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**Agenda item 3: Best practices on assessment and reporting scales (practices of regional seas and of Contracting Parties)**

# Temporal and geographical scales of monitoring, reporting and assessment to further develop the implementation of the map integrated monitoring and assessment programme (IMAP)



UN-Environment/MAP
Plan Bleu, 2017

**Temporal and geographical scales of monitoring, reporting and assessment to further develop the implementation of the map integrated monitoring and assessment programme (IMAP)**

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**LIST OF ABREVIATIONS**

| | |
|---|---|
| CI | Common Indicator |
| EO | Ecological Objective |
| GES | Good Environmental Status |
| GSA | GFCM Geographical Sub Areas |
| IMAP | Integrated Mediterranean Monitoring and Assessment Programme |
| RBA | Risk Based Approach |
| SPI | Science Policy Interface |

## Introduction

1. The 19th Meeting of Contracting Parties (COP 19, February 2016), through Decision IG. 22/7 (Integrated Monitoring and Assessment Programme of the Mediterranean Sea and Coast and Related Assessment Criteria) agreed on further quantification of good environmental status (GES) through a specific list of common indicators (CI listed in Annex 1) as a basis of an Integrated Mediterranean Monitoring and Assessment Programme (IMAP), accompanied by a clear timeline and deliveries for its implementation over 2016-2021 (UNEP/MAP, 2017).

2. Within IMAP, the elaboration of the relevant geographical and temporal scales for monitoring reporting and assessment has been identified as one of the main issues to guarantee its accurate and consistent implementation. The concept reflects the necessity to clearly define the different scales of the integrated monitoring, reporting and assessment actions, as they have been depicted in the IMAP initial draft guidance document (UNEP(DEPI)/MED IG.22/Inf.7 ), using a “nested approach”. This reveals that monitoring scales are not the same as assessment scales – the latter defined for each specified element on whether GES has been achieved or not, which needs to draw from and aggregate the monitoring data which will often be collected at finer spatio-temporal scales.

3. With the view to facilitate the discussions on these scales, Plan Bleu with the technical support of consultants have developed this document that aims to contribute to the design of the relevant geographical and temporal scales for monitoring, reporting and assessment under IMAP. It takes into account the output of the recent Science Policy Interface (SPI) Meeting on Risk-Based Approach methodologies (SPI-RBA Meeting, March 2017, Madrid), as well as the latest information presented at the CORMON Meetings in relation to the 2017 Quality Status Report assessment fact sheets.

4. In terms of ecology “scale” is an important concept due to the fact that populations, communities and ecosystems that are localized in patchy, fluctuating environments spread globally and cannot directly be apprehended. For the purpose of this document “scale” primarily relates to the divisions of continuous space and time which allow for the evaluation of the functioning of ecosystems at the level where they may be compromised by pressures and thereby inform on measures to be taken.

5. This document is composed of thematic sections corresponding to three IMAP clusters (Biodiversity and Fisheries, Pollutions and Marine litter, Hydrography and Coasts) and includes a final synthesis and recommendations, to be discussed during the meeting.

## Section 1: Spatial and temporal scales of reporting, monitoring and assessment for IMAP cluster Biodiversity

### Relevant monitoring scales for CI of the IMAP Biodiversity & Fisheries EOs

6. For the Ecological Objectives EO1, Biodiversity, EO2 Non Indigenous Species and EO1-EO3 Fisheries monitoring spatial and temporal guidance is summarized in Table 1, as agreed in the draft guidance factsheets within each Common Indicator (UNEP(DEPI)/MED WG.430/3 – CORMON Biodiversity and Fisheries - March 2017).

*Table 1. Temporal and spatial scope guidance for each common indicator (EO1, EO2 and EO3) – Common Indicator Fact sheet March 2017*

| | |
|---|---|
| EO1, 1 –Habitat distributional range – Habitat extent | |
| Spatial scope guidance and selection of monitoring stations | The spatial basis should be realized according to the Mediterranean biogeographic sub-areas in order to reflect changes in the biological characters of each habitat type across the Mediterranean and its sub-regions in relation to human induced pressures. |
| Temporal scope guidance | Monitoring intervals of 3-6 years are probably appropriate for long life span species/communities (e.g. *Posidonia oceanica,* macrozoobenthos). |
| EO1, 2 – Condition of typical habitat (both as species and communities attribute). | |
| Spatial scope guidance and selection of monitoring stations | Habitat related indicator, typical and/or characteristic species lists, (macrozoobenthos and macrophytes), should be developed for every type of habitat, at a sub-regional scale (or bioregion within each sub-region). Benthic biotic indices are also applicable in all sub-regions but appropriate adjustments might be still needed to cover biogeographic heterogeneity. Pressure analysis should be taken into consideration. |
| Temporal scope guidance | 1 per year at assessed sites; every 5 years at reference sites |
| EO1, 3 – Species distributional range (related to marine mammals, seabirds, marine reptiles) | |
| Spatial scope guidance and selection of monitoring stations | **Mammals**: Priority should be given to the less known areas (south-eastern portion of the basin, the coasts of North Africa and the central offshore waters) Regional (and is some cases e.g. toothed cetaceans) subregional scale for monitoring and assessment in line with the regional (and in some cases subregional) distribution of marine mammals.<br>**Reptiles**: The presence of the species should be monitored all along the Mediterranean coast and in the known breeding, wintering, and feeding/developmental areas. The spatial basis for assessment should be according to the Mediterranean biogeographical sub-areas to reflect changes in the abundance of sea turtles in each habitat type across the Mediterranean and its sub-regions. Each Contracting Party should assess all marine (coastal and oceanic) and beach habitats across their national maritime waters. However, it is recommended that these areas are assessed at a smaller scale if they belong to different biogeographical sub-regions or if differences in pressure intensity are obvious between sub-basins.<br>**Birds**: The presence of the selected species should be monitored all along the Mediterranean coast and in the known breeding colonies or wintering or feeding areas. |
| Temporal scope guidance | **Mammals**: seasonal monitoring programmes should be conducted in winter and summer, a six-year interval between large scale monitoring programmes is appropriate, but smaller intervals are recommended<br>**Reptiles**: Yearly for each of the species and areas (breeding, wintering, feeding/developmental). Seasonality to be determined by the local experts as i.e. breeding season can vary along and across the Mediterranean. Nesting is on April/May to September/October (hatching period extending 45 to around 70 days after this). Wintering from October to March/April in the Ionian/north Aegean for loggerheads, and lasts from November to March/April along the north coast of Africa for greens, and is limited to 1-2 months for loggerheads in |

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| | this region. Furthermore, the quantity of wintering habitats in the northern parts of the Mediterranean may increase with climate change. Foraging and developmental sites are expected to be inhabited year-round, but with seasonal fluctuations.<br>**Birds**: Yearly for each of the species and areas (breeding, wintering, feeding). Seasonality to be determined by the local experts as i.e. breeding season can vary along and across the Mediterranean. |
| EO1, 4 – Population abundance of selected species (related to marine mammals, seabirds, marine reptiles) | |
| Spatial scope guidance and selection of monitoring stations | **Mammals**: Priority should be given to the less known areas but most of the species selected as indicator in relation to this CI are migratory species, whose range extends over wide areas in the Mediterranean. It is therefore recommended to consider monitoring these species at regional or sub-regional scales for the assessment of their population abundance.<br>**Reptiles**: a number of sites should be selected that represent a sufficiently large proportion of the subregional or national population (criteria being delineated by expert groups). Comprehensive surveys should be carried out every 5 years, with the aim of covering all breeding, foraging, wintering and developmental sites. However, it is recommended that the whole coastal and marine area is covered on a national or subregional scale.<br>**Birds**: a number of sites should be selected that represent a sufficiently large proportion of the subregional or national population; this should be at least 40% and in no case less than 10%. The comprehensive surveys to be carried out every 6 years should aim at covering the whole area on a national or subregional scale. Assessment scales should be set at a subregion level considering the extent of the Mediterranean and the biogeographical divisions. |
| Temporal scope guidance | **Mammals**: seasonal monitoring programmes should be conducted in winter and summer, a six-year interval between large scale monitoring programmes is appropriate, but smaller intervals are recommended.<br>**Reptiles**: Annual – breeding surveys at selected sites (number of breeding females from nest counts from April to September; number of breeding males and females from direct counts of in-water surveys from April to July).<br>Annual – winter censuses at selected sites (number of wintering individuals, from October to April).<br>Annual – foraging/developmental censuses at selected sites (number of foraging/developmental individuals from January to December).<br>Every year – comprehensive breeding surveys at index beaches (included all beaches that are monitored annually through various programs) to estimate the no. of breeding individuals, number of breeding sites and average size.<br>Every year – comprehensive censuses of index winter, foraging, developmental sites to estimate no. of wintering, foraging and developmental individuals at coastal and marine sites.<br>Monitoring every 5 years of the entire coastline of all countries to detect changes in sporadic beach use or the use of new sites driven by climate change or changes to the habitat at existing sites (e.g. erosion or development)<br><br>As the lack of knowledge of these sites remains in the first two years, all oceanic and coastal areas must be uniformly monitored, followed by a meeting of experts to decide index sites for the different categories (foraging, wintering, developmental) within each country (the marine area all countries of the Mediterranean are used by sea turtles, so a set number per country should be selected). At this point, index sites should be monitored annually, while all other sites should be monitored every 5 years.<br>**Birds**: Annual – breeding surveys at selected sites to estimate the number of breeding pairs<br>Annual – winter censuses at selected coastal and wetland sites to estimate number of wintering individuals<br>Annual – mid-winter census (IWC) at important wintering sites<br>Annual – migration counts at key bottlenecks or prominent headlands |

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| | Every 6 years – comprehensive breeding surveys to estimate number of breeding pairs, number of colonies and average size<br>Every 6 years – comprehensive winter censuses to estimate number of wintering individuals at coastal & wetland sites |
| EO1, 5 – Population demographic characteristics (e.g. body size or age class structure, sex ratio, fecundity rates, survival/mortality rates related to marine mammals, seabirds, marine reptiles) | |
| Spatial scope guidance and selection of monitoring stations | **Mammals**: Priority should be given to the less known areas (south-eastern portion of the basin, the coasts of North Africa and the central offshore waters). Regional (and is some cases e.g. toothed cetaceans) subregional scale for monitoring and assessment in line with the regional (and in some cases subregional) distribution of marine mammals.<br>**Reptiles**: a number of sites should be selected that represent a sufficiently large proportion of the sub regional or national population. If possible, populations should be selected where animals have been tracked with a sufficient number of units (i.e. >50 individuals), from which the connectivity among these different habitat types can be established. The selected breeding sites should aim to be genetically diverse, so as this diversity can be detected at foraging/wintering/developmental grounds where different populations diverge.<br>**Birds**: data must be collected over the same time period from a few colonies that are representative of the environmental and anthropic conditions encountered by the species across its range. This includes sites with protected status, where conditions are likely to be favourable and more stable, and those with the lowest levels of protection. Practical aspects, such as accessibility and potential impact of the presence of the researchers, must also be taken into account when selecting the study sites. |
| Temporal scope guidance | **Mammals**: Demographic studies on marine mammals, which are long-living species, require long-term projects, to allow robust indications on trends in population size and demographic parameters over time.<br>**Reptiles**: Annual – breeding surveys at selected sites to determine adult male and female sex ratios, recruitment, mortality and longevity of breeding, as well as genetic structure and physical health indices (April-July).<br>In parallel, data on offspring should also be collected (July to October), to determine the number of individuals and ratio of offspring entering the population. This is the only point until adulthood that the offspring are in a single place and not mixed with other breeding populations at developmental/feeding sites.<br>Annual – winter censuses at selected sites to estimate the age/size class, sex ratio of adults, recruitment and dispersal of individuals, as well as genetic structure and physical health indices (expect mixing of turtles from different breeding populations) of individuals (October to April)<br>Annual – foraging/developmental censuses at selected sites to estimate the age/size class, sex ratio of adults, recruitment and dispersal of individuals, as well as genetic structure and physical health indices (expect mixing of turtles from different breeding populations) of individuals (January-December).<br>**Birds**: For the study of survival, the absolute minimum length is 4 study seasons; this provides the minimum 3 data points required to draw a curve of interannual survival. Every year, a survey season is needed to obtain capture-recapture data on the presence of the individually-marked birds and to mark a new cohort of individuals. In parallel, data on breeding performance must be obtained for every breeding season (not necessarily at the same site). |
| EO1 –EO3, 12 – Bycatch of vulnerable and non-target species | |
| Spatial scope guidance and selection of monitoring stations | In GSA (GFCM Geographical Sub Areas: homogeneous areas for statistical and management purpose) in relation to different fishing activities. Data shall be provided per species per fishing metier for each GSA, to identify fishing operation and gears most contributing to by-catches. |
| Temporal scope guidance | To be defined |
| EO2, 6 – Trends in abundance, temporal occurrence, and spatial distribution of non-indigenous species (NIS) | |

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| Spatial scope guidance and selection of monitoring stations | The monitoring should start on a localised scale, “hot-spots” and “stepping stone areas” for alien species introductions. Including ports and their surrounding areas, docks, marinas, aquaculture installations, heated power plant effluents sites, offshore structures. Areas of special interest such as marine protected areas, lagoons etc. may be selected on a case by case basis, depending on the proximity to alien species introduction “hot spots”. The selection of the monitoring sites should therefore be based on a previous analysis of the most likely “entry” points of introductions and “hot spots” expected to contain elevated numbers of alien species. |
| Temporal scope guidance | Monitoring at “hot-spots” and “stepping stone areas” for alien species introductions would typically involve more intense monitoring effort, e.g. sampling at least once a year at ports and their wider area and once every two years in smaller harbours, marinas, and aquaculture sites. |

7. Regarding IMAP EO1 CI 1 Habitat distributional range, CI 3 species distributional range and CI 4 General assessment of population abundance range of selected mammals and birds, the spatial scales of the assessment are related to Mediterranean sub regions or at biogeographical scale. These are large scale, area –related and long term indicators that can be managed by the use of Geographical Information System (GIS) for the assembling of the monitoring data and elaboration of the distributional range maps. The selection of temporal scales should take into account the long-term variability of these CI and the monitoring frequencies could be from three years up to ten years.

8. On the other hand, EO1 CI 2, CI 4 (for reptiles and birds), CI 5, EO3 &1 CI 12 (Bycatch of vulnerable and non-target species) as well as EO2 CI 6, are monitored at local scales (sites, station points, location). Monitoring data at local level must be then implemented in suitable statistical processing database to report data to sub regional level. For some these common indicators a higher frequency of monitoring activities may be needed.

9. In relation to EO2, CI 6 regarding ballast waters assessment for the introduction of NIS, the IPA Adriatic BALMAS Project (BALlast water MAnagement system for Adriatic Sea protection) followed the International Maritime Organization (IMO) Ballast Water Management Convention (BWMC) guidelines that encourage the port states to undertake Port Baseline Survey (PBS), suggesting a sampling protocol based on CRIMP protocol1 (Hewitt and Martin, 2001). The objectives of PBS protocol were to outline the steps that should be taken for baseline survey, specify the abiotic and biotic parameters spatial and temporal scales and describe the report format.

10. In relation to EO1, CI4, HELCOM recommendations for monitoring abundance and distribution of water birds during non- breeding seasons states that wintering is the most suitable period for water bird monitoring as they aggregate in certain feeding grounds and are less mobile than in other non-breeding seasons. Thus coordinated counts within this period allows collecting the least biased data and the winter season is top priority for water bird monitoring during the non- breeding period. The ground counts should be carried out annually. Usually the effective counting belt reaches up to a distance of 1km from the coast, however, the actual distance depends on the species and visibility during the count. The HELCOM agreement covers the whole territory of the Baltic Sea. The “marine waters under the sovereignty and jurisdiction of Member States of the European Union” are in scope of the MSFD and thus its reporting obligations cover both its territorial and EEZ waters.

11. All HELCOM countries, except RU, have reported that they are aiming for large scale surveys of wintering populations at least once in 6 years in their monitoring programmes. Many countries even have reported such surveys every 3rd or 2nd year. Populations of wintering birds have to be monitored during the winter months (mid- December – end of February). If the weather allows, the January is preferred.

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[1] Centre for Research on Introduced Marine Pests (Australia)

**Gaps in spatial and temporal coverage**

12. It is clear that the EO 1 and 2 are described by a series of very heterogeneous indicators ranging from habitat extension to the structure and composition of the typical communities, to species/population attributes.

**Recommendations for relevant monitoring scales**

13. In the broader context of the IMAP framework there is the need to keep the monitoring requirements manageable. It is recommended (UNEP(DEPI)/MED WG.432/4) to focus on so called "representative sites" with the criteria for the selection as follows:

- Where pressures and risks on biodiversity are most strongly associated, following a risk based approach (vulnerable habitats and species locations);
- Where most information/historic data are available;
- Where well established monitoring (in general, not only for biodiversity) is already undertaken;
- Sites of high biodiversity importance and conservation interest (according to national, regional or international regulations);
- Expert opinion.

14. Locations to be monitored should be prioritised to cover at least areas of influence from anthropogenic activities, which are expected to cause non adverse impacts upon biological diversity, with priority on the areas at highest risk. In this case, where possible, is recommended to use transects from high to low pressure, so as to cross the "GES boundary"; – can help define the boundary between areas in GES and those not in GES.

15. Monitoring activities should be conducted also in areas considered representative of un-impacted from pressures (areas to be used as reference conditions/levels). Such areas require less conditions, i.e. not thought to be subject to, or impacted by, pressures frequent monitoring compared to the heavy impacted from pressures assessment areas. Accordingly, monitoring in marine and coastal protected areas or Specially Protected Areas under the SPA/BD Protocol should be a core activity undertaken during the initial phase.

16. The OSPAR experience related to the Joint Assessment and Monitoring Programme (JAMP) 2014 – 2021, suggests that monitoring efforts could be focussed on areas where there is the greatest likelihood of significant change as a result of changes in drivers (pressures) determining the local or (sub)regional situation.

17. Decreasing the monitoring frequency is possible for locations where established time series show status to be well below risk levels concern, and without any deteriorating trend over a number of years.

## Section 2: Spatial and temporal scales of reporting, monitoring and assessment for the IMAP cluster on Pollution and Marine Litter

18. This section addresses the design of relevant scales within the IMAP Ecological Objectives of the cluster: Eutrophication (EO5), Pollution (EO9), Marine Litter (EO10) and Underwater Noise (EO11).

19. The regional scale assessment, through national marine monitoring, in relation to the Barcelona Convention Pollution land-based sources Protocol (the LBS Protocol) has been conducted through the UNEP/MAP MEDPOL Programme. The table in Annex 2 provides the common basic marine pollution MED POL monitoring programmes within the Contracting Parties which could be adapted to deliver IMAP Common Indicators for Pollution and Marine Litter.

20. Considerable amounts of information (e.g. on air quality, microbial pollution, etc.) are available through the pollution monitoring and assessment component of MEDPOL from the past decades, including monitoring pilot programmes (e.g. ecotoxicological effects of contaminants).

### Gaps in spatial and temporal coverage

21. For a complete GES assessment of eutrophication (EO5), 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, water transparency and oxygen as minimum requirements. The spatial coverage and differences between areas will hinder the assessment of thresholds unless a nested approach would be clearly defined and joint workshops and comparative exercises at regional/subregional/subdivision levels in the Mediterranean area are performed. With regard to the CI 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 larger scales, including harmful algal blooms (e.g. Adriatic Sea).

22. With regard to EO9 (Pollution) important developments in the Mediterranean Sea over the next few years for CI 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, for example, that those contaminants which are considered to be important within each assessment area (including offshore areas) are included in monitoring programmes. For CI 19, while the Prevention and Emergency Protocol includes a pollution monitoring and reporting obligation, the information and data submitted is still scarce. For CI 20, monitoring protocols and scales, risk-based approaches, and assessment methodologies would need to be further examined between Contracting Parties, to gather information from national food safety authorities, research organizations and/or environmental agencies. Finally, with regard CI 21, related to bathing water quality, its applicability beyond recreational waters protection and management would need to be clearly determined.

23. The marine litter (EO10) was supported by notable pilot projects and research programmes at sub-regional levels, such as DeFishGear Project in the Adriatic and Ionian Seas. However, in terms of IMAP implementation, there is a gap on marine litter (ML) beach monitoring programmes at national, sub-regional and regional levels and without harmonized monitoring methods. With respect to seafloor litter, few studies covered extensive geographical areas or high depths. While there is sufficient knowledge on seafloor ML for the northern part of the Mediterranean Sea, more information shall be generated in the southern part. In terms of geographical scales, the ML accumulation areas shall be assessed with priority on the convergence zones and deep-sea canyons. On the contrary, few studies have been published on floating marine litter in Mediterranean waters, and therefore, cannot be estimated with accuracy. There is a need to determine suitable cost-effective monitoring and assessment strategies for ML. Finally, for candidate CI24, completely new metrics to assess entanglement or ingestion of ML should be developed, which may also open new perspectives in the context of monitoring.

24. 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 beyond coastal waters. To this regard, the maritime activities and maritime traffic routes in the Mediterranean Sea could be identified as sea-based sources of marine pollution in relation to the Common Indicators for Ecological objectives EO9 and EO10.

**Relevant monitoring scales related to the CIs for the four IMAP Pollution and Marine Litter EOs**

Eutrophication

25. As indicated in the IMAP indicator Guidance Factsheets, for CI 13 and 14, the geographical scale of monitoring and assessment of GES for eutrophication will depend on a number of hydrological, morphological and oceanographic conditions of an area (e.g. freshwater inputs from rivers, bays, semi-enclosed lagoons, stratification, upwelling phenomena). Therefore, the spatial distribution of the monitoring stations should be risk-based evaluated and proportionate to the anticipated extent of eutrophication and aiming for the determination of spatially homogeneous areas prior to the establishment of the eutrophication status of the marine sub-region/area. . Monitoring beyond coastal waters may not be necessary due to low risk, such as in cases where the threshold values are achieved in coastal waters, taking into account nutrient input from atmospheric, sea-based including coastal waters, and transboundary sources. The eutrophication monitoring programmes should pursue to assess the eutrophication phenomena, based on the differentiation of the scale and time dependent signals from human induced versus natural eutrophication. In the Mediterranean Sea latitudes, in general terms, the pre-summer and winter primary production blooms of natural eutrophication will define the strategy for the sampling frequency (i.e. twice a year), although year round measurements of eutrophication parameters may be more appropriate (i.e. monthly), in order to both control the deviations of the known natural cycles of eutrophication in coastal areas and the (decreasing) trends monitoring in impacted areas.

Chemical Pollution

26. As included in the IMAP indicator Guidance Factsheets, the spatial scope for monitoring CI 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 sediments; and therefore, should be based on the risk-based approaches (RBA). The selection of the sampling sites for the monitoring of contaminants and biological effects in the marine environment should consider: hotspots areas where the risks of not achieving GES are high, coastal areas and reference areas, as well as to allow the collection of a realistic and identical number of samples over the years (e.g. decades) to capture temporal trends. It is essential that the monitoring strategies will be coordinated at regional and/or sub regional level, sustained and developed to get a sound and coherent assessment of the GES.

27. The sampling frequencies within IMAP will be determined by the development status of the national marine monitoring with regard to the current MEDPOL Programme (see Figure 3), for example, taking into account a two phase monitoring: a) Initial phase monitoring: Biota (sampling bivalves yearly) and Sediments (sampling coastal sediments every two years), which respond to an screening monitoring to be revised, and b) Advanced phase monitoring (e.g. Contracting Parties with fully completed and reported MEDPOL Phase III datasets): Biota (from 1 to 3 years according temporal trends and chemicals measured) and Sediments (from 3 to 6 years depending on the characteristics of sedimentation areas and the chemicals concerned). In this latter phase, it could be possible to decrease the sampling frequencies and target chemicals in cases where already assessed temporal trends and levels show concentrations well below levels of concern without any trend changes. However, surveillance monitoring should be maintained.

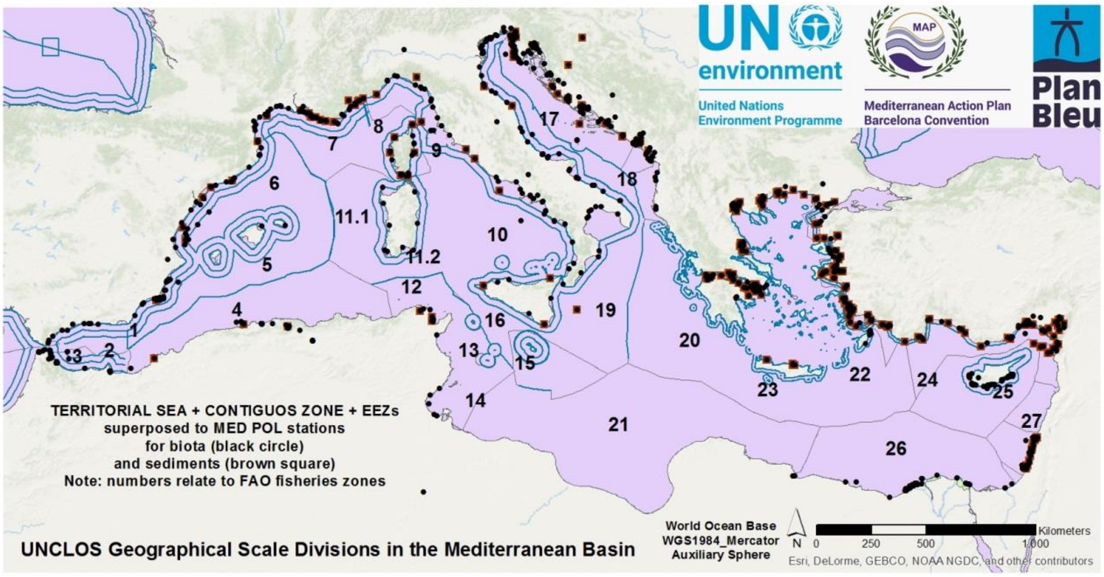


*Figure 1. MEDPOL Monitoring networks for coastal biota (black points) and sediments (brown squares) overlapping the UNCLOS geographical divisions. (Data Sources: UNEP/MAP/MEDPOL, www.marineregions.org and ADRIPLAN)*

28. With regard to CI 19 (acute pollution events), the Regional Marine Pollution Emergency Response Centre for the Mediterranean Sea (REMPEC), part of the MAP system, will continue to be the central organisation coordinating and maintaining a database on oil spills data supplied by Contracting Parties. As oil and HNS pollution incidents from ships occurs unexpectedly or are not systematic (e.g. maritime casualties, illicit discharges, etc.), it is expected that acute pollution monitoring datasets will continue to be reported "in real time" when pollution incidents actually happen or are detected.

29. The CI 20 (contaminants in seafood) should be based on risk-based methodologies, despite the temporal scope is highly linked to the data confidence and uncertainty of the indicator. The yearly statistics in territorial waters by Contracting Parties could be the basic time and geographical scales units for assessments.

30. The temporal scope for monitoring under CI 21 (microbial pathogens) is based under different international, regional and national policy. The spatial scale is selected in bathing waters areas where microbiological pollution could threaten the recreational uses. A temporal scope guideline in use, for control and monitoring, can be found in the EU Directive 2006/7EC (following the update of the World Health Organization). In practice, it reduces significantly the number of analysis to be performed and should be further considered at a regional scale in the Mediterranean Sea.

Marine Litter

31. With regard to the spatial scope for the CI 22 (beach litter), as stated in IMAP Indicator Guidance Factsheets, the selected sites should represent litter abundance and composition for a given region. However, not any given coastal site is completely representative, as they may be limited in terms of accessibility, suitability to sampling and/or beach cleaning activities. The frequencies of monitoring should be at least two surveys per year in spring and autumn, and ideally, four surveys (seasonally).

32. The IMAP Indicator Guidance Factsheets, in terms of the CI 23 (marine litter in the water column and the seafloor), recommends the monitoring following the approach of the European Union (JRC, 2013), in terms of the spatial scales and methodologies according to the depth of the surveys:

shallow sea-floor (<20m) and the sea-floor (20-800m). With regard to floating marine litter, the monitoring by observers should be the methodology indicated for short transects in selected areas being advisable to start by screening surveys. The selected areas should include expected low density areas (e.g. open sea) as well as expected high density areas (e.g. coastal areas close to ports).

33. The Candidate CI 24 (litter impacts) is mainly directed towards the assessment of the litter effects in selected marine organisms, namely, mammals, seabirds and marine turtles. The spatial and temporal coverage would involve routine opportunistic monitoring. For seabirds, these could be collected from beaches or from accidental mortality such as in long-line fishing, fledgling road kills, etc. For sea turtles, specimens could be collected from beaches or at sea from accidental mortalities such as victims of long-line fishing or boat collisions. In order to perform assessments a continuous sampling is required. For reliable conclusions on change or stability in ingested litter quantities by marine organisms, datasets over periods from 4 to 8 years (depending on the category of litter) are needed. For turtles the scales are not yet defined.

Underwater noise

34. The EO11 and the candidate CI 26 and 27 (underwater noise) are probably both new and poorly studied in the Mediterranean Sea by all the Contracting Parties. At present, ACCOBAMS (http://www.accobams.org) is a leading organisation working in the Mediterranean Sea to assess the environmental issues in relation to underwater noise.

**Synthesis of the relevant temporal monitoring scales**

35. The Table 2 below summarizes the relevant frequencies set for the IMAP Common Indicators (EO5, EO9 and EO10). Although the temporal IMAP requirements need to be guaranteed, the selection of the temporal scales (monitoring frequencies) for each CI should take into account the availability of ongoing monitoring programmes at national levels in order to combine efforts and resources. To this extent CI 20 and 21 corresponding to EO9 (Pollution) and CI 22 and 23 corresponding to EO10 (Marine Litter) could initiate monitoring activities with adapted marine monitoring programmes without much effort to include the screening, surveillance and/or monitoring of these new Common Indicators.

**Recommendations and guidelines regarding relevant monitoring scales related to the 8 CI regarding IMAP cluster pollution and marine litter**

36. For all the CI and for assessment purposes under EOs related to Pollution and Marine Litter, the development of geospatial statistics, the use of GIS tools, RBA approaches and uncertainty analysis would assist the setting of temporal and spatial scales, and therefore, fit-for-purpose monitoring, reporting and assessments to deliver IMAP expectations.

37. At the initial stage of IMAP the differentiation between initial/screening monitoring and long-term monitoring is particularly important. Some of the CI introduced within the Ecological Objectives for GES determination lack of sufficient information. Therefore, the initial monitoring programmes should provide basic environmental information to be able to refine the monitoring approaches in the long-term monitoring.

*Table 2.Frequencies of monitoring for the Common Indicators related to the Pollution and Marine Litter cluster under IMAP (2016-2021).*

| Ecological Objective | Common Indicator | Frequencies of monitoring | Nested approach suitability |
|---|---|---|---|
| EO5 | **CI13**.Concentration of key nutrients in water column | In situ, from monthly (12 times a year) to twice a year (spring/winter) | Yes |
| | **CI14**.Chlorophyll-a concentration in water column | | Yes |

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| EO9 | **CI17**. Concentration of key harmful contaminants measured in the relevant matrix (biota, sediment, seawater) | Initial phase: yearly for biota and biannual for sediments; Advanced phase: 1-3 years for biota and 3-6 years for sediments. (Note: to consider both number of parameters and replicates). See text. | Yes |
| | **CI18**. Level of pollution effects of key contaminants where a cause and effect relationship has been established | | Yes |
| | **CI19**. Occurrence, origin (where possible), and extent of acute pollution events | Continuous, set on an occurrence/accidental basis for reporting. | No |
| | **CI20**. Actual levels of contaminants that have been detected and number of contaminants which have exceeded maximum regulatory levels in seafood | Initial frequencies under other national monitoring programes (e.g. fisheries management). | No/Yes |
| | **CI21**.Percentage of intestinal enterococci concentration measurements within established standards | In situ monitoring under other national monitoring programes (e.g. bathing water quality) | Yes |
| EO10 | **CI22**.Trends in the amount of litter washed ashore and/or deposited on coastlines (including analysis of its composition, spatial distribution and, where possible, source) | Initial frequencies under other national monitoring programes (e.g. bathing water quality). Minimun established from 2 to 4 times a year for beach monitoring | Yes |
| | **CI23**.Trends in the amount of litter in the water column including microplastics and on the seafloor | Initial frequencies under other national monitoring programes (e.g. fisheries management) | Yes |
| | **Candidate CI24**: Trends in the amount of litter ingested by or entangling marine organisms focusing on selected mammals, marine birds and marine turtles | Continuous frequency, set on an occurrence/accidental basis for reporting and assessment. 4 to 8 years for temporal trends. | No |

## Section 3: Spatial and temporal scales of reporting, monitoring and assessment for IMAP cluster Coasts and Hydrography

### EO 7 Hydrography

38. In relation to EO7, the key recommendation of the Integrated CORMON was to develop a guidance document on how to reflect changes in hydrographical conditions in relevant assessments, such as EIAs and others. In response to this recommendation the "Guidance Document on how to reflect changes in hydrographical conditions in relevant assessments" was prepared (Spiteri, 2015).

Monitoring requirements and programmes regarding CI 15

39. There is limited information available on temporal frequency in existing marine monitoring programmes. As regards the spatial scope, territorial waters are monitored by a majority of the existing programmes reported, while coastal waters are monitored by half. The monitoring of transitional waters and the EEZ is also mentioned.

Relevant temporal and spatial monitoring scales related to CI 15

40. It is not the scale of the construction that is important but the scale of the impacts. The chosen spatial and temporal scales must be able to assess all the (main) hydrographical alterations induced by the future structure. These scales are strongly site-dependent.

41. Regarding the Spatial scale (in cross-shore and long-shore directions):

- 10 to 50 times the characteristic length of the structure should initially be used.

- Depending on the first results obtained for this area, the area should be enlarged or zoomed in around the structure.

42. To correctly assess changes in time on habitats induced by constructions, different monitoring time scales are proposed:

- Before construction, initial state assessment (baseline conditions):
- Monitoring should provide the initial hydrodynamics conditions surrounding the future construction.
- During construction: monitoring should ensure that impacts due to works are limited in space and in time.
- After construction, short term changes (0 to 5 years after): at least yearly up to 5 years.
- During this period, strong changes should happen on hydrographical, morphological and habitats conditions. The monitoring frequency should be high* enough to assess these changes. It should be annual (at the same period of year) and provide, each year, the changes in hydrodynamic conditions (assessed by comparing present and initial conditions).
- After construction (5 to 10 years after): at least biennium to 10 years.
- Same as before with a lower* monitoring frequency as the changes should be lower.
- Long term changes (10 to15 years after construction)
- Same as before with a lower* monitoring frequency as the changes should be lower.

* The monitoring frequencies to be used in these different phases should depend on the intensity of changes in hydrographical and morphological conditions occurring on the site (case by case).

43. As concerns the spatial scale and resolution in the context of numerical modelling two main spatial scales are considered:

- Near-field, i.e. the area within the immediate vicinity of the development (5 times the obstacle length (Lambkin et al., 2009).)
- Far-field, e.g. the coastline, non-immediate areas of scientific and conservation interest

44. As for the determination of the extent of the domain to be considered, this will depend on the distance from the specific human activity to areas subject to impact and areas of specific interest, for example adjacent coasts or bays, or sensitive habitats. A clear identification of the sensitive receptors, such as local habitats, fauna and/or flora and habitat/ecosystem functions, and their natural extent is a key input for the determination of the spatial scale, as the boundaries of the model might need extending or adjusting to fully include these into the computational domain. The scale determination should therefore take into account the scales used for theEO1/EO6 habitat assessments. The EIHA[2] of the OSPAR Commission advises to consider the spatial scale equivalent to EUNIS level 3 as the most appropriate scale (Spiteri, 2015).

Focus on the frequency of monitoring

45. The frequency of monitoring the changes after construction will depend on the natural dynamics of the site:

- Short term: yearly up to 5 years.
- Mid/long term: biennium to 5- 10 years
- Long term: more than 10 years

[2] OSPAR Environmental Impacts of Human Activities Committee

Gaps in spatial and temporal coverage, general appreciation

46. Several gaps and difficulties have been identified relatively to EO7 indicator assessment. It is not possible to propose a unique and well-defined assessment methodology as it strongly depends:

- On the site of interest and its natural hydrographical conditions.
- On the dimension, the location and the functions of the future structure.
- On the data and means available.

47. There is also a strong dependency on EO1 "Biodiversity", in terms of data on existing habitat and on their sensitivity to hydrographical changes. The knowledge gaps that pose an obstacle of drawing conclusion on CI 15 on regional level are mainly related to insufficient surveys and experience in monitoring of the state of the marine environment regarding this indicator. The methodological gaps are related to the definition of types and dimensions of new structures to be taken into account; gaps related to the complex information needs to define the base-line conditions as well as the spatial and temporal scales of assessment.

48. Assessments that estimate the extent of hydrographic alterations (knowing conditions before and after construction) and its intersection with marine habitats are extremely rare in the Mediterranean, except for some local studies of EIA/SEA. Instead, only trends of some hydrographic parameters are known, mostly unable to be connected to anthropogenic drivers and, more often, impacts by changes of these parameters are either not assessed or assessed in limited/qualitative way. (Sekovski, 2017).

49. There is a lack of knowledge on how to develop the assessment of impacts; the major concern would be on how to aggregate assessment results from habitat to ecosystems levels. In any case, most comments indicate that assessments should be done at both habitats and ecosystem levels under EO 7, by using a stepwise approach. However, in the current situation, it is more important to focus on habitat level effects. In any case local scales should not be excluded for the assessment of EO 7 (Gonzalez et al., 2015).

**Recommendations and guidelines regarding relevant monitoring scales related to the CI 15 regarding IMAP Ecological objective 7**

50. EO7 relies on the use of state-of-art numerical models (hydrological, sediment, wave, habitat) together with field data to set-up and validate models. The development of numerical models is typically carried out by academic/scientific institutes. In order to enhance the SPI the further development of models should be in line with policy requirements, e.g. requirements of CI 15. Best use should be made of existing products e.g. Copernicus Marine Environment Monitoring Service, (sub) regional models etc. It is recommended to establish partnerships between administrative bodies and scientific institutes (Spiteri, 2015).

**Scales for monitoring and assessment for IMAP EO 8 "Coasts"**

51. Until now there has been no systematic monitoring in Mediterranean regarding the EO8 Common Indicator, in particular not quantitatively based monitoring or any major attempt to homogenously characterize coastal ecosystems on a wider Mediterranean basis. There are some estimations, however, based on data from night-time light radiation survey. According to these about 40% of the total Mediterranean coastal zone is under some form of artificial land cover.

52. At local scale, some ongoing initiatives are monitoring artificialisation and morphological evolution of the coast (see Table 3).

*Table 3. Some Mediterranean examples of web based dissemination of geospatial data related to coastal monitoring*

| **Region (Country)** | | **Structures included** | **Viewer** |
|---|---|---|---|
| **Balearic islands (Spain)** | SACosta | Based on NOAA 2002 classification | http://gis.socib.es/sacosta/composer |
| **French Mediterranean coasts** | MEDAM (French Mediterranean Coasts. Inventory and Impact of Reclamations from the Sea) | Port; Port of refuge; Landfill; Artificial beach (horseshoe shaped beach); Groyne; Pontoon; River mouth dykes. | http://www.medam.info/index.php/en/medam-module-donnees-chiffrees |
| **Costa di Tosca (Italy)** | ResMar | Coastal defence; ports | |

Source UNEP(DEPI)/MED WG.433/Inf.2

53. The aim of the EU MEDINA (Marine Ecosystem Dynamics and Indicators for North Africa) project was to enhance the capacities of Mediterranean Northern African Countries (Morocco, Algeria, Tunisia, Libya and Egypt) to monitor their coastal and marine ecosystems through the development of indicators and the integration of coastal monitoring tools into GEOSS. One of the DPSIR indicators includes the “North Africa coast: Share of built up in the 0-10km coastal strip” which is very much related to Indicator 25. This indicator is defined by the artificialized surface of coastal strips surface (see Figure 4) delimited by 10 km inland deep and divided by NUTS3.

54. This indicator was applied in five case studies: the Bay of Bejaia (Algeria), Lake Burullus (Egypt), the Gulf of Syrte (Libya), the Lagoon of Nador (Morocco) and the Gulf of Gabes (Tunisia).


*Figure 2. Example of cartographic representation of coastal defense and ports in Egypt. (Source: MEDINA Project); b) Coasta Toscana (Source: ResMar Project )*

55. As regards the Candidate CI 25, a pilot study in the Adriatic region (Albania, Bosnia and Herzegovina, Croatia, Italy, Montenegro, and Slovenia) was carried out as part of EcAp MED I project (2012-2015), the results if which are depicted in Figure 5. The main conclusions of the Pilot project suggest that by using the common remote data and a common method for processing and presenting the results are feasible and a very positive step forward as far as monitoring the processes, the state and evolution of the coastal zones (UNEP(DEPI)/MED WG.420/Inf.18).

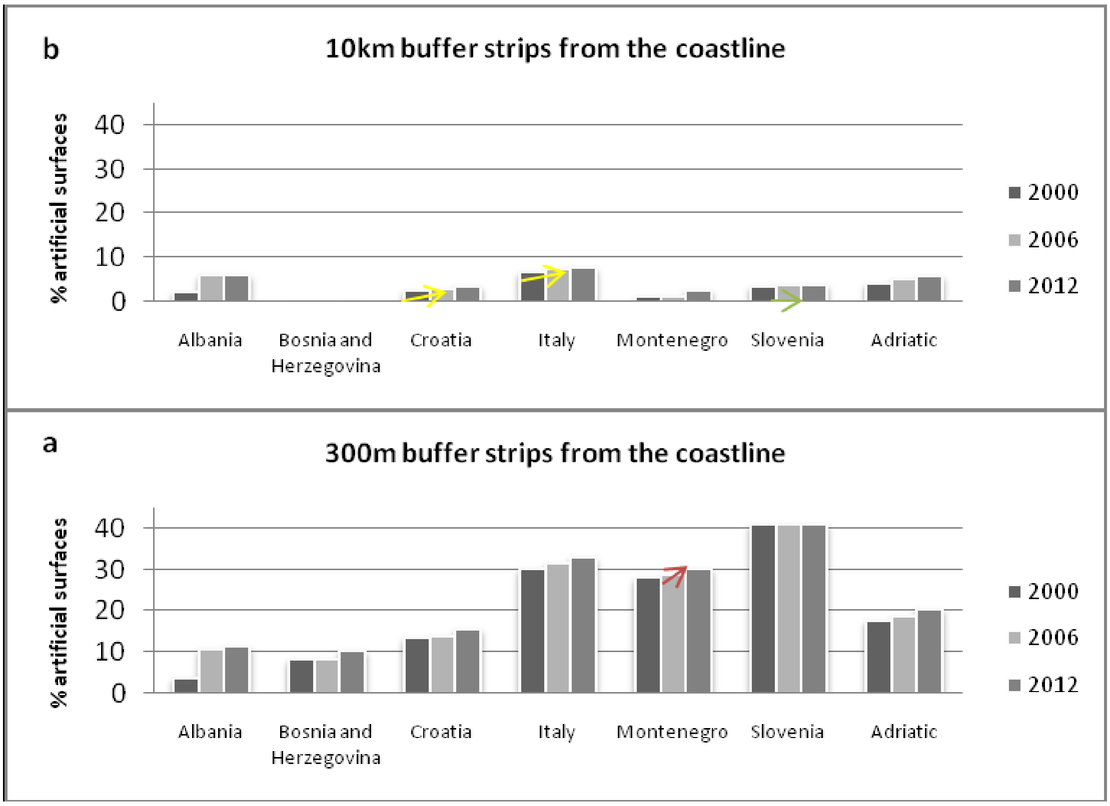


*Figure 3. The share of artificial areas, in total area through the 2000-2012 period for 300m buffer strip (a) and 10 km buffer strip (b) in Adriatic countries and as a whole sub-region. Source: Pilot project in the Adriatic on testing the candidate common indicator 'Land use change' in the Mediterranean" (UNEP/MAP/PAP, RAC, 2015).*

<u>Existing monitoring requirements and programmes</u>

56. Monitoring the length of coastline subject to physical disturbance due to the influence of manmade structures and its trend is of paramount importance to preserve habitat, biodiversity and prevent coastal erosion phenomena. Until now there has not been systematic monitoring in the Mediterranean regarding this, in particular not quantitatively based monitoring or any major attempt to homogenously characterize coastal ecosystems on a wider Mediterranean basis. As far as the Indicator 25 Land use change it is commonly use in land use planning and for similar purposes. However, it has not been utilised for the EcAp per se although it is widely recognised that is a significant link between land use changes and impacts on habitats and ecosystems.

<u>Considerations regarding the appropriate scale of monitoring for CI 16 and Candidate CI 25</u>

57. Regarding CI 16, in comparative terms, the assessment of environmental coastal issues requires a more detailed monitoring scale than the offshore waters approach (e.g. sub-regional level). This is especially true when coping with coastal infrastructures detection. The spatial coverage where manmade structures can be found only involves a coastal fringe of 200 metres in amplitude (offshore structures are covered by another EcAp indicator). Moreover, some of the elements required to monitor are structures of a few metres in length and/or amplitude (e.g. groynes, seawalls, etc.).

58. The monitoring of the CI 16 entails an inventory of:

(i) the length and location of manmade coastline (hard coastal defence structures, ports, marinas. Soft techniques e.g. beach nourishment are not included.

(ii) land claim, i.e. the surface area reclaimed from the 1980's onward (ha); and
(iii) the Impervious surface in the coastal fringe (100m from the coastline).

59. With regard to the coastline to be considered: the fixed reference official coastline as defined by the responsible Contracting Party should be considered. The optimal resolution should be 5 m or 1: 2000 spatial scale.

60. Once a proper geographic scale has been established, monitoring should focus, in particular, on the location, the spatial extent and the types of coastal structures taking into account the minimum coastal length that can be classified as artificial or natural.

61. For the assessment purpose, ideally the appropriate scale would be at the level of coastal water bodies. Thereafter, if needed, the scanned data (i.e. metres of coastline affected, or hectares reclaimed or occupied by impervious surfaces) can be added to higher levels (e.g. administrative boundaries or Mediterranean sub-regions). The MEDAM Project inventory (http://www.medam.info/index.php/en/) offers a good example of this bottom up approach by recording the length of manmade structures and the area occupied by land claim at different spatial levels: water body, town, department, region and country.

62. The optimum spatial scale for a proper identification of manmade structures should be 5 m by satellite imagery or aerial photographs.

63. In the case of the Candidate CI 25, the ICZM Protocol defines the landward limit of coastal zone as the "limit of the competent coastal units as defined by the Parties" (Article 3) as the spatial scale of monitoring. In other words, the landward limit will be country specific, e.g. dependent on the definition given by a certain Contracting party when ratifying the Protocol. As for the resolution of the source data it is a compromise between precision and efforts needed in processing the satellite images. The following indications (UNEP(DEPI)/MED WG.433/Inf.2) could be considered minimum requirements:

- Minimum mapping unit of 25 ha and 100 m of linear elements
- Minimum change detection 5 ha

The frequency of monitoring for CI 16, and Candidate CI 25

64. Monitoring manmade structures data should be updated at least every six years. This shall lead to a homogeneous level of knowledge, which will make data comparison and transfer/exchange of project and management experiences more effective (UNEP(DEPI)/MED IG.22/Inf.7). As monitoring should be performed every 6 years, every Contracting Party should fix a reference year in the time interval 2000-2012 in order to eliminate the bias due to old or past manmade infrastructures.

65. Shoreline survey of the sandy coastline under man-made pressure should be repeated preferably annually (at the same time of the year) (UNEP(DEPI)/MED WG.433/Inf.2).

66. The frequency of monitoring for the Candidate CI 25 should be 5 years, in order to be effective in counteracting negative effects and taking early actions in problematic areas (UNEP(DEPI)/MED WG.433/Inf.2).

Gaps in spatial and temporal coverage, general appreciation

67. Regarding the CI 16, the identified knowledge gaps relate to the spatial resolution and temporal coherence. Regarding the Candidate CI 25, the identified knowledge gaps relate to the different delineation of analytical units of the coastal zone and the limitation of spatial resolution/change detection.

68. Recommendations and guidelines regarding relevant monitoring scales related to CI 16 and Candidate CI 25regarding IMAP Ecological Objective 8. It is recommended to employ well trained personnel for GIS digitalization and agreed procedures applied uniformly on the overall coastline. Merging products carried out by different teams, although based on the same data sources, can result in an inhomogeneous final output (Giorgi, 2017). Regarding the CI 25 the definition of the analytical units of the coastal zone may be revised in view of more detailed data on habitats distribution, or input from national experts. The needs of several of the 7 beneficiary countries of ECAP MED II in in terms of monitoring capacity in addressing this CI in terms of training and equipment would need to be addressed.

## Conclusions and Recommendations

69. In general, it is recommended that monitoring and assessment scales should in general reflect the following, in line with OSPAR (2011):

- Ecologically relevant scales for biodiversity components
- Spatial variability of pressures and their impacts on biodiversity
- Linking of pressures and measures
- Adopting a risk based approach through the screening of environmental state[3].

70. Regional seas conventions have used similar approaches to scales for monitoring and assessment as presented in Annex 3 to the present document (Deltares, 2013).

### Biodiversity and Fisheries cluster

71. In the broader context of the IMAP framework there is the need to keep the monitoring requirements manageable. Especially, but not exclusively, when considering biodiversity, it is recommended (UNEP(DEPI)/MED WG.432/4) to focus on so called "representative sites" with the criteria for the selection as the following:

- Where pressures and risks on biodiversity are most strongly associated, following a risk based approach (vulnerable habitats and species locations);
- Where most information/historic data are available;
- Where well established monitoring (in general, not only for biodiversity) is already undertaken;
- Sites of high biodiversity importance and conservation interest (according to national, regional or international regulations);
- Expert opinion.

72. Locations to be monitored should be prioritised to cover at least areas of influence from anthropogenic activities, which are expected to cause impacts upon biological diversity, with priority on the areas at highest risk. In this case, where possible, is recommended to use transects from high to low pressure, so as to cross the "GES boundary"; – can help define the boundary between areas in GES and those not in GES.

73. Monitoring activities should be conducted also in areas considered representative of un-impacted (reference) conditions, i.e. not thought to be subject to, or impacted by, pressures. Accordingly, monitoring in marine and coastal protected areas or Specially Protected Areas under the SPA/BD Protocol should be a core activity undertaken during the initial phase.

74. A risk-based approach, with the definition of representative sites, helps to prioritize areas and indicators for monitoring and assessment. A pragmatic prioritization is made based on the risk of non-achievement of the GES, which enables general statements about environmental status at large scales while keeping monitoring requirements manageable. (Cardoso et al. 2010).

75. Furthermore the OSPAR Joint Assessment and Monitoring Programme (JAMP) 2014 – 2021, suggests that monitoring efforts could be focused on areas where there is the greatest likelihood of

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[3] In the risk-based approach, a pragmatic prioritization is made according the risk to not achieve GES, which enables general statements about environmental status at large scales while keeping monitoring requirements manageable (Cardoso et al. 2010)

significant change as a result of changes in drivers (pressures) determining the local or (sub)regional situation.

76. Decreasing of the monitoring frequency is possible for locations where established time series show status to be well below risk levels of concern, and without any deteriorating trend over a number of years.

**Marine Pollution and Litter Cluster**

77. The implementation of the EcAp in Southern Mediterranean Countries is challenging, due to the large investment required and, in some instances, to the fragmentation and overlapping of mandates among different monitoring agencies at present. At the initial stage of IMAP, it is especially important to differentiate between initial/screening monitoring and long-term monitoring.

78. There is also the need to outline appropriate and reasonable monitoring scales to catch the natural and the pressure-inducted variability, in order to maximise the cost/benefits ratio, and therefore, to define the reference data/reference sites for each of these indicators.

79. For all the Common Indicators and for assessment purposes under EOs related to Pollution and Marine Litter (EO5, EO9, EO10 and EO11), the development of geospatial statistics, the use of GIS tools, RBA approaches and uncertainty analysis would assist the setting of temporal and spatial scales, and therefore, fit-for-purpose monitoring, reporting and assessments to deliver the IMAP expectations.

**Coast and Hydrography Cluster**

80. Regarding EO7 it is essential to recall that it is not the scale of the construction that is important but the scale of the impacts. The chosen spatial and temporal scales must be able to assess all the (main) hydrographical alterations induced by the future structure. These scales are strongly site-dependent.

81. As for the determination of the extent of the domain to be considered, this will depend on the distance from the specific human activity to areas subject to impact and areas of specific interest, for example adjacent coasts or bays, or sensitive habitats. A clear identification of the sensitive receptors, such as local habitats, fauna and/or flora and habitat/ecosystem functions, and their natural extent is a key input for the determination of the spatial scale, as the boundaries of the model might need extending or adjusting to fully include these into the computational domain. The scale determination should therefore take into account the scales used for the EO1/EO6 habitat assessments. The OSPAR Commission advises to consider the spatial scale equivalent to EUNIS level 3 as the most appropriate scale (Spiteri, 2015).

82. Two temporal scales can be distinguished in coastal and marine processes: short-term (hours/days/weeks/months) and long-term (months/years/decades). Short-term processes are largely instantaneous and include the swift response of processes occurring on these time scales. These include transient processes like tidal movements, local currents, waves, as well as storm events and initial scour in mobile sediments. Long-term processes tend to describe the cumulative effects of short-term processes. They often refer to changes in larger-scale background circulations, changes in regimes, e.g. residual currents, salinity and temperature, morphological evolution of seabed and/or coastline due to a development (steady), and extreme events, such as storms. With respect to EO7, the 10-year time period associated to the definition of “permanent” should be taken into account for a long-term impact analysis assessment. However, since short-term processes need to be resolved in order to perform an assessment of the long-term effects, the first step is to predict these processes on a short term and assess the initial changes (e.g. 2-3 years). The choice of assessment method, e.g. model, must allow for obtaining the required information at the appropriate temporal scale. For example, a model that is required to assess the effect of a structure on currents must be able to resolve changes in

current speed and direction on a suitable timescale, typical minutes to hours. A model that is required to simulate the morphological evolution on the long term does not need to resolve the individual wave spectra on a short time scale but rather calculates the net response to a statistically-described wave climate or to a long-term residual transport pattern (Lambkin et al., 2009). In this respect, the selection of the model time step should also take into account the natural time scales of the processes/phenomena that are captured by the model (Spiteri 2015).

83. Regarding EO8 and the CI 16, if spatial resolution is too low manmade structures could be poorly identified or completely missed with heavy consequences on the calculation of length of artificial coastline. Spatial resolution depends both on the resolution of data sources as satellite imagery or aerial photographs and on the accuracy assured by the digitalization process. It would therefore be necessity to employ well trained personnel for GIS digitalization and agreed procedures applied uniformly on the overall coastline. Merging products done by different teams, although based on the same data sources, can result in an inhomogeneous final output (Giorgi, 2017). Regarding the CI 25 the definition of the analytical units of the coastal zone may be revised in view of more detailed data on habitats distribution, or input from national experts. In any case it is important to take into account the implications of the different delineations on the interpretation of the results (UNEP(DEPI)/MED WG.433/Inf.).

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## Annex 1

## List of IMAP Common Indicators and related Ecological Objectives

**Annex 1. List of IMAP Common Indicators and related Ecological Objectives**

| Ecological Objective | IMAP Indicators |
|---|---|
| EO 1 Biodiversity | |
| Biological diversity is maintained or enhanced. The quality and occurrence of_coastal and marine habitats and the distribution and abundance of coastal and marine species are in line with prevailing physiographic, hydrographic, geographic and climatic conditions. | Common Indicator 1: Habitat distributional range (EO1) to also consider habitat extent as a relevant attribute |
| | Common Indicator 2: Condition of the habitat's typical species and communities (EO1) |
| | Common Indicator 3: Species distributional range (EO1 related to marine mammals, seabirds, marine reptiles) |
| | Common Indicator 4: Population abundance of selected species (EO1, related to marine mammals, seabirds, marine reptiles) |
| | Common indicator 5: Population demographic characteristics (EO1, e.g. body size or age class structure, sex ratio, fecundity rates, survival/mortality rates related to marine mammals, seabirds, marine reptiles) |
| EO 2 Non-indigenous species | |
| Non-indigenous species introduced by human activities are at levels that do not adversely alter the ecosystem | Common Indicator 6: Trends in abundance, temporal occurrence, and spatial distribution of non-indigenous species, particularly invasive, non-indigenous species, notably in risk areas (EO2, in relation to the main vectors and pathways of spreading of such species) |

| | |
|---|---|
| EO 3 Harvest of commercially exploited fish and shellfish | |
| EIHA | Common Indicator 7: Spawning stock Biomass (EO3); |
| | Common Indicator 8: Total landings (EO3); |
| | Common Indicator 9: Fishing Mortality (EO3); |
| | Common Indicator 10: Fishing effort (EO3); |
| | Common Indicator 11: Catch per unit of effort (CPUE) or Landing per unit of effort (LPUE) as a proxy (EO3) |
| | Common Indicator 12: Bycatch of vulnerable and non-target species (EO1 and EO3) |
| EO 4 Marine food webs | |
| Alterations to components of marine food webs caused by resource extraction or human-induced environmental changes do not have long-term adverse effects on food web dynamics and related viability | To be further developed |
| EO 5 Eutrophication | |
| Human-induced eutrophication is prevented, especially adverse effects thereof, such as losses in biodiversity, ecosystem degradation, harmful algal blooms and oxygen deficiency in bottom waters. | Common Indicator 13: Concentration of key nutrients in water column (EO5); |
| | Common Indicator 14: Chlorophyll-a concentration in water column (EO5) |
| EO 6 Sea-floor integrity | |
| Sea-floor integrity is maintained, especially in priority benthic habitats | To be further developed |
| EO7 Hydrography | |

| | |
|---|---|
| Alteration of hydrographic conditions does not adversely affect coastal and marine ecosystems. | Common Indicator 15: Location and extent of the habitats impacted directly by hydrographic alterations (EO7) to also feed the assessment of EO1 on habitat extent |
| EO 8 Coastal ecosystems and landscapes | |
| The natural dynamics of coastal areas are maintained and coastal ecosystems and landscapes are preserved | Common Indicator 16: Length of coastline subject to physical disturbance due to the influence of man-made structures (EO8); |
| | Candidate Indicator 25: Land use change (EO8) |
| EO 9 Pollution | |
| Contaminants cause no significant impact on coastal and marine ecosystems and human health | Common Indicator 17: Concentration of key harmful contaminants measured in the relevant matrix (EO9, related to biota, sediment, seawater) |
| | Common Indicator 18: Level of pollution effects of key contaminants where a cause and effect relationship has been established (EO9) |
| | Common Indicator 19: Occurrence, origin (where possible), extent of acute pollution events (e.g. slicks from oil, oil products and hazardous substances), and their impact on biota affected by this pollution (EO9); |
| | Common Indicator 20: Actual levels of contaminants that have been detected and number of contaminants which have exceeded maximum regulatory levels in commonly consumed seafood (EO9); |
| | Common Indicator 21: Percentage of intestinal enterococci concentration measurements within established standards (EO9) |

| | |
|---|---|
| EO 10 Marine litter | |
| Marine and coastal litter do not adversely affect coastal and marine environment | Common Indicator 22: Trends in the amount of litter washed ashore and/or deposited on coastlines (EO10); |
| | Common Indicator 23: Trends in the amount of litter in the water column including microplastics and on the seafloor (EO10); |
| | Candidate Indicator 24: Trends in the amount of litter ingested by or entangling marine organisms focusing on selected mammals, marine birds, and marine turtles (EO10) |
| EO 11 Energy including underwater noise | |
| Noise from human activities cause no significant impact on marine and coastal ecosystems | Candidate Indicator 26: Proportion of days and geographical distribution where loud, low, and mid-frequency impulsive sounds exceed levels that are likely to entail significant impact on marine animal |
| | Candidate Indicator 27: Levels of continuous low frequency sounds with the use of models as appropriate |

**Annex 2**

**Common basic marine monitoring programmes within the Barcelona Convention which could be adapted to deliver IMAP CI for Pollution and Marine litter**

## Annex 2. Common basic marine monitoring programmes within the Barcelona Convention which could be adapted to deliver IMAP CI for Pollution and Marine litter

*Table 4. * indicates the CI which could be potentially delivered*

| Type of Programme | Objectives and implementation | Ecological Objectives (EOs) and Common Indicators (CIs) potentially covered |
|---|---|---|
| MEDPOL Programme (Eutrophication and Chemical pollution) | Monitoring, control and assessment of land-based sources of pollution (eg. Hotspots, coastal sites and reference areas scattered through national coastlines) | **EO5-CI13**.Concentration of key nutrients in water column;<br>**EO5-CI14**.Chlorophyll-a concentration in water column;<br>**EO9-CI17**. Concentration of key harmful contaminants measured in the relevant matrix (biota, sediment, seawater);<br>**EO9-CI18**. Level of pollution effects of key contaminants where a cause and effect relationship has been established |
| MEDPOL Programme (Bathing Waters Quality) | Monitoring and control of microbial pathogens in recreational areas (eg. selected beaches during the touristic season) | **EO9-CI21**.Percentage of intestinal enterococci concentration measurements within established standards;<br>***EO10-CI22**.Trends in the amount of litter washed ashore and/or deposited on coastlines (including analysis of its composition, spatial distribution and, where possible, source.) |
| Fisheries and aquaculture management programmes (driven by FAO) | Monitoring, control, statistics and surveillance of comercial fisheries and aquaculture activities (e.g. sampling in comercial ports/fish markets, ship observers, catch quota) | ***EO9-CI17**. Concentration of key harmful contaminants measured in the relevant matrix (biota, sediment, seawater);<br>***EO9-CI18**. Level of pollution effects of key contaminants where a cause and effect relationship has been established;<br>***EO9-CI20**. Actual levels of contaminants that have been detected and number of contaminants which have exceeded maximum regulatory levels in commonly consumed seafood;<br>***EO10-CI23**.Trends in the amount of litter in the water column including microplastics and on the seafloor;<br>***EO10-Candidate CI24**: Trends in the amount of litter ingested by or entangling marine organisms focusing on selected mammals, marine birds and marine turtles; |
| Marine Protected Areas (MPAs) Programmes | Surveillance and environmental control (eg. protected species, marine ecosystems, etc.) | ***EO5-CI13**.Concentration of key nutrients in water column;<br>***EO5-CI14**.Chlorophyll-a concentration in water column;<br>***EO9-CI17**. Concentration of key harmful contaminants measured in the relevant matrix (biota, sediment, seawater);<br>***EO9-CI18**. Level of pollution effects of key contaminants where a cause and effect relationship has been established<br>***EO10-CI22**.Trends in the amount of litter washed ashore and/or deposited on coastlines (including analysis of its composition, spatial distribution and, where possible, source.)<br>***EO10-CI23**.Trends in the amount of litter in the water column including microplastics and on the seafloor;<br>***EO10-Candidate CI24**: Trends in the amount of litter ingested by or entangling marine organisms focusing on selected mammals, marine birds and marine turtles; |
| National Programmes to combat Marine and Coastal Pollution | Surveillance, Oil spill response | ***EO9-CI19**. 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; |

## Annex 3

## Approaches to scales for monitoring and assessment by Regional Sea Conventions

## Annex 3. Approaches to scales for monitoring and assessment by Regional Sea Conventions

### Baltic Sea (HELCOM)

Under HELCOM a subdivision of the Baltic Sea was developed for monitoring and assessment purposes. This subdivision consists of four hierarchical scales (Figure 6):

- The entire Baltic Sea
- A subdivision of the Baltic Sea into 19 sub-basins that are divided by sills, and exhibit different physical, chemical (size, volume, depth, salinity) and biological characteristics. These 19 basins include the Kattegat and the northern part of the Sound, (part of the Greater North Sea).
- A further division of the sub-basins in coastal and offshore areas, including Exclusive Economic Zone (EEZ) boundaries between Baltic States
- A further division of the coastal areas into water bodies (in this case as defined under the WFD).

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. Under HELCOM it is recommended that the scale to be used should be chosen from the four possible scales (HELCOM 2013).

### Mediterranean Sea (Barcelona Convention)

In the process of the application of the Ecosystem Approach (ECaP) adopted by the Barcelona Convention in 2008, the Mediterranean was subdivided into four geographic areas for the identification of the important ecosystem properties and the assessment of ecological status and pressures. These four areas are (1) Western Mediterranean, (2) Adriatic Sea (3) Ionian Sea and Central Mediterranean, (4) Aegean-Levantine Sea. This operational subdivision was the result of a decision by the Contracting Parties based on biogeographical and oceanographic considerations (UNEP/MAP 2008). The subdivision was used to produce four sub-regional assessments (UNEP/MAP 2010) and the Initial Integrated Assessment of the Mediterranean Sea (UNEP/MAP 2012) that informs on marine and coastal ecosystem status, pressures and impacts. The subdivision was used for the assessment of hazardous substances using the MEDPOL monitoring Database (UNEP/MAP 2011).


*Figure 4. Map of the Baltic Sea presenting the HELCOM sub-division into 17 open sub-basins and 42 coastal areas. EEZs of the countries are shown with a grey dashed line.*

**Northeast Atlantic (OSPAR)**

OSPAR distinguishes five sub-areas (OSPAR regions I to V). The OSPAR sub-areas are to a large extent similar to the sub-regional seas within the NE Atlantic, but it should be noted that there are differences in the boundaries between the areas and in the outer boundaries.

In the latest Quality Status Report (OSPAR 2010) the results of environmental assessments are presented for a number of themes. Well-developed approaches for assessments have been developed for the whole OSPAR area for the topics eutrophication, hazardous substances and radioactive substances.

Figure 2. Subdivisions of the OSPAR area used in contaminant data assessment for the QSR 2010, showing offshore areas, and coastal waters defined by the 12 nautical mile limit, in OSPAR Regions I-IV. The colours are of no significance, but are included to improve clarity of the map.

*Figure 5. Sub-divisions of the OSPAR area used for contaminant data assessment of the QSR 2010.*

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. The assessments are 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.

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