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Meeting of the Ecosystem Approach Correspondence Group on Pollution Monitoring

Podgorica, Montenegro, 2-3 April 2019

Approaches on Scales of Monitoring for Common Indicators related to pollution

Agenda item 6: Monitoring Protocols for IMAP Common Indicators Related to Pollution

UNEP/MAP
Athens, 2019

Note by the Secretariat

At their 19th Ordinary Meeting (COP 19, Athens, Greece, 9-12 February 2016), the Contracting Parties to the Convention for the Protection of the Marine Environment and the Coastal Region of the Mediterranean (Barcelona Convention) in Decision IG.22/7 adopted a novel and ambitious Integrated Monitoring and Assessment Programme and related Assessment Criteria (IMAP). At the 20th Ordinary Meeting (COP20, Tirana, Albania, 17-20 December 2017), the Contracting Parties endorsed in Decision IG.23/6 the key findings of the 2017 MED QSR (the QSR Decision); underlined the gaps of the 2017 MED QSR; and requested the Secretariat to make all possible efforts to overcome them.

The Contracting Parties recommended as general directions towards a successful 2023 Mediterranean Quality Status Report (2023 MED QSR): (i) harmonization and standardization of monitoring and assessment methods; (ii) improvement and ensuring availability of long time series of quality assured data to monitor the trends in the status of the marine environment; (iii) improvement of availability of synchronized datasets for marine environment state assessment, including use of data stored in other databases where some of the Mediterranean countries regularly contribute; and (iv) improvement of data accessibility with the view to improving knowledge on the Mediterranean marine environment, ensuring that Info-MAP System is operational and continuously upgraded to accommodate data submissions for all the IMAP Common Indicators.

It must be noted that the 'scales' of assessment and monitoring, both in terms of geographical dimensions (spatial scale) and timely representativeness (temporal or period scales), present one of the key issues to perform assessments within implementation of IMAP. Those scales need necessarily to be established and reviewed according to the protection objectives. The scales approach is the primary conceptual scheme both to monitor and assess the marine ecosystems. In this sense, the monitoring and assessment scales are a transversal characteristic to be defined which should allow, ultimately, the integrated assessment of the IMAP Ecological Objectives with the aim to evaluate GES.

The elements of relevance for scales of monitoring and assessment have been discussed in different meetings since the adoption of the IMAP, including the Meeting of the Ecosystem Approach Correspondence Group on Pollution Monitoring (CorMon on Pollution Monitoring) held in Marseilles, France, 19-21 October 2016. During this Meeting, occasional good practices for developing monitoring assessment scales in Europe were presented by the European Environmental Agency (EEA). The temporal and geographical scales of monitoring, reporting and assessment to further develop IMAP were also considered by the Science-Policy Interface Workshop on Scales of Monitoring and Assessment and on the draft Quality Status Report which was held in Nice, France, 27-28 April 2017.

To further develop the monitoring and assessment scales for IMAP Common Indicators, several guidance and directions of importance for future work were noted by the the Regional Meeting on IMAP Implementation: Best Practices, Gaps and Common Challenges (IMAP Best Practices Meeting), held in Rome, Italy, 10-12 July 2018 and further elaborated in the document related to cross-cutting issues (UNEP/MED WG.463/5). This issue is further elaborated in the present document whereby the approaches of scales of monitoring are submitted for consideration of the present Meeting of CorMon on Pollution Monitoring.

In that respect, this document culminates the efforts of the Secretariat to initiate and guide discussions of the present Meeting of CorMon on Pollution on scales of monitoring; providing at the same time direction to the Contracting Parties and MED POL on future work for selection of the spatial monitoring scales under IMAP in relation to current practices (i.e. definition of Mediterranean sub-divisions within sub-regions).

To this aim, it is imperative for the Meeting to consider the scales of monitoring along with the scales of assessment as a condition to define the "adequate" nested approach of the monitoring units into assessment scales. It is important to understand the obligations that Contracting Parties hold in relation to the monitoring, and therefore, to define the monitoring accordingly in order to provide data which will allow the assessment for each Ecological Objective at the most appropriate scale.

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List of Abbreviations / Acronyms

CI	Common Indicator
COP	Conference of the Parties
CORMON	Correspondence Group on Monitoring
EEA	European Environmental Agency
EO	Ecological Objective
EU	European Union
GES	Good Environmental Status
HELCOM	Baltic Marine Environment Protection Commission - Helsinki Commission
IMAP	Integrated Monitoring and Assessment Programme of the Mediterranean Sea and Coast and Related Assessment Criteria
MAP	Mediterranean Action Plan
MED POL	Programme for the Assessment and Control of Marine Pollution in the Mediterranean Sea
MED QSR	Mediterranean Quality Status Report
MSFD	Marine Strategy Framework Directive
MRU	Marine Reporting Unit
OSPAR	Convention for the Protection of the Marine Environment for the North-East Atlantic

1. Background

1. The definition of the scales of monitoring and assessment are both key and essential steps within initial phase of IMAP implementation (2016-2019). The geographical and temporal scales for monitoring and assessment have been considered since the adoption of the UNEP/MAP IMAP and remain a cross-cutting issue as the holistic and integrated assessments between IMAP Ecological Objectives and Common Indicators requires, however, properly defined fit-for-purpose scales with the possibility of the aggregation from national to regional level (i.e. nested approach).

2. The nested approach (Figure 1) is the working rule within IMAP. It could be defined as the optimal monitoring and assessment spatial strategy which should allow both 'zoom in' and 'zoom out' geographically (and temporally), whilst maintaining the structure, significance and adequacy of the environmental monitoring data information to assess the Good Environmental Status (GES) objectives under IMAP.

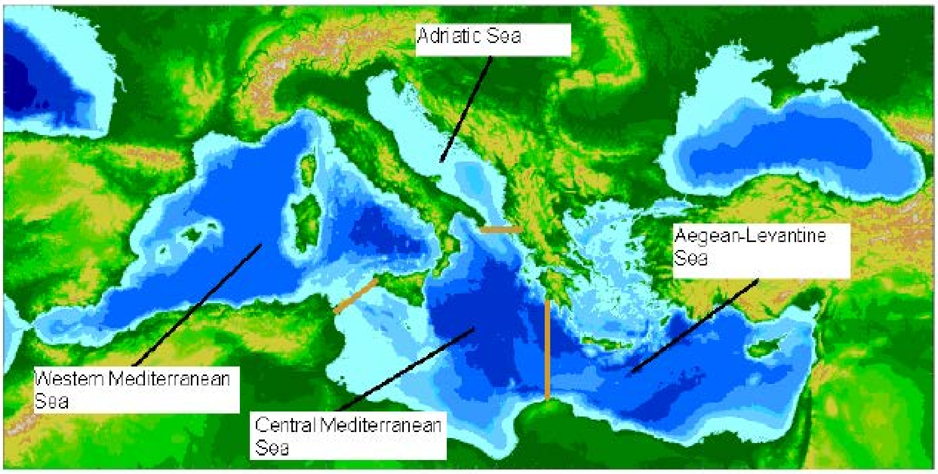

Figure 1. The four Mediterranean MEDPOL sub-regions (WMS, Western Mediterranean Sea; ADR, Adriatic Sea; CEN, Central Mediterranean and AEL, Aegean and Levantine Seas)

3. A nested scale system is considered as one of the best-fitted approaches in the view of GES assessment by by the the Regional Meeting on IMAP Implementation: Best Practices, Gaps and Common Challenges (IMAP Best Practices Meeting), Rome, Italy, 10-12 July 2018. This meeting confirmed a need of providing consistency and clarity on the scales/areas to be used for monitoring as the basis for the Contracting Parties to further work together at regional level to develop the nested approach as an operational mechanism.

4. Therefore, the definition and achievement of the targets and objectives for each Ecological Objective depends on its characteristics, its available (and practical) monitoring and assessment methodologies, as well as on their scales of assessment. The scales of monitoring and assessment are then fit-for-purpose according the general or specific objectives to be covered according to the environmental threat. The geographical complexity of the land-sea interfaces and sea-bottom interfaces, from both bi- and tri-dimensional points of view, originates even more difficulties in the simplification of the scales to be addressed from an ecosystem point of view. It is worth to mention here, that temporal scales are also a key element to achieve an integrated monitoring and assessment program implementation.

5. On the other hand, the administrative boundaries of the Contracting Parties on the Mediterranean Sea, beyond ecosystem-based considerations (ca. economical), may play also a main role in defining the scales for IMAP monitoring and assessment. Therefore, the scale concept is important in policy-making, including the fact that financial resources for monitoring are limited and

should be allocated in a cost-efficient way. The harmonization of the scales approach within Contracting Parties is the starting point to scale up the marine assessment to sub-regional and regional scales in a later stage as required under IMAP.

6. Thus, the establishment of the monitoring and assessment scales for the IMAP implementation has to take into account both the ecosystem characteristics and the administrative boundaries of the Contracting Parties that actually determine the spatial range of adopted measures. This approach is an extension of the learning process and practical implementation through the strategies performed under the MED POL Program since it started, taking also into account that within IMAP, marine pollution monitoring complexity is increased in accordance with the enlargement of the ecosystem components to be monitored and assessed.

7. In the Mediterranean Sea region, the four main areas have been established for assessment purposes (as tabulated in Table 1 below) namely: the Western Mediterranean Sea (including the Alborán Sea characterized by the exchange of the Mediterranean waters with the Atlantic Ocean), the Adriatic Sea (which is a double semi-enclosed area by itself and the Mediterranean Sea), the Central Mediterranean (acting as the nexus for the eco-regions and located in the centre of the basin with a low anthropogenic influence), and the Aegean and Levantine Sea in the Eastern Mediterranean part.

Table 1. The Mediterranean sub-regions and subareas aggregation according the database sources and availability proposed within the report (UNEP(DEPI)/MED WG.427/Inf.3) and present document.

Sub-regions	Sub-division (e.g. subareas/seas)
Western Mediterranean Sea (WMS)	Alboran Sea (ALBS) North Western Mediterranean Sea (NWMS) Tyrrhenian Sea (TYRS) Western Mediterranean Islands and Archipelago (WMIA)
Adriatic Sea (ADR)	North Adriatic (NADR) Middle Adriatic (MADR) South Adriatic (SADR)
Central Mediterranean (CEN)	Central Mediterranean (CEN) Ionian Sea (IONS)
Aegean and Levantine Seas (AEL)	Aegean Sea (AEGS) Levantine (LEVS)

8. The scale concept reflects the necessity to clearly define the extent of the integrated monitoring, reporting and assessment, as it has been implemented in similar Regional Conventions (i.e. HELCOM, OSPAR), and included as an example in this document (Annex I).

9. In HELCOM's view, the various hierarchical sub-division levels can be used depending on the needs. The configuration composed of the 17 open sub-basins and 40 coastal areas (i.e. individually listed off-shore and coastal areas for unequivocal reference) conform the basic divisions to be used.

10. In the OSPAR, the five sub-areas continue to be the main reference to perform marine assessments in the northeast Atlantic (OSPAR regions I to V). In the earlier assessments carried out by the OSPAR States (OSPAR, 2008), different geographical scales for identifying individual assessment areas were used, ranging from small individual fjords to large coastal strips. A total of 204 assessment areas were used in the 2008 assessment, whilst for the elaboration of the Intermediate Assessment Report 2017, the marine reporting units were categorized in four levels (i.e. Level 0-4, being Level 0 the entire OSPAR area).

11. The scales theme within the marine regional strategies were presented in the document "Good Practices for developing Monitoring Assessment Scales in Europe" by the European Environmental

Agency (EEA) at the Meeting of the Ecosystem Approach Correspondence Group on Pollution Monitoring (Marseille, France, 19-21 October 2016) and at the Science-Policy Interface Workshop on Scales of Monitoring and Assessment and on the draft Quality Status Report in Nice, France, 27-28 April 2017 organised by Plan Blue.

12. The scope of this document is to provide a concrete guidance and updated examples, as well as to propose a step forward in the selection of the spatial scales under IMAP in relation to current practices for a harmonized understanding by Regional Sea Conventions.

1.1. Mediterranean scales of existing monitoring programs related to eutrophication (EO5) and pollution (EO9).

13. The MED POL Programme for pollution monitoring, historically, has had its sampling sites located in the coastline, coastal waters and coastal sediments within the territorial waters of the Contracting Parties (Figure 2). The spatial resolutions of the selected areas and sampling stations were selected according to the known anthropogenic pressures and impacts; and therefore, classified as hotspots, coastal and reference sites. With regard to the eutrophication phenomena the spatial scale covers the major known sites for land-based inputs of nutrients (such as river mouths and wastewater treatment plants); whilst, in relation to chemical pollution the compartments sampled are marine sentinel organisms (primarily, bivalves species) and coastal sediments in depositional and stable areas.

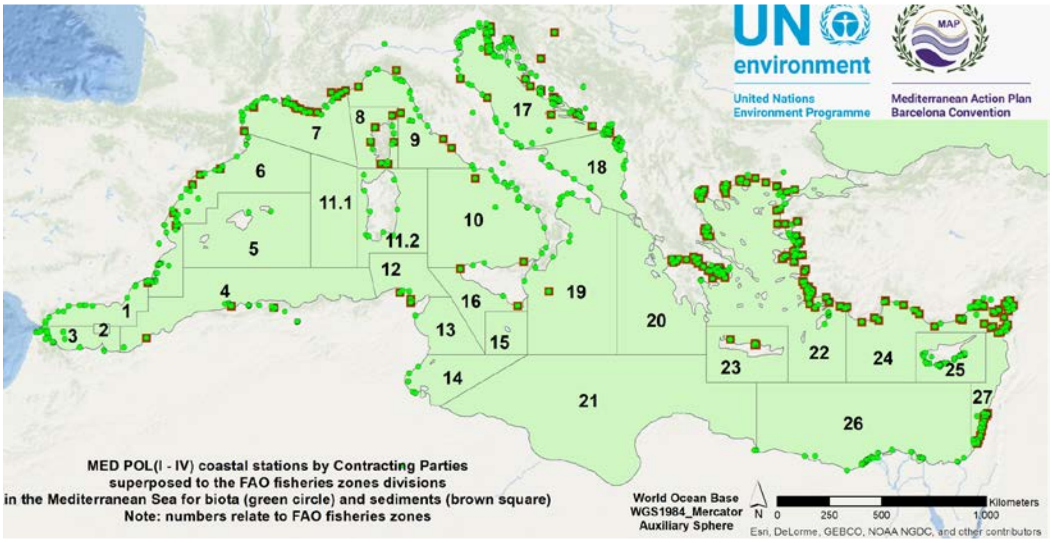

Figure 2. MED POL Monitoring networks

14. In the recent decades the growing number of coastal and offshore economic activities, have driven the expansion of the spatial scale for potential monitoring under EO9. This fact is being taken into account, for example, under the Barcelona Convention Offshore Protocol (Protection of the Mediterranean Sea against Pollution resulting from Exploration and Exploitation of the Continental Shelf, the Seabed and its Subsoil). Furthermore, the maritime activities and maritime traffic routes in the Mediterranean Sea could be indicated as sea-based sources of marine pollution in relation to the Common Indicators, particularly for EO9.

15. The selection of the spatial scales under IMAP needs to closely relate to the temporal scales of monitoring. With regards to the existing temporal scales for monitoring eutrophication and chemical pollutants, it must be noted these have resulted in the balance of both program requirements and actual capabilities, after almost four decades of MED POL Programme implementation in the Mediterranean Sea by the Contracting Parties of the Barcelona Convention. On the other hand, for eutrophication, temporal scales should respond to minimum yearly episodes (spring and winter in the Mediterranean Sea), and yearly data for chemical pollution. Under IMAP, the monitoring of the so-called ‘legacy

pollutants' might undertake a revision of the frequencies in monitoring, whilst pilot studies should be undertaken for the 'emerging contaminants' in the marine environment with increased frequency until sufficient information will be collected. However, it should be pointed here that the MED POL Programme established a clear harmonized methodology between the Contracting Parties for temporal trends assessment of chemical pollution, taking into account the within- and between- annual variabilities which relates to national monitoring methodologies and has been very successful for MED POL implementation during its Programme Phases III and IV. Despite harmonization and scientific-based temporal assessment approaches linked to monitoring strategies, the major issue with regard to the temporal scope for monitoring has been the gaps in the temporal series of datasets for some countries due to different causes beyond science, as well as the data uncertainty conflicting with the achievement of the desired statistical power.

16. The next sections present the relevant spatial and temporal scales for the Common Indicators as recommended within the IMAP Indicator Guidance Factsheets, for proper monitoring and reporting.

1.2. Eutrophication (EO5)

17. As included in the IMAP indicator Guidance Factsheets, for **Common Indicators 13 (concentration of key nutrients in water column)** and **14 (Chlorophyll-a)**, the geographical scale of monitoring for eutrophication depends on the hydrological and morphological conditions of an area (e.g. freshwater inputs from rivers, stratification and upwelling to mention few). The spatial distribution of the monitoring stations should, prior to the establishment of the eutrophication status of the marine sub-region/area, be risk-based and proportionate to the anticipated extent of eutrophication and aiming for the determination of spatially homogeneous areas. The eutrophication monitoring programmes should pursue to assess eutrophication phenomena, based on the differentiation of the scale and time dependant signals from human-induced versus natural eutrophication.

18. In the Mediterranean Sea latitudes, in general terms, the pre-summer and winter primary production bloom intensity peaks of natural eutrophication will define the strategy for the sampling frequency, although year-round measurements of eutrophication parameters could be performed. The optimum frequency (either seasonal 2 to 4 times per year or monthly 12 times per year) for monitoring at the selected stations should be chosen taking into account the necessity to control the deviations of the known natural cycles of eutrophication in coastal areas and the control of (decreasing) trends monitoring in impacted areas.

1.3. Chemical Pollution (EO9)

19. As included in the IMAP indicator Guidance Factsheets, the spatial scope for monitoring **Common Indicator 17 (chemical contaminants) and 18 (biological effects of contaminants),** should include long-term master stations, distributed spatially as relevant and include local spatial refinements, such as transect sampling (for sediment and/or active biomonitoring); and furthermore, should be based on Risk-Based Approaches (RBA). Therefore, the selection of the sampling sites for the monitoring of contaminants and biological effects in the marine environment should consider hotspots/risk areas, coastal locations and reference areas. The selected sites should allow the collection of a feasible number of samples over the years (e.g. be suitable for sediment sampling, allow sampling for a sufficient number of biota for the selected species during the duration of the program). It is essential that the monitoring strategies will be coordinated at regional and/or sub regional level. Furthermore, the coordination with the monitoring for other Ecological Objectives is crucial for cost-effective and future integrated monitoring and assessment.

20. The sampling frequencies will be determined by the purpose and the development status of the national marine monitoring with regard to the MEDPOL Programme, taking into account two phase monitoring in accordance with IMAP: a) Initial phase monitoring: Biota (bivalves sampled yearly) and Sediments (coastal every two years), which respond to a screening monitoring phase to be revised later on, and b) Advanced phase monitoring (e.g. countries with fully completed and reported MEDPOL

Phase IV datasets): Biota (from 1 to 3 years according trends and chemicals) and Sediments (from 3 to 6 years depending on the characteristics of sedimentation areas and the chemical concerned). In this latter phase, it could be possible to decrease the sampling frequencies and target chemicals (i.e. legacy pollutants) in cases where established time trends and levels show concentrations well below levels of concern (i.e. IMAP assessment criteria), and without any upward trend over a number of years, while a minimum monitoring should be maintained. For trend determinations the sampling frequencies (yearly recommended) will depend on the ability to detect trends considering the environmental noise and the analytical variability (ca. total uncertainty).

21. Regarding **Common Indicator 19** (acute pollution events), the Regional Marine Pollution Emergency Response Centre for the Mediterranean Sea (REMPEC); one of the components of the UN Environment / MAP system, continues to be the central organisation coordinating and maintaining a database on oil and HNS acute events, supplied by Contracting Parties. As oil and HNS pollution incidents from ships occur unexpectedly or are not systematic (as a consequence of maritime casualties, illicit discharges, etc.), it is expected that acute pollution monitoring will continue to be reported "in near-real time" when pollution incidents actually occur or are detected or immediately afterwards.

22. The **Common Indicator 20 (contaminants in seafood)** should be based on risk-based methodologies, despite the temporal scope, and is highly linked to the data confidence and uncertainty of the indicator. Yearly statistics would be the basic time period for assessments. This common indictor is equivalent to Descriptor 9 under the EU Marine Strategy Framework Directive (MSFD), and to this regard, a scientific paper published by Italian scientist could serve here, as an example of the monitoring scales and assessment methods involved (Maggi et al., 2014).

23. The temporal scope for monitoring under **Common Indicator 21 (microbial pathogens)** is currently based under different international, regional and national policy. The spatial scale of this common indictor is locally selected in bathing waters sites where microbiological pollution could threaten the recreational uses. A temporal guideline for control and monitoring can be found in the EU Directive 2006/7EC. In practice, the updated legislation with respect to bathing water quality control recently introduced in the European countries (following the update of the World Health Organization) reduces significantly the number of analysis to be performed with regard this Common Indicator and should be considered in a regional scale in the Mediterranean Sea.

1.4. Temporal and spatial scales defined for EO5 and EO9

24. Table 2 below summarizes the temporal and spatial scales defined within the IMAP Guidance Factsheets for Common Indicators related to eutrophication (EO5) and pollution (EO9) whilst detailing those by parameters to be measured and reported.

Table 2. Summary of mandatory parameters and reporting scales under each IMAP Common Indicator (CIs) for EO5 and EO9.

CIs	Parameters	Temporal scale (period)	Spatial scale (geographical)	Remarks
CI13	• Ammonium • Nitrite • Nitrate • Total Nitrogen • Orthophosphate • Total Phosphorous • Orthosilicate	Eutrophic – mesotrophic: monthly, mesotrophic – oligotrophic: monthly near the coast, bimonthly in open waters, and oligotrophic: bimonthly near the coast, seasonally in open waters.	Regional, sub-regional, subdivision, coastal cases	The temporal scale is calculated from the number of samples needed to discriminate two adjacent mean values. The spatial scale depends on the hydrography and underlying processes in certain area.

CIs	Parameters	Temporal scale (period)	Spatial scale (geographical)	Remarks
		For open waters sampling frequency to be determined on a sub-regional level following a risk-based approach.		
CI14	• Chlorophyll *a* • Dissolved Oxygen • Transparency	Eutrophic – mesotrophic: monthly, mesotrophic – oligotrophic: monthly near the coast, bimonthly in open waters, and oligotrophic: bimonthly near the coast, seasonally in open waters. For open waters sampling frequency to be determined on a sub-regional level following a risk-based approach.	Regional, sub-regional, subdivision, coastal cases	The temporal scale is calculated from the number of samples needed to discriminate two adjacent mean values. The spatial scale depends on the hydrography and underlying processes in certain area. Supporting parameters as are temperature and salinity can be measured with higher frequency and resolution than the CI parameter. Specifically, salinity as serve for the definition of the water typology.
CI17	IN MARINE BIOTA: • Trace/Heavy Metals (TM): Total mercury (HgT), Cadmium (Cd) and Lead (Pb) • Organochlorinated compounds (PCBs, Hexachlorobenzene, Lindane and ΣDDTs) • Polycyclic Aromatic Hydrocarbons (PAHs) IN MARINE SEDIMENTS: In coastal and marine areas, continental platform and offshore, sediments should be collected by mechanical means and processed at the laboratory (< 2 mm particle size fraction). Further the following hazardous substances should be measured: • Trace/Heavy Metals: Total mercury (HgT),	Initial phase: biota to be sampled yearly and sediments every two years with the purpose to collect environmental information. Advanced phase: biota to be sampled every 1-3 years and sediments between 3-6 years.	The spatial scale corresponds to the coastal networks of MEDPOL monitoring stations for biota, whilst for sediment the continental platform should be sampled.	-

CIs	**Parameters**	**Temporal scale (period)**	**Spatial scale (geographical)**	**Remarks**
	Cadmium (Cd) and Lead (Pb) • Organochlorinated compounds (PCBs (at least, congeners 28, 52, 101, 118, 138, 153, 180, 105 and 156), aldrin, dieldrin, Hexachlorobenzene, Lindane and ΣDDTs) • Polycyclic Aromatic Hydrocarbons (PAHs)			
CI18	In marine bivalves (such as *Mytilusgalloprovincialis*) and/or fish (such as *Mullus barbatus*) • Lysosomal Membrane Stability (LMS) as a method for general status screening. • Acetylcholinesterase (AChE) assay as a method for assessing neurotoxic effects in aquatic organisms. • Micronucleus assay as a tool for assessing cytogenetic/DNA damage in marine organisms.	Initial phase: biota to be sampled yearly as for CI17. In an advance phase, the objective should be to integrate both chemical and biological monitoring	Idem as CI17	The objective should be to integrate the chemical and biological monitoring
CI19	• Oil spills reporting over 50 tonnes	Any	Any	The occurrence of oil spill above this volume are normally related to environmental accidents
CI20	• Number of detected regulated contaminants* in commercial species. • Number of detected regulated contaminants* exceeding regulatory limits. (*lists of regulated contaminants can be found in the links from the previous section, including the European Regulation EU 1881/2006)	Risk-based methodologies are recommended. The temporal scope is highly linked to the data confidence and uncertainty of the indicator. Yearly statistics would be the basic time period.	In line with monitoring strategies set for CI17 and larger spatial scales according risk-based methodologies	Alignment with the CI17 biota monitoring and assessment should be established.

CIs	**Parameters**	**Temporal scale (period)**	**Spatial scale (geographical)**	**Remarks**
CI21	• The concentration (Colony-forming unit, CFU) of intestinal enterococci in the water sample (normalised to 100 mL) collected at one beach location.	Regulations set under Decision IG.20/9. (Criteria and Standards for bathing waters quality), as well as the EU Directive 2006/7EC.	Coastal waters (sampling should be performed in recreational waters where microbiological pollution could threat the recreational uses).	

2. Possible directions for selection of the spatial monitoring scales under IMAP

25. This section summarizes main findings related to definition of the “adequate” nested approach of the monitoring units into assessment scales for the main Common Indicators with regard to EO5 and EO9.To that aim it furthermore indicates possible directions on future work for selection of the spatial monitoring scales under IMAP in relation to current practices.

26. For a complete assessment of eutrophication (EO5) and GES achievement, the reference conditions (natural background concentrations) are needed not only for chlorophyll-a, but such values must be set in the near future for nutrients, transparency and oxygen as minimum requirements. However, the spatial coverage and differences between areas will hinder the assessment of thresholds unless a nested approach would be clearly defined and joint efforts and comparative exercises at regional/sub-regional/subdivision levels in the Mediterranean area are performed. For Common Indicator 14 it should be mentioned that satellite imagery has been applied for more than 30 years now for the understanding of the eutrophication phenomena on a large scale, including harmful algal blooms (e.g. Adriatic Sea). For better integration on the spatial scale for instance Chlorophyll a climatology can be used as shown on Fig. 3. In any case, this available technology and their current developments should continue to be considered.

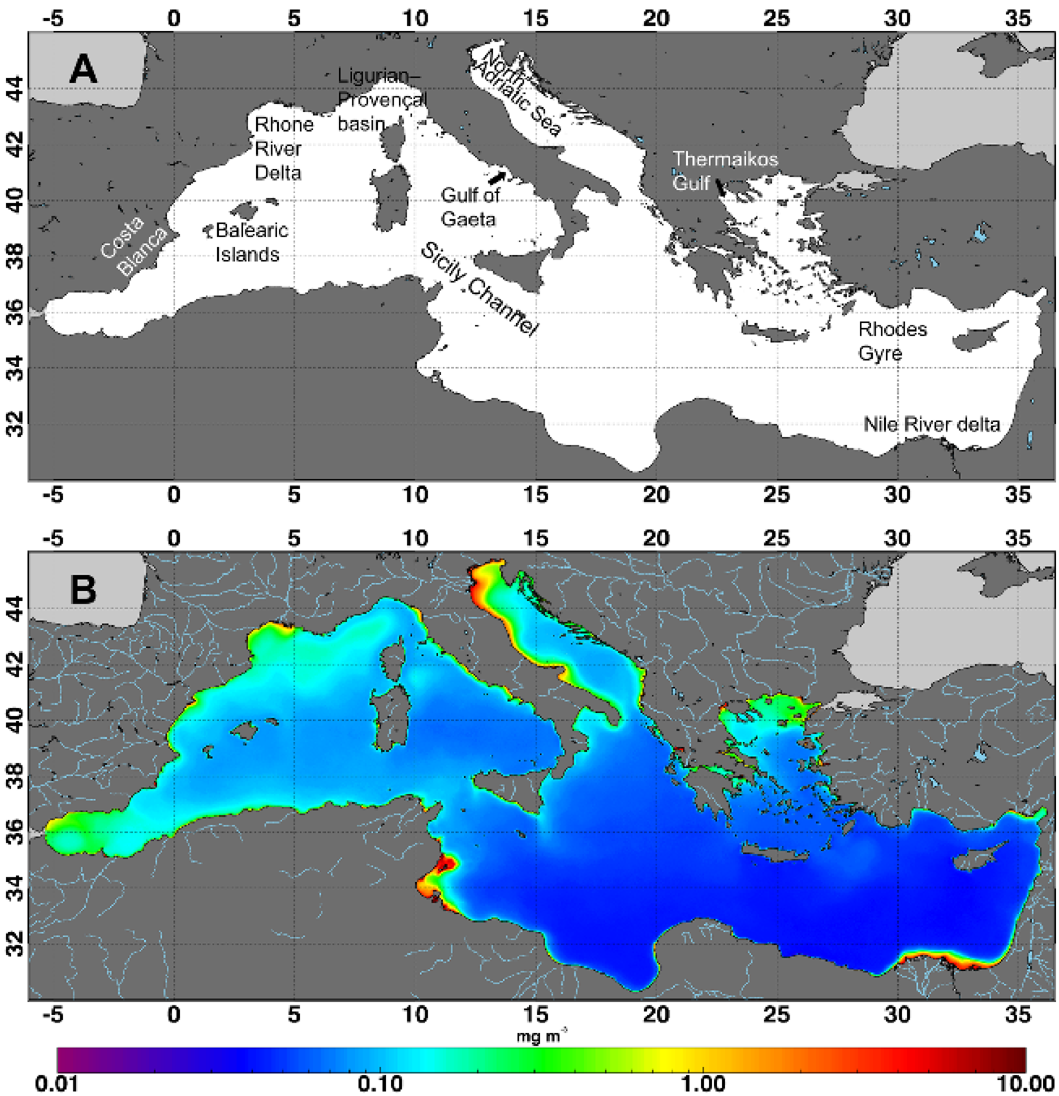

Figure 3. The Mediterranean basin and its chlorophyll *a* concentration pattern. (A) Geographic regions (B) chlorophyll a concentration (µg L^{-1}) climatology over the Mediterranean Sea relative to 1998–2009 time period. From: Colella *et al.*, 2016.

27. Differences that arise from complex hydrological processes in some areas as are estuaries (northern Adriatic, Gulf of Lyon, northern Aegean Sea, Nile Delta) or exchange areas as the Gibraltar strait, will pose great challenges in the definition of homogeneous subdivisions to be monitored. Additional effort has to be envisioned between countries to synchronize their monitoring from the time and spatial aspects. This problem is not solved even at the level of the northern Mediterranean countries as can be visible from the definition of the Marine Reporting Units (MRU) for eutrophication (DO5) under MSFD in the Mediterranean Sea. Even exist a clear obligation that the sub-regional scales are important most of the reporting areas are defined at the EU Member States level. One also has to consider that all the southern part of the Mediterranean was never involved in such an issue.

28. For above mentioned reasons. it is important to identify the gaps in the scales of monitoring (both temporal and spatial) for the southern part of the Mediterranean as the main input in the later definition of the assessment scales. As along the southern part the data, provided through Barcelona Convention, is rather scarce an effort to reinforce it through data mining (from other databases, from scientific papers etc) has to be undertaken. The best solution is to initiate collection of these data and on top of the analysis identify the main gaps for the spatial and temporal coverage, including a possible contribution of the scientists from Mediterranean region (e.g. through an On-line working

group (OWG)). This analysis is the first step toward the definition of water types and a rudimentary definition of reference condition as possibility to extrapolate the G/M (i.e. Good/Moderate) boundary for GES assessment. It will also serve to validate the strength of the ongoing monitoring programmes. At the end it will trace the possibility to complement the already performed task through the MSFD Marine Reporting Unit definition. Through the integration of monitoring scales, based on nested approach and proposing the list of monitoring and reporting units in the Mediterranean Sea, a better definition of the real space assessment scales for the Mediterranean will be achieved.

29. With regard to pollution (EO9), it has to be recognized that the open and deep sea is much less covered by monitoring efforts than coastal areas in terms of assessing chemical pollution, and therefore, there is also a need for monitoring programmes to include areas beyond the coastal areas in a representative and efficient way where risks warrant coverage. Furthermore, important developments in the Mediterranean Sea over the next few years for Common Indicators 17 and 18 should include harmonization of monitoring targets (determinants and matrices) within sub-regions and the review of the scope of the monitoring programmes to ensure that those contaminants which are considered to be important within each assessment area are included in monitoring programmes (task under development by revision of the National Monitoring Programmes). Significant matrix should be thoroughly selected according to transport and fate of specific contaminants: in open sea, water matrix could be more relevant in order to take into account atmospheric deposition process and, for persistent and lipophilic contaminants, biota for bioaccumulation and bio-magnification effect, while sediments are much more important for coastal and hotspot areas due to their conservativeness characteristics for long term trend analysis.

30. As for eutrophication (EO5), the final definition of the spatial scales should be concluded to allow further steps, and thus, including possible contribution of the scientists from Mediterranean region (e.g. through an On-line working group (OWG)) in close consultations with the Secretariat. In such a manner it would contribute in addressing tasks such as integration of monitoring scales based on nested approach, proposing the list of monitoring and reporting units in the Mediterranean Sea, and consequently better defining the real space assessment scales for the Mediterranean.

31. For Common Indicator 19, while the Contracting Parties to the Barcelona Convention and the Prevention and Emergency Protocol have a pollution monitoring and reporting obligation, the information and data submitted is still scarce. For Common Indicator 20, monitoring protocols and scales, risk-based approaches, and assessment methodologies would need to be further examined between the Contracting Parties, gathering information from national food safety authorities, research organisations and/or environmental agencies. Finally, with regard Common Indicator 21, related to bathing water quality, its applicability beyond bathing waters (recreational waters), protection and management measures would need to be clearly determined.

3. Way forward

32. In line with the findings and directions presented above the main needs to be further addressed may be summarized as follows:

1) A revision and agreement on the nested areas (bottom-up approach) is needed for the Mediterranean Sea that includes integration of monitoring scales based on nested approach, proposing the list of monitoring and reporting units in the Mediterranean Sea, and consequently better defining the real space assessment scales for the Mediterranean.

2) There is a need to enhance substantial knowledge from environmental monitoring, either research or routine monitoring, in order to be in position to define the spatial and temporal scales for CI13 (Key nutrients). To that effect, Mediterranean countries should maintain a collaborative approach to set background values, as well as task-oriented but flexibly-structured scales, with clear IMAP assessment criteria for CI13 and CI14, at appropriate spatial representativeness for the whole Mediterranean.

3) In a similar way, as for the Eutrophication (EO5), the main needs identified for the spatial and temporal coverage with regards the Pollution (EO9) should be further addressed, whilst taking into account the different approaches between Common Indicators related to EO9 (CI17, CI18, CI19, CI20 and CI21). It should be noted that the definition of reporting units in the Mediterranean may also benefit the selection of the offshore stations EO9, as well the selection of reference stations both coastal and offshore. Improved knowledge on new and emerging potential chemicals in the marine environment is needed for defining temporal and spatial scales for their monitoring.

Annex I
Other Regional Sea Conventions scales approaches

Baltic Sea (HELCOM)

Figure 1 shows the map of the Baltic Sea and represents the HELCOM Monitoring and Assessment sub-divisions into 17 open sub-basins and 40 coastal areas (HELCOM, 2013a).

Figure 1. Operational subdivisions of the Baltic Sea (HELCOM, 2013a).

In HELCOM's view, the various hierarchical sub-division levels can be used depending on the needs. For example, monitoring and assessment of mobile marine mammals such as grey seals may require the whole Baltic Sea scale while assessment of eutrophication indicators may be most relevant at the sub-basin scale in the open sea combined with "water body" or "type" level in the coastal zone.

Therefore, as mentioned above, this configuration (with individually listed off-shore and coastal areas for unequivocal reference) conform the basic divisions to be used, such as for the development of the Integrated Assessment of Hazardous Substances in 2017 (HELCOM, 2017). Obviously, the mapping tools are preceded by a strong expert analysis of the relevant data available in each of the 17 open sub-basins and 40 coastal areas. In Figure 2, the monitoring stations for contaminants can be observed superposed to the spatial scales defined for the Baltic Sea.

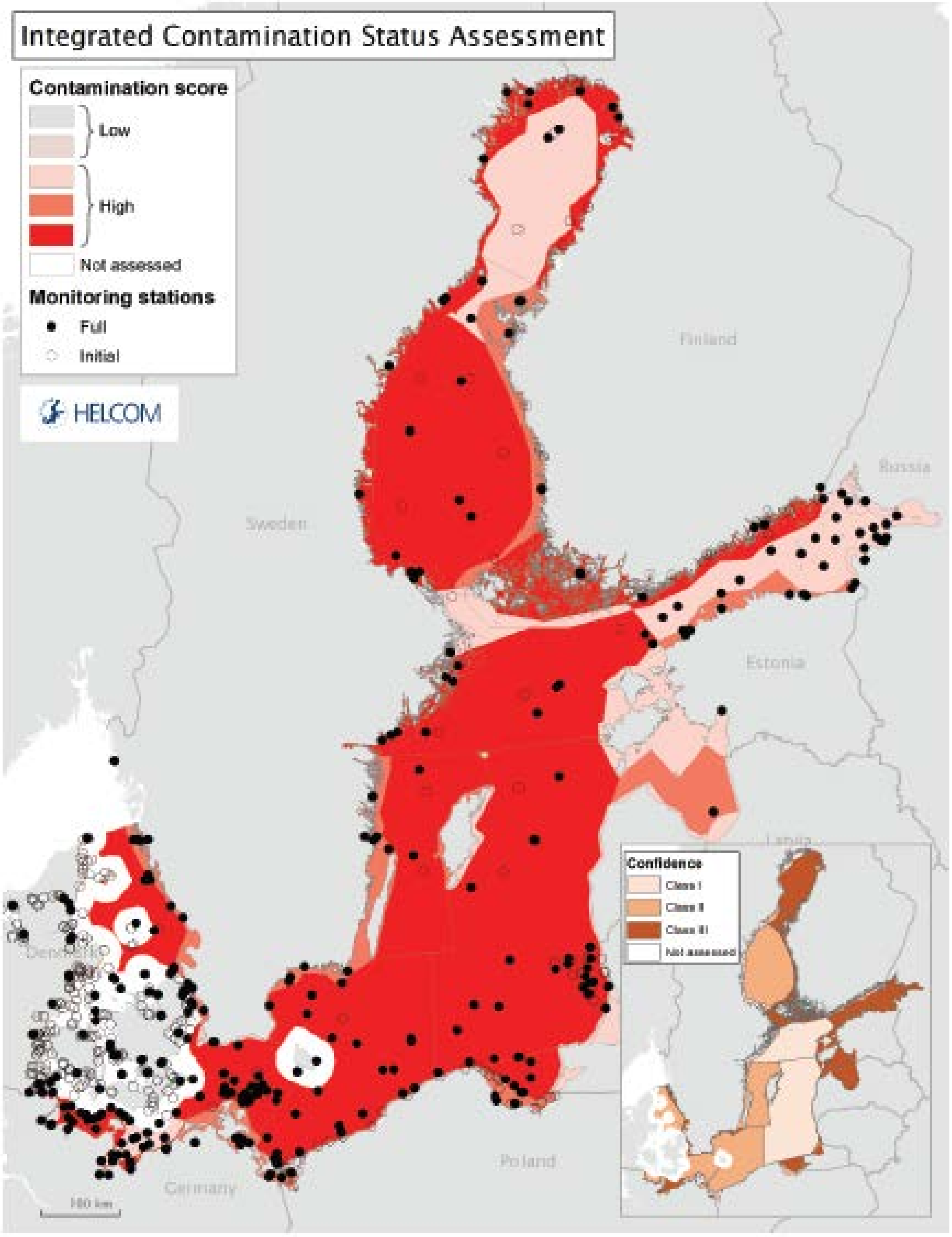

Figure 2. Integrated contamination status of the Baltic Sea assessed using the CHASE tool, with the monitoring stations. The integrated assessment of contamination status is based on data that has been processed through the full core indicator script, and additionally initial status assessment data has been included. Assessment units with lower confidence, as indicated in the map in the lower right corner, typically also have slightly better contamination status, indicating that these results may be worsened if more data were available. Filled circles denote that data allowed for a full indicator assessment and empty circles denote initial status assessment data. In these cases, only one or two years of monitoring data are available. Data can also be included in this category if many measurements are below the limit of detection (Reproduced from HELCOM, 2017)

Northeast Atlantic (OSPAR)

In the OSPAR Intermediate Assessment Report 2017 the five sub-areas in Figure 3 continue to be the main reference to perform marine assessments in the northeast Atlantic (OSPAR regions I to V). OSPAR covers nearly the entire marine region of the Northeast Atlantic, with the exception of the waters of the Macaronesia sub-region south from 36º N. The OSPAR sub-areas are to a large extent similar to the sub-regional seas (i.e. EU MSFD) within the NE Atlantic, but it should be noted that there are differences in the boundaries between the areas and in the outer boundaries.

Figure 3. The 5 sub-areas of the OSPAR Commission (Reproduced from the OSPAR Intermediate Assessment Report 2017 (IA 2017), accessed online https://oap.ospar.org/en/ospar-assessments/intermediate-assessment-2017/). Note: The number beside each icon corresponds to the number of assessments (both standard and/or thematic) by OSPAR Thematic Strategy used in the specific regions. For the purposes of the IA 2017 only, the OSPAR boundary between the Greater North Sea and the Celtic Seas in the English Channel has been realigned to reflect the EU MSFD Sub-Region.

In the earlier assessments carried out by the OSPAR states (OSPAR, 2008), different geographical scales for identifying individual assessment areas were used, ranging from small individual fjords to large coastal strips. A total of 204 assessment areas (Greater North Sea: 93; Celtic Seas: 84; Bay of Biscay and Iberian Coast: 27) were used in the 2008 assessment. The size of the assessment areas increased from inshore waters (estuaries, bights, fjords) to offshore. Parameters used to define subareas were hydrographical and physico-chemical characteristics like salinity gradient, depth, mixing characteristics (such as fronts, stratification), transboundary fluxes, upwelling, sedimentation, residence time/retention time, mean water temperature (water temperature range), turbidity (expressed in terms of suspended matter), mean substrate composition (in terms of sediment types) and typology of offshore waters.

The Coordinated Environmental Monitoring Programme (CEMP) provides a common framework for the collection of marine monitoring data by OSPAR countries. Status and trends in pollution are assessed for a number of substances, by monitoring concentrations in water, sediments and biota (OSPAR, 2009). CEMP monitoring is mainly focused on coastal areas, because these are close to discharge and emission sources. Increasing attention is being paid to monitoring in offshore areas, in relation to activities like oil and gas production and shipping. With the new released online OSPAR Intermediate Assessment Report 2017, the aggregation of data and information has been refined (https://oap.ospar.org/en/ospar-assessments/intermediate-assessment-2017/).

The previous Quality Status Report 2010 assessments were based on a large number of (predominantly coastal) monitoring stations. The results were aggregated for each of the 5 OSPAR regions by grouping stations into coastal stations (<12 nm), likely to be more affected by land-based inputs of contaminants, and offshore stations (Figure 4).

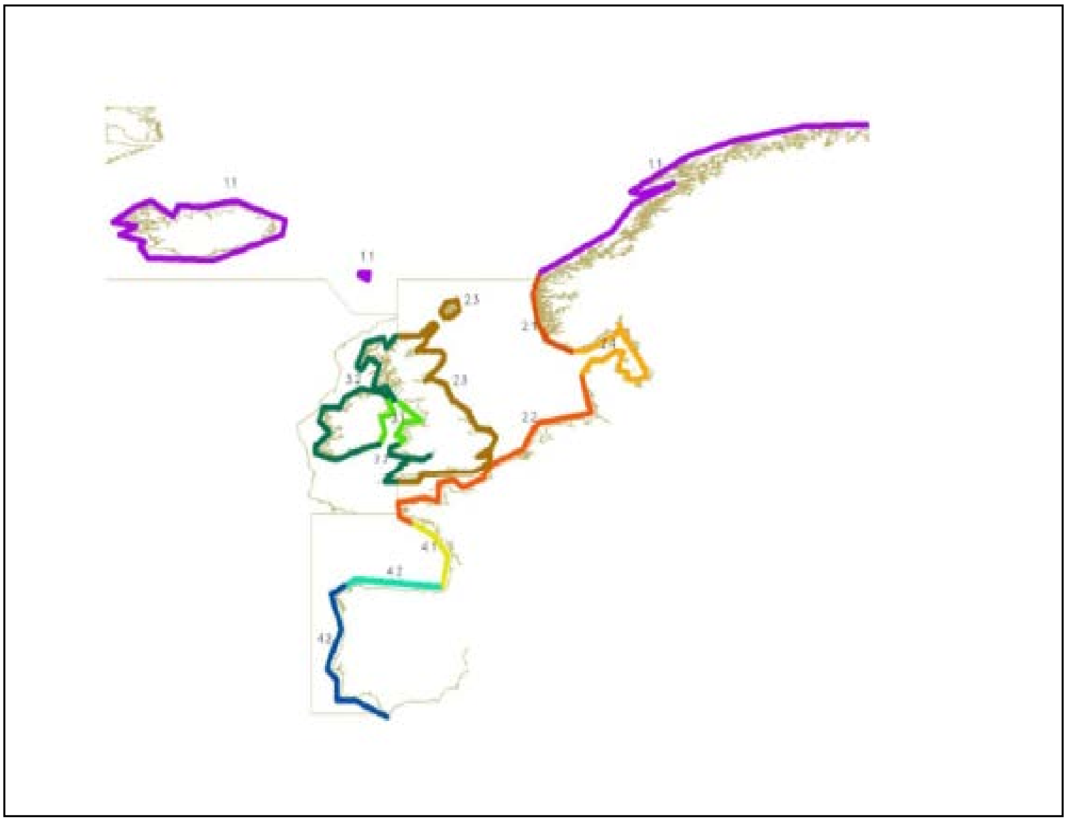

Figure 4. Sub-divisions of the OSPAR area used for contaminant data assessment of the QSR 2010. Source: OSPAR Commission.

Further subdivisions of the coastal stations were made where appropriate (Table 1; OSPAR, 2009). The above map shows subdivisions of the OSPAR area used for contaminant data assessment (Task Group 8 Report, Law et al. 2010).

For the elaboration of the Intermediate Assessment Report 2017, a number of guidance documents were published with regard the definitions and use of the marine reporting units categorized in four levels (i.e. Level 0-4, being Level 0 the entire OSPAR area). Table 2, shows an example of classification used for the assessment report which corresponds with the example in Figure 5, overall, within the nested approach strategy.

Table 1. OSPAR regions and sub-areas of coastal (<12 nm) and offshore (>12 nm) waters (Source: OSPAR, 2009).

ICES Region	ID	Subregion
I – Arctic	1	Offshore (no CEMP monitoring data)
	1.1	Coasts of Norway and Iceland
II – North Sea	2	Offshore
	2.1	North Sea coast of Norway west of ca.7°E
	2.2	North Seas Coasts of France (north of 48°N), Belgium, Netherlands, Germany and Denmark (south of Hanstholm)
	2.3	East coast of UK from Cape Wrath to the Lizard
	2.4	Coasts of the Skagerrak and Kattegat,
		With a western boundary from Lindesnes area (Norway – ca.7°E) to Hanstholm (Denmark – ca.8°E)
III – Celtic Seas	3	Offshore
	3.1	Coasts of Irish Sea
		Bordered in the North by a line from Larne to Corsewall Point (ca. 55°N) and in the south by a line from Wexford to St David's Head (ca. 52°N)
	3.2	Atlantic coasts of UK Ireland
		Coast of UK from the Lizard to St David's Head, Atlantic coast of Ireland from Wexford to Larne and Coast of UK from Corsewall Point to Cape Wrath
IV – Bay of Biscay	4	Offshore
	4.1	Biscay Coast of France, (south of ca.48°N – Brest to Hendaye)
	4.2	North coast of Spain (Irun to Cabo Ortegal)
	4.3	West Coasts of Spain and Portugal
V – Wider Atlantic	5	No CEMP Monitoring Data

Table 2. Nested naming breakdown of OSPAR Reporting Units (Source: Guidance for the application of OSPAR reporting units for the IA2017) corresponding to Figure 6.

Unit Name	Naming Breakdown				
L0	L0				
L1.2	L1	2			
L2.2.5	L2	2	5		
L3.2.5.14	L3	2	5	14	
L4.2.5.14.25	L4	2	5	14	25

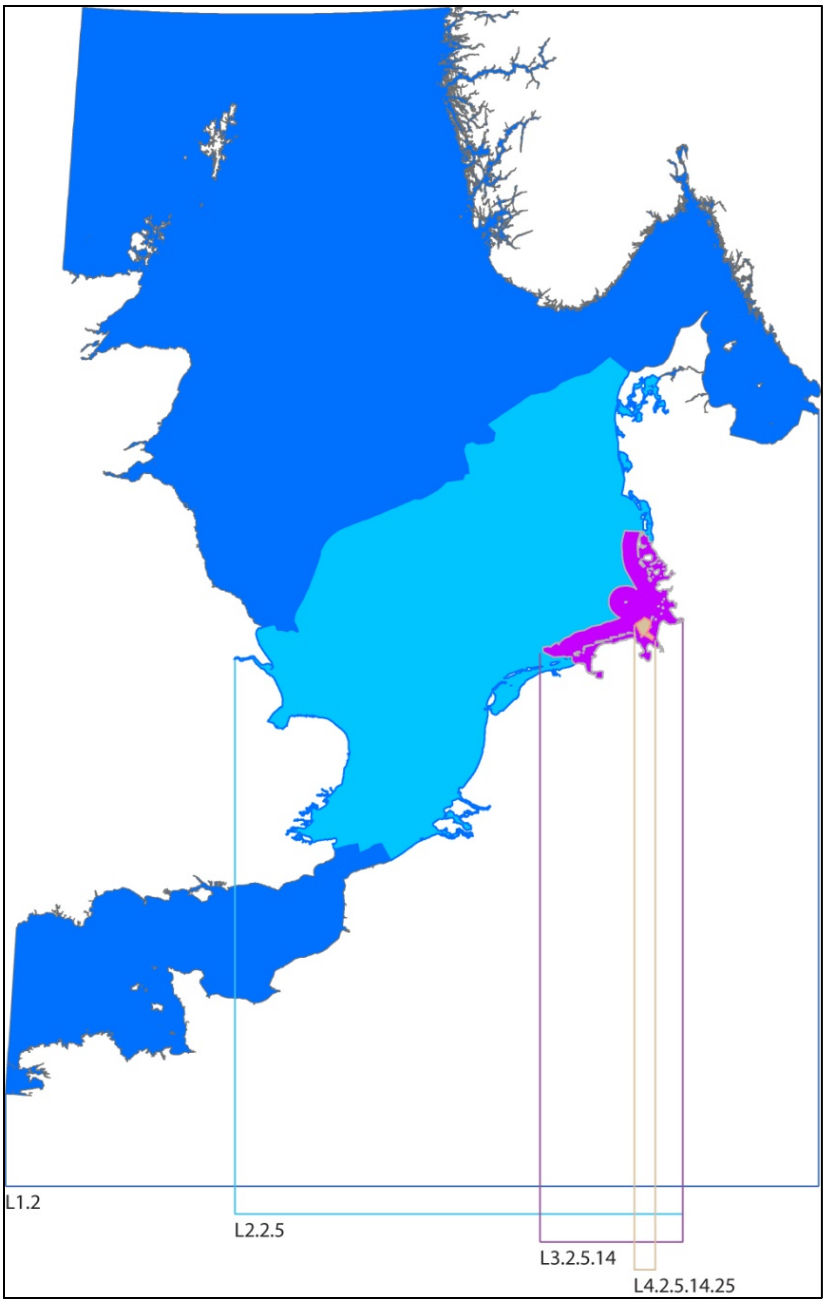

Figure 5. Following the spatial structure, OSPAR Reporting Units have a unique identifier (ID), using a nested approach. A unit ID begins with the corresponding Level number and the ID of the larger unit within which it is nested. The additional numbers in the ID represent the subdivisions of the larger unit (see Table 2 with a visual representation shown in Figure 6).

Annex II
References

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