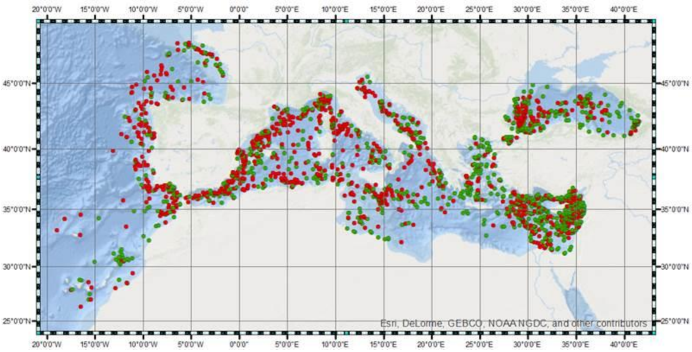
Source: REMPEC, 2014.

Key Findings for Illicit Discharges:

REMPEC's Alerts and Accidents Database contains a category for "Illicit Discharges". Only 5 cases were reported (1 in 2012, 1 in 2013 and 3 in 2015). By nature, as they are illegal, illicit discharges of oil are not voluntarily reported by the ship source. The use of satellite imagery can be a useful tool provide a better picture of the number of oil spills from ships, however, unless evidence is provided that a detected illicit discharge originates from a specific ship, no definite conclusion can be made as to whether or not the spill is caused by any ship, and therefore it is difficult to precisely assess the number of illicit discharges actually happening.

Trends: oil pollution occurrences still an issue in the Mediterranean.

In 2016, the CleanSeaNet platform of the European Maritime Safety Agency (EMSA) recorded a total of 1073 detections of probable pollution occurrences, and a total of 1060 detections of possible pollution occurrences in the area covering the Mediterranean Sea and the Atlantic Ocean coasts of Morocco, Portugal, Spain and France (Figure 7). Although there is no judicial evidence that all occurrences characterized as probably or possibly oil spills are actually discharges from ships, the map provides a clear indication that oil pollution incidents from ships is still of concern.

Content	Actions	Guidance
		Figure 7: Number of spills detected in 2016 by satellite imagery. **Class A** (red dots on the map) –the detected spill is most probably oil (mineral or vegetable/fish oil) or a chemical product. **Class B** (green dots on the map)- the detected spill is possibly oil (mineral/vegetable/fish oil) or a chemical product.  **Source: CleanSeaNet, European Maritime Safety Agency (EMSA).**
Conclusions		
Conclusions (brief)	Text (200 words)	Accidents rates have gone down globally and regionally despite the increase in shipping transportation and we can conclude that the impact of the international regulatory framework adopted through the IMO as well as technical cooperation activities undertaken at regional level is very positive, especially as far as prevention of accidental pollution is concerned. However, risks associated with the transport by ships of oil and HNS with possible harmful consequences on biota and ecosystems cannot be completely eliminated, especially in vulnerable areas such as the Mediterranean Sea. In addition, efforts have to be made to strengthen monitoring and reporting of illicit discharges from ships.
Conclusions (extended)	Text (no limit)	**Decrease of pollution occurrences globally: a**ccidents rates have gone down globally and regionally despite the increase in shipping transportation. Accidental pollution from both oil and HNS has decreased which can be related to the adoption and implementation of environmental maritime conventions addressing oil and HNS pollution prevention, preparedness and response. Indeed, statistical analysis indicates that there is a correlation between the period where the IMO regulatory framework was put in place (in the 70') and the years where we started seeing this downward trends happening (the 80'). We can therefore conclude that the impact of the international regulatory framework adopted through the IMO as well as technical cooperation activities undertaken at regional level is very positive, especially as far as prevention of accidental pollution is concerned. However, the issue of illicit discharges from ships remains of concern, especially in semi-enclosed areas where the ability of the marine environment to regenerate is less likely to happen. **Oil pollution long term effects:** it is also important to keep in mind that recovery of habitats following an oil spill takes can take place from between a few seasonal cycles (plankton); to several years: within one to three years (sand beaches; exposed rocky shores); between 1 and 5 years (sheltered rocky shores), between 3 and 5 years (saltmarshes) and up to 10 years or greater for mangrove.

Content	Actions	Guidance
		According to ITOPF, while considerable debate exists over the definition of recovery and the point at which an ecosystem can be said to have recovered, there is broad acceptance that natural variability in ecosystems makes a return to the exact pre-spill conditions unlikely. Most de definitions of recovery instead focus on the re-establishment of a community of fora and fauna that is characteristic of the habitat and functioning normally in terms of biodiversity and productivity. Therefore, despite the progress achieved in mitigating oil spill incidents from ships, it is clear that continuous monitoring of illicit discharges occurrences and cumulative effects and impacts, and of accidental post-spill consequences on biota and ecosystems is needed.
Key messages	Text (2-3 sentences or maximum 50 words)	Chronic sources (illicit discharges) of pollution into the marine environment from ships are the principal target for pollution reduction, as the trends for acute pollution (accidents) are controlled and decreasing.
Knowledge gaps	Text (200-300 words)	• The information collected via pollution reports is related to specific pollution events and not always useful or compatible with the information needed to assess the status of the marine environment, • Maintaining the Mediterranean Alerts and Accidents Database is a prerequisite and the condition for being able to measure Common Indicator CI19, • There is no obligation for countries to carry out environmental surveys of sea and shorelines affected by a spill. Systematic environmental shorelines assessment post spill is today recognized as a "must do" practice and can provide information on biota on a case by case basis. • Very little data is available regarding illegal discharges from ships. **Environmental monitoring and reporting:** the focus of IMO environmental conventions and guidelines is on ships' compliance monitoring rather than on monitoring or measuring the state of the marine and coastal environment. The same can be noted with respect to reporting obligations. Reporting is required in the case of an accident causing a pollution or in case an illegal pollution is discovered (operational discharges). This perspective is reflected in the Protocol Concerning Cooperation in Combatting Pollution of the Mediterranean Sea by Oil and other Harmful Substances in Cases of Emergency. Therefore, the information collected is related to specific pollution events and not always useful or compatible with the information needed to assess the status of the marine environment. **Accidents monitoring and reporting:** there is an increase in the number of accidents reported to REMPEC, which is most likely due to a better compliance by the Contracting Parties to the Barcelona Convention to report casualties, as required by Article 9 of the 2002 Prevention and Emergency Protocol. It is of utmost importance that the Contracting Parties continue to report on accidents as accurately as possible, as it is paramount that REMPEC continues maintaining the Mediterranean Alerts and Accidents database to keep track of pollution events. This is a prerequisite and the condition for being able to measure Common Indicator CI19. **Impact on biota affected by a pollution:** for the reason explained above, there is little information on the impact of pollution events caused by shipping on biota. Ship generated pollution impact is usually considered from a response perspective (protection of sensitive areas and facilities). There is no obligation for countries to carry out environmental surveys of sea and shorelines affected by a spill. However, systematic environmental

Content	Actions	Guidance
		shorelines assessment post spill is today recognized as a “must do” practice in terms of assessing the level of cleanness of the affected area, as well as from a remediation perspective. **Illicit discharges from ships:** very little data is available regarding discharges from ships. As these are illegal operations by nature (when not within the limits set by the MARPOL Convention) it is extremely difficult to get information on occurrences and extent of spills. Marine surveillance requires aerial means and equipment (planes; airborne radars; sampling sets) or special technology such as the use of satellite images. There is no regionally centralized system for surveying the Mediterranean waters as defined in the Barcelona Convention. The CleanSeaNet platform, the European satellite-based oil spill monitoring and vessel detection service, is a good resource, but only available in principle to EU members.
List of references	Text (10 pt, Cambria style)	Allianz Global Corporate & Specialty: Safety and Shipping Review 2016 - An annual review of trends and developments in shipping losses and safety, 2016. EMSA: Addressing Illegal Discharges in the Marine Environment, 2012. IMO/UNEP: Regional Information System; Part C2, Statistical Analysis - Alerts and Accidents Database, REMPEC, December 2014. IMO/UNEP: Regional Information System; Part C2, Statistical Analysis - Alerts and Accidents Database, REMPEC, February 2011. ITOPF: Oil Spill Statistics, February 2017. ITOPF: Effect of Oil Pollution the Marine Environment, Technical Information Paper 13. Ömer Faruk Görçün, Selmin Z. Burak : Formal Safety Assessment for Ship Traffic in the Istanbul Straits. Published by Elsevier, 2015. Study of Maritime Traffic Flows in the Mediterranean Sea, Final Report - Unrestricted Version, July 2008. UNCTAD: Review of Maritime Transport 2015. UNEP/MAP: State of the Mediterranean Marine and Coastal Environment, UNEP/MAP – Barcelona Convention, Athens, 2012. WWF: Accident at Sea, Summary, 2013.

Ecological Objective 9 (EO9): Pollution

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

Content	Actions	Guidance
General		
Reporter	Underline appropriate	**UNEP/MAP/MED POL** SPA/RAC REMPEC PAP/RAC Plan Bleu (BP)
Geographical scale of the assessment	Select as appropriate	Regional: **Mediterranean Sea** Eco-regional: NWM (North Western Mediterranean); ADR (Adriatic Sea); CEN (Ionian and Central Mediterranean Seas); AEL (Aegean and Levantine Sea) Sub-regional: Please, provide appropriate information
Contributing countries	Text	**Contracting Parties by research studies**
Core Theme	Select as appropriate	**1-Land and Sea Based Pollution** 2-Biodiversity and Ecosystems 3-Land and Sea Interaction and Processes
Ecological Objective	Write the exact text, number	**EO9. Contaminants cause no significant impact on coastal and marine ecosystems and human health**
IMAP Common Indicator	Write the exact text, number	**CI20. Actual levels of contaminants that have been detected and number of contaminants which have exceeded maximum regulatory levels in commonly consumed seafood**
Indicator Assessment Factsheet Code	Text	**EO9CI20**
Rationale/ Methods		
Background (short)	Text (250 words)	The human exposure through commercial fish and shellfish species (both fisheries and aquaculture) is one the main concerns with regard the occurrence of pollutants in the marine environment. Wild and farmed marine species are exposed to environmental chemical contaminants through different mechanisms and pathways according their thropic level, which include from filter feeding to predatory species (crustaceans, bivalves, fish, etc.). The understanding of the health risks to humans (maximum levels, intake, toxic equivalent factors, etc.), through the consumption of potentially contaminated seafood is a challenge and a priority policy issue for governments, as well as a major societal concern.

<table>
<tr><th>Content</th><th>Actions</th><th>Guidance</th></tr>
<tr><td></td><td></td><td>
Image provided:
CommonseafoodMediterranean.jpg
Description: Major seafood species commercialized in the Mediterranean Sea (fish market shop in Athens, Greece).</td></tr>
<tr><td>Assessment methods</td><td>Text (200-300 words), images, formulae, URLs</td><td>(The present assessment has been undertaken based on bibliographic references and scientific documents in the Mediterranean Sea, as no enough representative datasets at regional scale are available)

The assessment of the Common Indicator 20 will be based on the statistics about the number of detected contaminants and their deviations from legal permissions in commercial fish species set by national, European and international regulations. Primarily, the levels set by the European Regulations (Official Journal of the European Union, 2006 and 2011) and amendments (Table 1) are of application to harmonize and compare data in the Mediterranean Sea. The majority of the datasets are hold in databases from surveys by national regulatory and inspection bodies. Therefore, the frequencies in the number and excess of the occurrence on a temporal basis will define the GES with regard to this common indicator (UNEP/MAP, 2016).

Table 1. Summary of current regulatory levels set by the European Union (from: Maggi et al., 2014)

Table 1. Regulatory levels, reference legislation, code and foodstuff categories.
<table>
<tr><th>Category code</th><th>Legislation</th><th>Foodstuff</th><th>Regulatory levels</th></tr>
<tr><td>Cd 3.2.5</td><td>Reg.1881/2006/CE</td><td>Muscle meat of fish (footnote 24)</td><td>0,05 mg/kg w.w.</td></tr>
<tr><td>Cd 3.2.6</td><td>Reg.1881/2006/CE</td><td>Muscle meat of listened fish</td><td>0,10 mg/kg w.w.</td></tr>
<tr><td>Cd 3.2.8</td><td>Reg.1881/2006/CE</td><td>Crustaceans</td><td>0,50 mg/kg w.w.</td></tr>
<tr><td>Cd 3.2.9</td><td>Reg.1881/2006/CE</td><td>Bivalve molluscs</td><td>1,0 mg/kg w.w.</td></tr>
<tr><td>Cd 3.2.10</td><td>Reg.1881/2006/CE</td><td>Cephalopods</td><td>1,0 mg/kg w.w.</td></tr>
<tr><td>Hg 3.3.1</td><td>Reg.1881/2006/CE</td><td>Fishery products and muscle meat of fish (footnotes 24, 25, 26)</td><td>0,50 mg/kg w.w.</td></tr>
<tr><td>Hg 3.3.2</td><td>Reg.1881/2006/CE</td><td>Muscle meat of listened fish</td><td>1,0 mg/kg w.w.</td></tr>
<tr><td>Pb 3.1.5</td><td>Reg.1881/2006/CE</td><td>Muscle meat of fish (footnote 24)</td><td>0,3 mg/kg w.w.</td></tr>
<tr><td>Pb 3.1.6</td><td>Reg.1881/2006/CE</td><td>Crustaceans</td><td>0,50 mg/kg w.w.</td></tr>
<tr><td>Pb 3.1.7</td><td>Reg.1881/2006/CE</td><td>Bivalve molluscs</td><td>1,5 mg/kg w.w.</td></tr>
<tr><td>Pb 3.1.8</td><td>Reg.1881/2006/CE</td><td>Cephalopods</td><td>1,0 mg/kg w.w.</td></tr>
<tr><td>Dioxins 5.3</td><td>Reg.1259/2011/CE</td><td>Muscle meat of fish and Bivalve molluscs</td><td>3,5 pg/g w.w.</td></tr>
<tr><td>Sum dioxins and dioxin like PCBs 5.3</td><td>Reg.1259/2011/CE</td><td>Muscle meat fish and Bivalve molluscs</td><td>6,5 pg/g w.w.</td></tr>
<tr><td>Benzo(a)pyrene 6.1.4</td><td>Reg.1881/2006/CE</td><td>Muscle meat of fish (footnote 24)</td><td>2,0 µg/kg w.w.</td></tr>
<tr><td>Benzo(a)pyrene 6.1.5</td><td>Reg.1881/2006/CE</td><td>Crustaceans and Cephalopods</td><td>5,0 µg/kg w.w.</td></tr>
<tr><td>Benzo(a)pyrene 6.1.6</td><td>Reg.835/2011/CE</td><td>Bivalve molluscs</td><td>5 µg/kg w.w.</td></tr>
<tr><td>Sum PAH 6.1.6</td><td>Reg.835/2011/CE</td><td>Bivalve molluscs</td><td>30 µg/kg w.w.</td></tr>
</table>
doi:10.1371/journal.pone.0108463.t001</td></tr>
<tr><td>Background (extended)</td><td>Text (no limit), images, tables, references</td><td>The human exposure through commercial fish and shellfish species (both fisheries and aquaculture) is one of the main concerns with regard the occurrence of pollutants in the marine environment. Wild and farmed marine species are exposed to environmental chemical contaminants through different mechanisms and pathways according their thropic level, which include from filter feeding to predatory species (crustaceans, bivalves, fish, etc.).</td></tr>
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Content	Actions	Guidance
		Consequently, there exist both bioaccumulation and biomagnifications processes of these chemicals released in the marine environment. Common examples are the well-known bioaccumulation of metals and organic compounds in commercial bivalve species (such as *Mytillus galloprovincialis* in the Mediterranean Sea) or alkyl mercury compounds in fish (e.g. methylmercury in tuna fish), however, many of the current emerging target chemicals have already been detected in commercial fisheries. The understanding of the health risks to humans (maximum levels, intake, toxic equivalent factors, etc.), through the consumption of potentially contaminated seafood is a challenge and a priority policy issue for governments, as well as a major societal concern. There are different initiatives and regulations at national and international, which have established public health recommendations and maximum regulatory levels for some contaminants (mainly, legacy pollutants), in numerous marine commercial target species. Methylmercury poisoning continues as a global priority policy issue and in 2013 the Global Legally Binding Treaty (Minamata Convention on Mercury) was relaunched by UNEP (UNEP, 2002). Further, the USFDA (US Food and Drugs Administration), the EFSA (European Food Safety Authority) and FAO/WHO (Food and Agriculture Organization and World Health Organisation) (FAO/WHO, 2011), are also leading national and international authorities with regard seafood safety. In relation to this, as mentioned, the European Council (EC) has introduced maximum levels for chemical contaminants, and subsequent amendments, including recently PCDDs, PCDFs and dioxin-like-PCBs in fishery products (Official Journal of the European Union, 2006 and 2011).
Results		NOTE: If the assessment has been performed at different geographical scales, include the results and conclusions accordingly.
Results and Status, including trends (brief)	Text (500 words), images	With regard the content of chemical contaminants fish and shellfish, different research studies have been recently conducted in the Mediterranean Sea taking into account a number of legacy and emerging chemicals. Therefore, at present, scattered datasets all along the Mediterranean sub-basins mostly from research studies are available with few assessments undertaken under European marine policy by European Contracting Parties of the Barcelona Convention (e.g. the Descriptor 9 under EU Marine Strategy Framework Directive). Future harmonization and data sharing will improve the assessment in the Mediterranean Sea at a regional scale.
Results and Status, including trends (extended)	Text(no limit), figures, tables	With regard the content of chemical contaminants fish and shellfish, different research studies have been recently conducted in the Mediterranean Sea taking into account a number of legacy and emerging chemicals. In the Eastern Mediterranean, selected toxic and essential metals (Cd, Pb, Cu and Zn) have been determined in some different brands and types of fishery products in Turkey (Çelik and Oehlen, 2007; Mol, S., 2011). Dioxins, dioxin-like and non dioxin-like PCBs have been also determined in Greek farmed fish (Costopoulou et al., 2016) and levels found were well below the limits set by EU Legislation. In the Ionian Sea, the levels of a large set of toxic metals (As, Cd, Cr, Pb, Mn, Ni, V and Zn) were assessed in fish and shellfish from the Gulf of Catania (Copat et al., 2013, 2014), and did not exceed the limits set by the EU legislation. However, a more recent study in the same area found levels exceeding the legal limits for some species, such as gastropods and fish (Giandomenico et al., 2016). The concentrations and congener specific profiles of legacy and emerging compounds, such as PCBs, PCDDs and PCDFs have been determined in various edible fish from the Adriatic Sea. The results obtained shown that levels were under the EU legislation (Storelli et al., 2011). Similarly, PCBs and PCDD/F concentrations and congener specific profiles were also determined in seafood (e.g. fish and cephalopods) in supermarkets in Southern Italy (Barone et al., 2014). Further, in terms of shellfish contaminant levels for risk to seafood consumers, cultured and harvested bivalves have been recently evaluated in the Adriatic Sea (Croatia), and shown no risk (Milun, V.,

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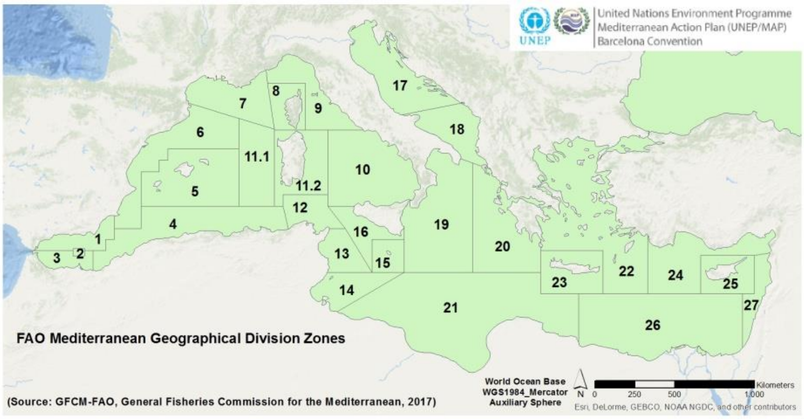
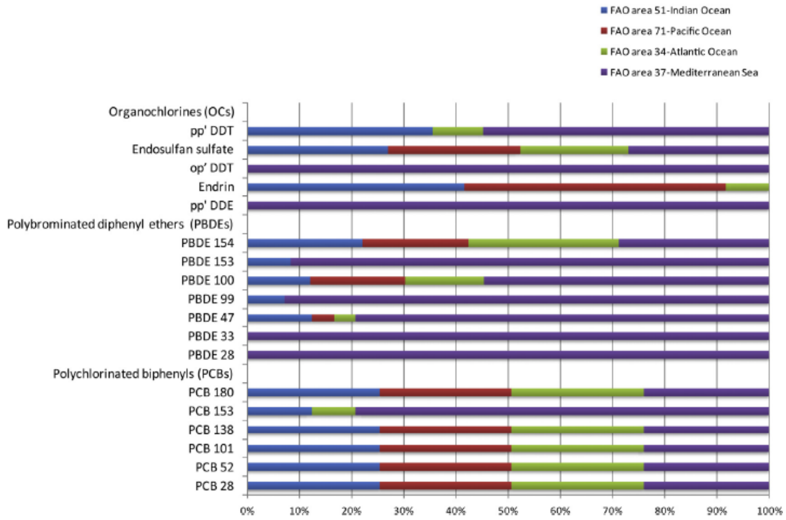
<tr><td></td><td></td><td>2016). Furthermore, with regard an assessment under the context of the EU Marine Strategy Framework Directive (MSFD), Italy investigated and assessed the Descriptor 9, which is equivalent to EO9 common Indicator 20. The conclusion, based on a statistical range of acceptance and defined criteria, was a good GES status. Nevertheless, the datasets for synthetic compounds and their spatial coverage were somehow limited (Maggi, et al., 2014). Fish, molluscs, and crustaceans of commercial size of 69 different species were sampled and analyzed for total mercury (HgT) from FAO georeferenced areas (Figure 1) around Italy and evaluated for their compliance with the EU Maximum Residue Limits (MRLs, Table 1) (Bambrilla, et al., 2013). In the NW Mediterranean, mercury contamination was studied in deep-sea organisms to understand the transfer, fate and human implications of contaminated commercial species (Koenig et al., 2013). France, as a part of a specific monitoring programme, determined, toxic metals in gastropods, echinoderms and tunicates, which are also consumed locally in the Mediterranean Sea (Noël, L., et al., 2011). In the southern Mediterranean countries, Morocco has investigated the coastal population exposure to mercury via seafood consumption (Elhsmri, H., 2007). From a human health perspective, beyond environmental levels and compliance with set regulatory limits, some studies have been undertaken both for legacy and emerging chemical of concern to assess the intake of seafood products end-consumers. To this regard, it is worth to mention the study of the intake of arsenic (As), cadmium (Cd), mercury (Hg), lead (Pb), polychlorinated dibenzo-p-dioxins and dibenzofurans (PCDD/Fs), polychlorinated biphenyls (PCBs), polychlorinated naphthalenes (PCNs), polybrominated diphenylethers (PBDEs), polychlorinated diphenylethers (PCDEs), hexachlorobenzene, and polycyclic aromatic hydrocarbons (PAHs) through fish and seafood consumption by children of Spain (Martí-Cid et al., 2007). Similarly, the estimated dietary intake of dioxins and dioxin-like PCBs in food marketed were also studied for seafood consumers in Spain (Marin, et al., 2011).

Figure 1. GFCM-FAO geographical sub-areas in the Mediterranean Sea.

</td></tr>
<tr><td>Conclusions</td><td></td><td></td></tr>
<tr><td>Conclusions (brief)</td><td>Text (200 words)</td><td>The FAO defined areas in the Mediterranean Sea (Area 37 and their subdivisions), have been investigated and assessed in different research studies for different toxic compounds and commercial species, despite the lack of current harmonization impedes to assess sufficiently this Common Indicator under the IMAP at a regional scale. Overall, no major significant concerns or extreme high levels are observed in relation to these recent research studies and no confirmation based on temporal trends could be performed. Nevertheless, few of these studies presented the percentages of number and levels of contaminants in relation to the EU policy and assessments, and therefore, could be used as indicative assessment in relation the Common Indicator 20.</td></tr>
</table>

Content	Actions	Guidance
Conclusions (extended)	Text (no limit)	The FAO defined areas in the Mediterranean Sea (Area 37 and their subdivisions), have been investigated and assessed in different research studies for different toxic compounds and commercial species, despite the lack of current harmonization impedes to assess sufficiently this Common Indicator under the IMAP at a regional scale. Overall, no major significant concerns or extreme high levels are observed in relation to these recent research studies and no confirmation based on temporal trends could be performed. Nevertheless, few of these studies presented the percentages of number and levels of contaminants in relation to the EU policy and assessments, and therefore, could be used as indicative assessment in relation the Common Indicator 20. For example, Naccari et al (2015), reported the residual levels of Pb, Cd and Hg in different species, caught from FAO zones around Italy; particularly, small pelagic, benthic and demersal fishes. Whilst in all samples was observed the absence of Pb, small concentrations of Cd and higher Hg levels were found, as well as differences between the two subdivisions. Only Cd concentrations exceeded the EU regulatory limits in different fish species, despite a large number of uncontaminated samples, 67%, 84% and 62% for Cd in mackerel, mullet and seabream, respectively. A recent study with tuna (*Thunnus thynnus*) in Mediterranean FAO areas, shown that residues of PCBs and PBDEs are present. The study concludes that the Mediterranean area was the most polluted for these chemical compounds (Figure 2) compared to other evaluations presented in FAO areas worldwide (Chiesa et al., 2016). Figure 2. Comparison of levels of POPs in different FAO areas worldwide (source: Chiesa et al., 2016). 
Key messages	Text (2-3 sentences or maximum 200 words)	• Chemical contaminants occurrence in fish and shellfish and the possible intake scenarios for population have been studied in different locations of the Mediterranean Sea • Some of the Food and Agriculture Organisation (FAO) delimited zones in the Mediterranean Sea have been investigated for a number of legacy and emerging contaminants. • Pelagic, demmersal and benthic species have been targeted to assess the GES in terms of potential seafood contamination reflecting the health condition of the marine ecosystem • Datasets available to perform an assessment of the Common indicator 20 are scattered in the Mediterranean Sea, mostly from research studies and national databases.
Knowledge gaps	Text (200-300 words)	As this is a new Common Indicator within the context of marine environmental protection policy under the Barcelona Convention (*ca*. Ecosystem Approach and IMAP implementation) its appropriateness, beyond food consumer protection and public health, is based on the capacity to reflect the health status

Content	Actions	Guidance
		of the marine environment in terms of their delivery of benefits (e.g. fisheries industry). The information required to assess this indicator (comparable and quality assured) is clearly lacking on a regional scale, and sub regional to some extent, to be able to perform a complete assessment. Monitoring protocols, risk-based approaches, analytical testing and assessment methodologies would need to be further developed and focus on the homogenization between Contracting Parties. The liason with national food safety authorities, research organisations and/or environmental agencies will be required.
List of references	Text	Examples: UNEP/MAP (2016). Decision IG.22/7 - Integrated Monitoring and Assessment Programme (IMAP) of the Mediterranean Sea and Coast and Related Assessment Criteria. COP19, Athens, Greece. United Nations Environment Programme, Mediterranean Action Plan, Athens. FAO/WHO, 2011. Report of the Joint FAO/WHO Expert Consultation on the Risks and Benefits of Fish Consumption. Rome, Food and Agriculture Organization of the United Nations; Geneva, World Health Organization, 50 pp. UNEP, 2002. Chemicals 2002 Global Mercury Assessment Geneva (Switzerland) December 2002, p. 244. United Nations Environment Programme. Official Journal of the European Union, 2006. Commission Regulation (EU) No 1881/2006 of 19 December 2006 setting maximum levels for certain contaminants in foodstuffs. L 364/5–23. Official Journal of the European Union, 2011. Commission Regulation (EU) No 1259/2011 of 2 December 2011 amending Regulation (EC) No 1881/2006 as regards maximum levels for dioxins, dioxin-like PCBs and non dioxin-like PCBs in foodstuffs. L 320/18–23. Martí-Cid, R., Bocio, A., et al., 2007. Intake of chemical contaminants through fish and seafood consumption by children of Catalonia, Spain: Health risks. Food and Chemical Toxicology, 45, 1968-1974. Celik, U., Oehlen Schläger, J., 2007. High contents of cadmium, lead, zinc and copper in popular fishery products sold in Turkish supermarkets. Food Control, 18, 258-261. Mol, S. Determination of trace metals in canned anchovies and canned rainbow trouts. Food and Chemical Toxicology, 49, 348-351. Noël, L., Testu, C., et al., 2011. Contamination levels for lead, cadmium and mercury in marine gastropods, echinoderms and tunicates. Food Control, 22, 433-437. Storelli, MM., Barone, G., 2011. Polychlorinated biphenyls (PCBs), dioxins and furans (PCDD/Fs): Occurrence in fishery products and dietary intake. Food Chemistry, 127, 1648-1652. Copat, C., Arena, G., et al., 2013. Heavy metals concentrations in fish and shellfish from eastern Mediterranean Sea: Consumption advisories. Food and Chemical Toxicology, 53, 33-37. Brambilla, G., Abete, M.C., et al., 2013. Mercury occurrence in Italian seafood from the Mediterranean Sea and possible intake scenarios of the Italian coastal population. Koenig, S., Solé, M., et al., 2013. New insights into mercury bioaccumulation in deep-sea organisms from the NW Mediterranean and their human health implications. Sci. Total. Env., 442, 329-335.

Content	Actions	Guidance
		Copat, C., Vinceti, M. et al., 2014. Mercury and selenium intake by seafood from the Ionian Sea: A risk evaluation. Ecotoxicology and Environmental Safety, 100, 87-92. Barone, G., Giacominelli, R., et al., 2014. PCBs and PCDD/PCDFs in fishery products: Occurrence, congener profile and compliance with European Union legislation. Food and Chemical Toxicology, 74, 200-205. Milun, V., Lusic, J., et al., 2016. Polychlorinated biphenyls, organochlorine pesticides and trace metals in cultured and harvested bivalves from the eastern Adriatic coast (Croatia). Chemosphere, 153, 18-27 Giandomenico, S., Cardellicchio, N., 2016. Metals and PCB levels in some edible marine organisms from the Ionian Sea: dietary intake evaluation and risk for consumers. Environ. Sci. Pollut. Res, 23, 12596-12612. Costopoulou, D., Vassiliadou, I., Leondiadis, L., 2016. PCDDs, PCDFs and PCBs in farmed fish produced in Greece: Levels and human population exposure assessment. Chemosphere, 146, 511-518. Elhamri, H., Idrissi, L., 2007. Hair mercury levels in relation to fish consumption in a community of the Moroccan Mediterranean coast, Food Additives & Contaminants, 24:11, 1236-1246. Maggi, C., Lomiri, S., et al., 2014. Environmental Quality of Italian Marine Water by Means of Marine Strategy Framework Directive (MSFD) Descriptor 9. PLoS ONE 9(9): e108463. Naccari, C., Cicero, N., et al. 2015. Toxic Metals in Pelagic, Benthic and Demersal Fish Species from Mediterranean FAO Zone 37. Bull Environ Contam Toxicol, 95, 67–57. Chiesa, L.M., Labella, G.F., et al., 2016. Distribution of persistent organic pollutants (POPS) In wild Bluefin tuna (*Thunnus thynnus*) from different FAO capture zones. Chemosphere, 153, 162-16

Ecological Objective EO9. Contaminants cause no significant impact on coastal and marine ecosystems and human health

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

Content	Actions	Guidance
General		
Reporter	Underline appropriate	**UNEP/MAP/MED POL** SPA/RAC REMPEC PAP/RAC Plan Bleu (BP)
Geographical scale of the assessment	Select as appropriate	Regional: **Mediterranean Sea** Eco-regional: NWM (North Western Mediterranean); ADR (Adriatic Sea); CEN (Ionian and Central Mediterranean Seas); AEL (Aegean and Levantine Sea) Sub-regional: Please, provide appropriate information
Contributing countries	Text	**Contracting Parties by research studies**
Core Theme	Select as appropriate	**1-Land and Sea Based Pollution** 2-Biodiversity and Ecosystems 3-Land and Sea Interaction and Processes
Ecological Objective	Write the exact text, number	**EO9. Contaminants cause no significant impact on coastal and marine ecosystems and human health**
IMAP Common Indicator	Write the exact text, number	**CI21. Percentage of intestinal enterococci concentration measurements within established standards**
Indicator Assessment Factsheet Code	Text	**EO9CI21**
Rationale/ Methods		
Background (short)	Text (250 words)	The Mediterranean Sea continues to attract every year an ever increasing number of international and local tourists that among their activities use the sea for recreational purposes. Up to 2005, the number of sewage treatment plants doubled with respect the precedent decade and the water quality with regard to fecal pollution clearly improved (UNEP/MAP MED POL, 2010). The establishment of sewage treatment plants and the construction of submarine outfall structures have decreased the potential for microbiological pollution; despite few major coastal hotpots still exist. A revision of the Mediterranean guidelines for bathing water quality were formulated in 2007 based on the WHO Guidelines for Safe Recreational Water Environments (WHO, 2003) and on the EC Directive for

<table>
<tr><th>Content</th><th>Actions</th><th>Guidance</th></tr>
<tr><td></td><td></td><td>Bathing Waters (Directive 2006/7/ EU). The proposal was made in an effort to provide updated criteria and standards that could be used in the Mediterranean countries, as well as to harmonize their legislation in order to provide homogenous information and data (UNEP/MAP, 2012). High levels of enterococci bacteria in recreational marine waters (coasts, beaches, tourism spots, etc) are known to be indicative of human pathogens due to non-treated discharges into the marine environment and cause human infections (Kay et al., 2004; Mansilha et al, 2009). Therefore, these standards for bathing waters quality in the framework of the implementation of Article 7 of the LBS Protocol should be further used to define GES for the indicator on pathogens in bathing waters.

Image provided:
Mudsedimentsample_CGuitart.jpg
Description: Kitesurf activities promote the use of the coastal bathing waters throughout the year.</td></tr>
<tr><td>Assessment methods</td><td>Text (200-300 words) images, formulae, URLs</td><td>(The present assessment has been undertaken based on bibliographic references and scientific documents in the Mediterranean Sea, as no original datasets at regional scale are available).

The assessment of Common Indicator 21will be based on the statistics from datasets submitted by local national authorities or/and the correspondant environment agency. Standard of application within IMAP Common Indicator 21 will be the proposed criteria by the EC Directive for “Bathing Waters” (EU/2006/7). See table below:

Table 1
Table of the proposed new requirements for coastal waters and transitional waters.
<table>
<tr><th></th><th>A
Parameter</th><th>B
Excellent quality</th><th>C
Good quality</th><th>D
Sufficient</th><th>E
Reference methods of analysis</th></tr>
<tr><td>1</td><td>Intestinal enterococci (cfu/100 ml)</td><td>100*</td><td>200*</td><td>185**</td><td>ISO 7899-1 or ISO 7899-2</td></tr>
<tr><td>2</td><td>Escherichia coli (cfu/100 ml)</td><td>250*</td><td>500*</td><td>500**</td><td>ISO 9308-3 or ISO 9308-1</td></tr>
</table>
(taken from DIRECTIVE 2006/7/EC of the European parliament and of the council of 15 February 2006).
* Based upon a 95-percentile evaluation.
** Based upon a 90-percentile evaluation.</td></tr>
<tr><td>Background (extended)</td><td>Text (no limit), images, tables, references</td><td>The Mediterranean Sea continues to attract every year an ever increasing number of international and local tourists that among their activities use the sea for recreational purposes. Up to 2005, the number of sewage treatment plants doubled with respect the precedent decade and the water quality with regard to fecal pollution clearly improved (UNEP/MAP MED POL, 2010). The establishment of sewage treatment plants and the construction of submarine outfall structures have decreased the potential for microbiological pollution; despite few major coastal hotpots still exist. Therefore, enterococci concentrations are frequently used as a faecal indicator bacteria, or general indicators of faecal contamination. Particularly, E. faecalis and E.faecium species are related to urinary tract infections, endocarditis, bacteriema, neonatal infections, central nervous system, abdominal and pelvic infections. It has been also shown a correlation between elevated levels of enterococci and the risks of human gastroenteritis. It has been</td></tr>
</table>

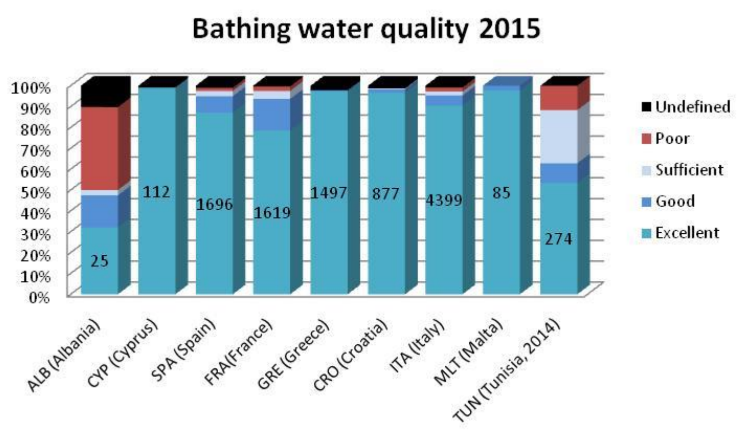
<table>
<tr><th>Content</th><th>Actions</th><th>Guidance</th></tr>
<tr><td></td><td></td><td>suggested and later on demonstrated that enterococci sp. might be more appropriate than traditional Escherichia coli in marine waters as an index of faecal pollution. Currently, is the only faecal indicator bacteria recommended by the US Environmental Protection Agency (EPA) for brackish and marine waters, since they correlate better than faecal coliforms or E.coli. The abundance in human and animal feces and the simplicity of the analytical methods for their measurements has favoured the use of entorococci as a surrogate of polluted recreational waters, and therefore, as a Common Indicator for GES under EO9. The World Health Organisation has been concerned with health aspects of the management of water resources for many years and published various documents concerning the safety of the water environment, including marine waters, and its importance for health. A revision of the Mediterranean guidelines for bathing water quality were formulated in 2007 based on the WHO Guidelines for Safe Recreational Water Environments (WHO, 2003) and on the EC Directive for Bathing Waters (Directive 2006/7/ EU). The proposal was made in an effort to provide updated criteria and standards that could be used in the Mediterranean countries, as well as to harmonize their legislation in order to provide homogenous information and data (UNEP/MAP, 2012). High levels of enterococci bacteria in recreational marine waters (coasts, beaches, tourism spots, etc) are known to be indicative of human pathogens due to non-treated discharges into the marine environment and cause human infections (Kay et al., 2004; Mansilha et al, 2009). Therefore, these standards for bathing waters quality in the framework of the implementation of Article 7 of the LBS Protocol should be further used to define GES for the indicator on pathogens in bathing waters.</td></tr>
<tr><td>Results</td><td></td><td>NOTE: If the assessment has been performed at different geographical scales, include the results and conclusions accordingly.</td></tr>
<tr><td>Results and Status, including trends (brief)</td><td>Text (500 words), images</td><td>Despite datasets of most of the Eastern and Southern Mediterranean countries are not available, and therefore, the full assessment at regional scale of the Common Indicator 21 is not possible; about a 90% or higher of the sites monitored during the bathing season in 2015 in Contracting Parties of the Barcelona Convention are classified as excellent or good. Exceptions are Albania and Tunisia were around a 40% and 10%, respectively, show a poor sanitary condition of the bathing and recreational waters. The temporal trends were calculated by the EEA (EEA, 2015) and exhibit an steady-state for almost all the countries with respect the number of acceptable sites were bathing water quality is controlled.</td></tr>
<tr><td>Results and Status, including trends (extended)</td><td>Text(no limit), figures, tables</td><td>

Figure 1. Percentages of the bathing water quality assessment with respect Common Indicator 21 for 2015 (source: EEA, 2015 and MED POL Database for Tunisia).

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Content	Actions	Guidance
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Conclusions		
Conclusions (brief)	Text (200 words)	The implementation of measures (e.g. sewage treatment plants) to reduce, among others, the fecal pollution in coastal waters, has been a story-of-success in the Mediterranean Sea. The generalization of the domestic waters depuration in a number of countries the latest decades has demonstrated the benefits of implementing the LBS protocol, despite some improvements still need to be made to solve few coastal issues.
Conclusions (extended)	Text (no limit)	The implementation of measures (e.g. sewage treatment plants) to reduce, among others, the fecal pollution in coastal waters, has been a story-of-success in the Mediterranean Sea. The generalization of the domestic waters depuration in a number of countries the latest decades has demonstrated the benefits of implementing the LBS protocol, despite some improvements still need to be made to solve few coastal issues.
Key messages	Text (2-3 sentences or maximum 200 words)	• Initial target of GES under Common Indicator 21 would be an increasing trend in measurements to test that levels of intestinal enterococci comply with established national or international standards and the methodological approach itself. • Water quality classification under the EU 2006/7 Directive is defined as excellent (95^{th} percentile < 100 CFU/100 mL), good (95^{th} percentile < 200 CFU/100 mL) and sufficient (90^{th} percentile < 185 CFU/100 mL) for intestinal enterococci.
Knowledge gaps	Text (200-300 words)	The lack of recent datasets on microbiological pollution in the Mediterranean Sea submitted to MED POL / MAP Secretariat is the main concern, and therefore, to be able to monitor the progresses under the Common Indicator 21.
List of references	Text	UNEP/MAP, 2012. Decision IG.20/9. Criteria and Standards for bathing waters quality in the framework of the implementation of Article 7 of the LBS Protocol. COP17, Paris, 2012. UNE/MAP MED POL, 2010. Assessment of the state of microbial pollution in the Mediterranean Sea. MAP Technical Reports Series No. 170 (Ammended). WHO, 2003. Guidelines for safe recreational water environments. VOLUME 1: Coastal and fresh waters. WHO Library. ISBN 92 4 154580. World Health Organisation, 2003. Directive 2006/7/EC of the European Parliament and of the council of 15 February 2006 concerning the management of bathing water quality and repealing Directive 76/160/EEC Mansilha, C.R., Coelho, C., et al., 2009. Bathing waters: New directive, new standards, new quality approach. Mar. Poll. Bull. 58, 1562-1565. Kay, D., Bartram, J., et al., 2004. Derivation of numerical values for the World Health Organization guidelines for recreational waters. Water Research, 38, 1296-1304.

Content	Actions	Guidance
		EEA, 2015. European bathing water quality in 2015. EEA Report. No 9/2016. Luxembourg: Publications Office of the European Union, 2016.