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REGIONAL MARINE POLLUTION EMERGENCY RESPONSE CENTRE FOR THE MEDITERRANEAN SEA (REMPEC)

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Agenda Item 2: Offshore Monitoring Programme – IMAP Common Indicators

Guidance Factsheets of the proposed IMAP Common Indicators to be monitored as part of the Offshore Protocol

REMPEC
Malta, 2023

Note by the Secretariat

Within the context of the Mediterranean Offshore Action Plan (MOAP) and more precisely of its - Specific Objective 9 – defining that "The Offshore monitoring programme will be developed in line with the Ecosystem Approach Process (EcAp) Roadmap and, in particular, with the Integrated Monitoring and Assessment Programme" (IMAP), this document reproduces Guidance Factsheets that have been endorsed by CPs in the context of the implementation of the EcAp, in order to assess the status of the Mediterranean Sea and coast.
The Guidance Factsheets reproduced are those of the proposed five keys IMAP CIs to be monitored as part of the Offshore Protocol (CIs 1, 2, 15, 17 and 18).

The Guidance Factsheets reproduced in this document have been extracted from:

- UNEP(DEPI)/MED WG.444/6/Rev.1;
- UNEP/MED WG.467/6; and
- UNEP/MED WG.467/5

The data and information included in this document are in support of the Meeting document REMPEC/WG.55/2.

Annex I

Introduction to the Structure of the Common Indicator Factsheets

1 The 19th Meeting of Contracting Parties (COP 19), held in February 2016, adopted the Integrated Monitoring and Assessment Programme (IMAP) of the Mediterranean Sea and Coast and Related Assessment Criteria (Decision IG. 22/7), with a list of regionally agreed good environmental status descriptions, common indicators and targets, with principles and clear timeline for its implementation.

2 IMAP, through Decision IG.22/7 lays down the principles for an integrated monitoring, which will, for the first time, monitor biodiversity and non-indigenous species, pollution and marine litter, coast and hydrography in an integrated manner. As such, IMAP aims to facilitate the implementation of article 12 of the Barcelona Convention and several other monitoring related provisions under different Protocols . Its backbone are the 11 Ecological Objectives and their 27 common indicators as presented in Decision IG. 22/7.

3 The UNEP/MAP Programme of Work (PoW) adopted at COP 19, includes Output 1.4.3 for *the Implementation of IMAP (the EcAp-based integrated monitoring and assessment programme) coordinated, including GES common indicators fact sheets, and supported by a data information centre to be integrated into Info/MAP platform*.

4 In line with the above, guidance factsheets have been developed for each Common Indicator to ensure coherent monitoring, with specific targets defined and agreed in order to deliver the achievement of Good Environmental Status (GES) and as such, provide concrete guidance and references to Contracting Parties to support implementation of their revised national monitoring programmes towards the overall goal of implementing the Ecosystem Approach (EcAp) in the Mediterranean Sea and achieving GES.

5 The structure of a Common Indicator Factsheet can be summarized by looking at the different organization levels of the developed factsheet templates. A common set of relevant policy and science-based information is required on each (ie. Indicator Title, Rational, Policy Context and Targets, Indicator analysis methods and Methodology for monitoring (temporal and spatial scope), Contacts and Document Registration). In each, detailed definitions, methodologies, references, gaps, uncertainties, data analysis approaches, basis for aggregation (if applies) and outputs complete the guidance factsheets, as described under, in Table 1 of the Annex.

Table 1: Scheme of IMAP Factsheet Template:

Indicator Title			
Relevant GES definition	**Related Operational Objective**	**Proposed Target(s)**	**IMAP Reference No and definition**
Rationale			**Scientific rationale and marine policy context (including relevant references)**
Justification for indicator selection			
Scientific References			
Policy Context and targets			
Policy context description			
Targets			
Policy documents			
Indicator analysis methods			**Agreed scientific methodologies in use, including detailed monitoring requirements**
Indicator Definition			
Methodology for indicator calculation			
Indicator units			
List of Guidance documents and protocols available			
Data Confidence and uncertainties			
Methodology for monitoring, temporal and spatial scope			
Available Methodologies for Monitoring and Monitoring Protocols			
Available data sources			
Spatial scope guidance and selection of monitoring stations			
Temporal Scope guidance			
Data analysis and assessment outputs			**Data reporting, analysis and aggregation (outpout)**
Statistical analysis and basis for aggregation			
Expected assessments outputs			
Known gaps and uncertainties in the Mediterranean			
Contacts and version Date			**Document Registration**
Key contacts within UNEP for further information			
Version No	**Date**	**Author**	

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Annex II

Reproduction of Guidance Factsheet for Common Indicator 1 : Habitat distributional range (EO 1).

Indicator Title	*Common Indicator 1: Habitat distributional range*		
Relevant GES definition	Related Operational Objective	Proposed Target(s)	
		State	**Pressure**
The habitat is present in all its natural distributional range	Coastal and marine habitats are not being lost	The ratio Natural / Observed distributional range tends to 1	Decrease in the main human causes of the habitat decline

Rationale

Justification for indicator selection

The loss of habitat extent i.e. from infrastructure developments and by damage from physical activities such as trawling and possibly damage from pollution is an important factor to monitor and assess. The indicator is in principle applicable to all habitat types across the Mediterranean region and it is considered to be highly sensitive to physical pressures.

Scientific References

List (author(s), year, Ref: journal, series, etc.) and url's

Andersen et al., 2013

- Coggan, R., Populis, J., White, J., Sheehan, K., Fitzpatrick, F., Peil, S. (eds) (2007) Review of standards and protocols for seabed habitat mapping, 192pp.
- Coll, M., Piroddi, C., Albouy, C., Lasram, F.B.R., Cheung, W.W.L., et al. 2012. The Mediterranean Sea under siege: spatial overlap between marine biodiversity, cumulative threats and marine reserves. Glob. Ecol. Biogeogr. 21, 465–480.
- Giakoumi, S., Sini, M., Gerovasileiou, V., Mazor, T., Beher, J., et al. 2013. Ecoregion-based conservation planning in the Mediterranean: dealing with large-scale heterogeneity. PLoS ONE 8(10): e76449. doi:10.1371/journal.pone.0076449.
- Halpern, B.S., Walbridge, S., Selkoe, K.A., Kappel, C.V., Micheli, F., et al., 2008. A global map of human impact on marine and coastal ecosystems. Science 319, 948–952.
- Halpern, B.S., Kappel, C.V., Selkoe, K.A., Micheli, F., Ebert, C.M., et al. 2009. Mapping cumulative human impacts to California current marine and coastal ecosystems. Conserv. Lett. 2, 138–148.
- Kappel, C.V., Halpern, B.S., Napoli, N., 2012. Mapping Cumulative Impacts of Human Activities on Marine and coastal ecosystems. Coastal and Marine Spatial Planning Research Report 03.NCEAS.12). Sea Plan, Boston. 109pp.
- Korpinen S., Meidinger M., Laamanen, M., 2013. Cumulative impacts on seabed habitats: An indicator.for assessments of Good Environmental Status. Mar. Poll. Bull., 74: 311–319.
- Micheli F, Halpern BS, Walbridge S, Ciriaco S, Ferretti F, et al. 2013. Cumulative Human Impacts on Mediterranean and Black Sea Marine and coastal ecosystems: Assessing Current Pressures and Opportunities. PLoS ONE 8(12): e79889.
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Policy Context and targets (other than IMAP)

Policy context description

The CORMON Biodiversity and Fisheries Meeting (Ankara 26-27 July, 2014) recommended that loss of habitat extent is typically more important/at higher risk, with loss of distributional range only secondarily at risk.

Indicator/Targets

This indicator is an area-related indicator, i.e. proportion of the area of habitats that are permanently or for a long-lasting period lost or subject to change in habitat-type due to anthropogenic pressures. As a target, the damaged or lost area per habitat type, especially for physically defined and not biogenic habitats could be set as to not exceed an acceptable percentage

Indicator Title	*Common Indicator 1: Habitat distributional range*

of the baseline value. As an example, this target was derived from OSPAR to not exceed 15% of the baseline value and was similarly proposed by HELCOM.
For habitats under protective regulations (such as those listed under the SPA/Biodiversity Protocol, EU Nature directives) the target could be set as habitat loss stable or decreasing and not greater than the baseline value. As an example, as regards the EU guidance for the assessment of conservation status under the Habitats Directive, Member States have generally adopted a 5% tolerance above the baseline to represent "stable". However, in some cases a more stringent <1% tolerance has been attached to the maintenance of habitat extent.
A list of the basic marine habitat types – at higher level – to be considered within this indicator is given below (supralittoral habitats are excluded). This list is based on the RAC/SPA Reference List of Marine and Coastal Habitat Types in the Mediterranean (see the RAC/SPA Reference List for a more detailed classification).

II.1 Mediolittoral muds, sandy muds and sands
II.2. Mediolittoral sands
II.3. Mediolittoral stones and pebbles
II.4. Mediolittoral hard beds and rocks
III.1. Infralittoral sandy muds, sands, gravels and rocks in euryhaline and eurythermal environment
III.2. Infralittoral fine sands with more or less mud
III.3. Infralittoral coarse sands with more or less mud
III.4. Infralittoral stones and pebbles
III.5. Infralittoral *Posidonia oceanica* meadows
III.6. Infralittoral hard beds and rocks
IV.1. Circalittoral muds
IV.2. Circalittoral sands
IV.3. Circalittoral hard beds and rocks
V.1. Bathyal muds
V.2. Bathyal sands
V.3. Hard beds and rocks
VI.1 Abyssal muds

Specific attention should be given to the types of marine habitats (defined at different levels) covered by the Updated Reference List of Marine Habitat Types for the Selection of Sites to be included in the National Inventories of Natural Sites of Conservation Interest in the Mediterranean (UNEP/MAP-RAC/SPA 2017) and EU Nature directives. Marine habitat types in *Annex I* of the EU Habitats Directive (92/43/EEC), based on MSFD Common Implementation Strategy (2012), with the exclusion of estuarine habitats, is given below:

1110 – Sandbanks which are slightly covered by sea water all the time
1120* – *Posidonia* beds (*Posidonion oceanicae*)
1140 – Mudflats and sandflats not covered by seawater at low tide
1160 – Large shallow inlets and bays
1170 – Reefs
1180 – Submarine structures made by leaking gasses
8330 – Submerged or partially submerged sea caves
** Priority habitats*

Policy documents
List and url's

- SPA/Biodiversity Protocol (http://www.rac-spa.org/protocol)
- EU Nature directives (http://ec.europa.eu/environment/nature/info/pubs/directives_en.htm)
- OSPAR (http://www.ospar.org/)

Indicator analysis methods

Indicator Title	*Common Indicator 1: Habitat distributional range*

Indicator Definition

This area-related indicator could be described as the proportion of the area of habitats that are permanently or for a long-lasting period lost or subject to change in habitat-type due to anthropogenic pressures, and is closely linked to condition elements (i.e., if a habitat condition is sufficiently poor and irrecoverable, it is lost).

Methodology for indicator calculation

Three options have been identified for the assessment of this indicator:

1. The use of condition indices and a representative sampling and assessment in a restricted number of areas with subsequent extrapolation into the larger area
2. Modelling habitats and mapping against impacts and spatial pressure intensity data. It may also be possible to combine options 1 and 2.
3. Direct monitoring of habitats

Indicator units

The parameter/metric for the assessment of this indicator is the surface area of lost habitat for each habitat type. It is suggested to largely use cumulative impact data derived from knowledge of anthropogenic pressures.

List of Guidance documents and protocols available

- RAC/SPA Protocol for the Posidonia meadows monitoring networks[1]
- RAC/SPA Protocol for the monitoring of coralligenous community[2]

Data Confidence and uncertainties

The identification of habitat sites in marine areas away from the coast has to be based on more general geological, hydrological, geomorphological and biological data than is the case for coastal or terrestrial areas. Where the location of sub-littoral habitat types is not already known, they can be located in two steps using available data: (1) broad scale geophysical or oceanographic information is often available for large sea areas, and can be used as the first step in the selection of sites by helping to identify the location of potential habitats; (2) step two then involves focused information gathering or new surveys, directed to those specific areas where existing information indicates that a habitat type is present or is likely to be present. This approach is particularly useful for Contracting Parties with large sea areas and deep waters, where detailed biological information is likely to be sparsely distributed. Collation of data should involve examination of scientific archives and data from relevant academic, government, NGO, and industry stakeholders. This information can include historical charts of relevant seabed features and fishing grounds.

Data regarding human activities causing habitat loss have been usually produced by projects requiring licensing procedures and Environmental Impact Assessments (e.g. wind farm constructions, sediment extraction). Therefore, relevant data should be available to Contracting Parties. A range of activity data regarding habitat damage caused by other activities (e.g. fishing) is also available from various sources (e.g. VMS or log book data for larger fishing vessels that undertake bottom trawling). On the basis of these data it should then be decided on a case by case basis, applying a risk based approach, where to focus monitoring/sampling efforts to validate, extrapolate or measure habitat area.

Methodology for monitoring, temporal and spatial scope

Available data sources

Sources and url's

UKSeaMap 2010 - predictive mapping of seabed habitats : http://jncc.defra.gov.uk/ukseamap
EMODnet Seabed Habitats (EUSeaMap) project : http://jncc.defra.gov.uk/euseamap
EMODnet Human Activities : http://www.emodnet.eu/human-activities

[1] Pergent G., 2007. Protocol for the setting up of Posidonia meadows monitoring systems. «MedPosidonia» Programme / RAC/SPA - TOTAL Corporate Foundation for Biodiversity and the Sea; Memorandum of Understanding N°21/2007/RAC/SPA_MedPosidonia Nautilus-Okianos: 24p + Annexes.

[2] RAC/SPA - UNEP/MAP, 2014. Monitoring Protocol for Reefs - Coralligenous Community. By Garrabou J, Kipson S, Kaleb S, Kruzic P, Jaklin A, Zuljevic A, Rajkovic Z, Rodic P, Jelic K, and Zupan D. Ed. RAC/SPA - MedMPAnet Project, Tunis. 35 pages + annexes.

Indicator Title	*Common Indicator 1: Habitat distributional range*

Recent European projects have produced updated habitat lists and catalogues with habitat map resources (e.g. CoCoNet, NETMED, MAREA-Mediseh, MERCES).

Spatial scope guidance and selection of monitoring stations

Considering that the monitoring under IMAP should follow a risk-based approach, the reference sites to be monitored should be located in zones with infrastructure developments or significant physical activities having the potential to generate damages to the marine habitats (dredging, trawling activities, etc.). Possible damage from pollution should be also considered.

For the marine areas located away from the coast, the identification of monitoring sites has to be based on general geological, hydrological, geomorphological and biological data.

The monitoring programmes of each Contracting Party should cover the reference habitat in at least two monitoring areas :

- low pressure area (e.g. marine protected area/Specially Protected Area of Mediterranean Importance)
- high pressure area from human activity

The monitoring sites should be selected among those which can showcase the relationship between environmental pressures and their main impacts on the marine environment.[3]

Temporal Scope guidance

Consistent scales and methods will be necessary for mapping a given habitat in a sub-region. The time of sampling should be synchronised for a sub-region so as to standardize the influence of seasonal, inter-annual or climate-related changes on results. Intervals of 3-6 years are probably appropriate when non-invasive surveys (e.g. side scan sonar, video) or models (to be validated by optimized sampling) are used for mapping.

Data analysis and assessment outputs

Statistical analysis and basis for aggregation

No statistical analyses are needed for this assessment.

Expected assessments outputs

I.e. trend analysis, distribution maps etc, and methods used

In general terms, the following steps should be part of the indicator's assessment:

- Generate maps of the marine habitats in each Contracting Party's marine areas;
- Attribute a specific sensitivity to physical pressures to different habitat types;
- Collate spatial and temporal pressure intensity data (e.g. VMS or log book data for fisheries, activity data from approved plans and projects);
- If vulnerability is addressed in the first three points, deduce impacts from either (i) known pressure/impact relationships, using reference sites and risk based monitoring of selected stations (link to condition indices), or (ii) mapping cumulative impact models (with ground-truthing);
- If vulnerabilities are not addressed in first three points, derive measures of habitat extent;

[3] Criteria for the selection of representative monitoring sites:

- Where pressures to and risks to/effects 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.

Indicator Title	*Common Indicator 1: Habitat distributional range*	
• Determine whether the target is reached (i.e. proportion of lost or damaged area, related to total area the habitat type, above which GES is not achieved).		
Known gaps and uncertainties in the Mediterranean Information sources on the distribution of habitats are substantially greater for the northern than the southern coasts of the Mediterranean Sea.		
Contacts and version Date		
Key contacts within UNEP for further information		
Version No	Date	Author
V.1	20/07/2016	SPA/RAC
V.2	14/04/2017	SPA/RAC

Common Indicator 1 : Page 5/5

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Annex III

Reproduction of Guidance Factsheet for Common Indicator 2 : Condition of the habitat's typical species and communities (EO 1).

Indicator Title	*Common indicator 2: Condition of the habitat's typical species and communities*	
Relevant GES definition	Related Operational Objective	Proposed Target(s)
The population size and density of the habitat-defining species, and species composition of the community, are within reference conditions ensuring the long term maintenance of the habitat	Coastal and marine habitats are not being lost	**State:** -No human induced significant deviation of population abundance and density from reference conditions -The species composition shows a positive trend towards reference condition over an increasing proportion of the habitat (for recovering habitats)
Rationale		
Justification for indicator selection The concept of "typical species" emerges from the conservation status of natural habitats to their long-term natural distribution, structure and functions, as well as to the long-term persistence of their typical species within the territory. Therefore, typical species composition should be near/close to natural conditions for their habitat to be considered in natural condition.		
Scientific References *List (author(s), year, Ref: journal, series, etc.) and url's* • Pérès JM, Picard J (1964) Nouveau manuel de Bionomie benthique de la Mer Méditerranée. Recueil des Travaux de la Stations Marine d'Endoume, 47: 3-137. • Templado, J., Ballesteros, E., Galparsoro, I., Borja, A., Serrano, A., Marín, L., Brito, A., 2012. Inventario español de Hábitats y Especies Marinos. Guía Interpretativa: Inventario Español de Hábitats Marinos. Ministerio de Agricultura, Alimentación y Medio Ambiente. 229 pp. • UNEP/MAP-RAC/SPA, 2015. Handbook for interpreting types of marine habitat for the selection of sites to be included in the national inventories of natural sites of conservation interest. Bellan-Santini, D., Bellan, G., Bitar, G., Harmelin J-G., Pergent, G. Ed. RAC/SPA, Tunis. 168 pp. + Annexes (Orig. pub. 2002). • UNEP-MAP-RAC/SPA, 2017. Draft Updated Reference List of Marine Habitat Types for the Selection of Sites to be included in the National Inventories of Natural Sites of Conservation Interest in the Mediterranean. Ed. RAC/SPA, Tunis. in press.		
Policy Context and targets (other than IMAP)		
Policy context description Typical species have already been identified by several Contracting Parties for listed habitat types to fulfill the assessment requirements under the Habitats Directive. Additionally, the coastal area out to 1 nautical mile offshore has already been covered by these Contracting Parties under the Water Framework Directive. Therefore, the indicator is available for considerable benthic habitats within these areas and is already covered by monitoring efforts and has been assessed using appropriate metrics. Soft-bottom benthic invertebrates and seagrasses are traditionally used in the Mediterranean Sea for environmental quality assessment and several indices have already been widely applied by Mediterranean Contracting Parties, Member States of the EU and compared in the framework of the Mediterranean Geographical Intercalibration Group of the EU Water Framework Directive (MED GIG), while two indices have also been based on macroalgae and compared in the framework of MED GIG. Already in 2009, the Meeting of UNEP/MAP MED POL experts on Biological Quality Elements (UNEP/DEPI/MED WG. 342/3) recommended the		

Indicator Title	*Common indicator 2: Condition of the habitat's typical species and communities*

application of benthic indices developed and tested under the Water Framework Directive for use by all Contracting Parties. Recent European projects have focused on MSFD indicators and monitoring aspects for various habitats (e.g. DEVOTES, PERSEUS, IRIS-SES). To this end, the 2015 PERSEUS Project specific training course targeting Southern Mediterranean countries could be utilized.

Indicator/Targets

In order to assess the state/condition of a habitat (i.e. its typical species composition and their relative abundance, absence pr particularly sensitive or fragile species or species providing a key function, size structure of species), the Contracting Parties need to define lists of typical and/or characteristic species (or groups of species) and to set targets to determine their presence. It is also important to compile typical species lists consistently per biogeographical region, to allow for the consistent assessment of state/condition. Typical species composition includes both macrozoobenthos and macrophytes, depending on the type of habitat (i.e. macrophytes do not occur in aphotic habitats). Long-lived species and species with high structuring or functional value for the community should preferably be included; however, the typical species list might also contain small, short-lived species if they characteristically occur in the habitat under natural conditions. The general target of this indicator is to reach a ratio of typical and/or characteristic species similar to baseline conditions as defined above, for all considered habitats. With regard to plankton communities, a recommended target might be: "Plankton community not significantly influenced by anthropogenic drivers". This target allows unmanageable climate change but triggers management action if linked to an anthropogenic pressure and could be used with all datasets across all Contracting Parties. Monitoring of important pelagic habitats should be considered in the future.

Policy documents

List and url's

UNEP/DEPI/MED WG. 342/3

http://www.unepmap.org/index.php

http://195.97.36.231/dbases/MEETING_DOCUMENTS/09WG342_3_eng.pdf

EU Water Framework Directive (MED GIG)

http://ec.europa.eu/environment/water/water-framework/index_en.html

http://publications.jrc.ec.europa.eu/repository/bitstream/111111111/10473/1/3010_08-volumecoast.pdf

Indicator analysis methods

Indicator Definition

This indicator should be implemented as a state condition indicator, with respect to baseline conditions, by using a list of typical and/or characteristic species in the communities of different habitats per sub-region.

Methodology for indicator calculation

The calculation of this indicator involves simple comparison of typical and/or characteristic species (or groups of species) per habitat and sub-region with respect to baseline conditions, for all considered communities. Within this process, an acceptable deviation from baseline conditions would need to be defined. This deviation might be implemented by setting a certain percentage value to define GES. However, for baseline setting, the use of current state might be inappropriate if the considered habitats actually underlie high human pressure and no reference sites are available. The definition of a reference state of Mediterranean Sea habitats may be problematic and the use of past state may be more appropriate. This cut-off value has to be habitat-specific and regionally adapted in view of the natural variability of species composition by habitat type and bioregion.

The required methods and effort strongly depend on the habitat type (and selected species) to be addressed.

Indicator Title	*Common indicator 2: Condition of the habitat's typical species and communities*

Detailed overviews presenting the basic guidelines and methodologies for the inventorying and monitoring of various Mediterranean key habitats (seagrass meadows, coralligenous and rhodolith beds and "dark habitats", i.e. marine caves and deep sea assemblages) have been recently produced by UNEP/MAP-RAC/SPA in the framework of MedKeyHabitats project. Large attached epibenthic species on hard substrates are preferably monitored using optical, non-destructive methods, such as underwater-video while endobenthic communities are sampled using standardized grabs or corers, which are commonly used in marine monitoring programmes. Several specific benthic biotic indices have been developed and have become operational, in particular to fulfill MED GIG requirements. They are all well methodologically defined but the way to combine these parameters in sensitivity/tolerance classification or depending on structural, functional and physiological attributes is heterogeneous, depending on the issue (pressure type), habitat types or sub-region. Qualified personnel, in particular experienced taxonomists, are required for both field and laboratory work to guarantee quality in sampling accuracy, consistency of data over time, meaningful data analyses and interpretation of the results.
The following resources are usually required for the calculation of this indicator:

- Research vessels, suited to work from sublittoral to bathyal zones, depending on the sub-region;
- Scuba diving sampling to infralittoral
- Adequate equipment (box core samplers, grabs, dredges, underwater camera systems, etc.) for sample collection from intertidal to bathyal zones;
- Laboratory infrastructure to analyze samples (e.g. microscopes, weighing scales).
- Qualified personnel for data processing, analysis and interpretation.
- Good taxonomy skills are essential for the adequate assessment of this indicator.

Indicator units
This indicator could be calculated as a ratio of typical and/or characteristic species for every habitat type with respect to baseline conditions for this sub-region. Within this process, an acceptable deviation from baseline conditions should be defined. This cut-off value has to be habitat-specific and regionally adapted in view of the natural variability of species composition by habitat type and bioregion. Furthermore, several specific well-defined benthic biotic indices have been developed and have become operational. The selection of the relevant parameters and the development of metrics strongly depend on the selected habitat.

List of Guidance documents and protocols available

- Lepidochronology and phenology protocols for *Posidonia oceanica*[4]
- ISO 16665: 2014 Guidelines for quantitative sampling and sample processing of marine soft-bottom macrofauna (http://www.iso.org/iso/catalogue_detail.htm?csnumber=54846) These guidelines provide standard methodology for collection and processing of subtidal soft-bottom macrofaunal samples in marine waters, in particular:
  - the development of the sampling programme;
  - the requirements for sampling equipment;
  - sampling and sample treatment in the field;
  - sorting and species identification;
  - storage of collected and processed material.

[4] Pergent G., 2007. Protocol for the setting up of Posidonia meadows monitoring systems. «MedPosidonia» Programme / RAC/SPA - TOTAL Corporate Foundation for Biodiversity and the Sea; Memorandum of Understanding N°21/2007/RAC/SPA_MedPosidonia Nautilus-Okianos: 24p + Annexes.

Indicator Title	*Common indicator 2: Condition of the habitat's typical species and communities*

- ISO 19493: 2007 Guidance for marine biological surveys of supralittoral, eulittoral and sublittoral hard substrate for environmental impact assessment and monitoring in coastal areas (http://www.iso.org/iso/catalogue_detail.htm?csnumber=39107): It covers:
  - the development of the sampling programme,
  - survey methods,
  - species identification,
  - storage of data and collected material

Data Confidence and uncertainties

For baseline setting of GES per habitat type, the use of current state might be inappropriate if the habitats actually underlie high human pressure and no reference sites are available. The use of past state may be more appropriate, as the definition of a reference state of Mediterranean Sea habitats may be problematic. In order to verify comparability and reproducibility, (a) descriptions of the followed methodology should be provided, and (b) biogeographic regions with common species compositions per habitat must be identified in advance.

Methodology for monitoring, temporal and spatial scope

Scientific literature*Sources and url's*

The monitoring techniques depend on the species to monitor and the related habitat. Non-destructive optical methods are recommended for the monitoring of large benthic species such as epibenthic species on hard substrates, while endobenthic species can be monitored using standardized grabs, drill sampling or corers.

- UNEP/MAP-RAC/SPA, 2015. Guidelines for Standardization of Mapping and Monitoring Methods of Marine Magnoliophyta in the Mediterranean. Pergent-Martini, C., Ed., RAC/SPA publ., Tunis: 48 p. + Annexes.
- UNEP-MAP-RAC/SPA, 2015. Standard methods for inventorying and monitoring coralligenous and rhodoliths assemblages. Pergent, G., Agnesi, S., Antonioli, P.A., Babbini, L., Belbacha, S., Ben Mustapha, K., Bianchi, C.N, Bitar, G., Cocito, S., Deter, J., Garrabou, J., Harmelin, J-G., Hollon, F., Mo, G., Montefalcone, M., Morri, C., Parravicini, V., Peirano, A., Ramos-Espla, A., Relini, G., Sartoretto, S., Semroud, R., Tunesi, L., Verlaque, M. Ed. RAC/SPA, Tunis. 20 pp. + Annex.
- UNEP-MAP-RAC/SPA, 2017. Draft Guidelines for Inventorying and Monitoring Dark Habitats. Aguilar, R., Pilar, M., Gerovasileiou, V. and contributors. Ed. RAC/SPA, Tunis. in press.
- Zamboukas, N., Palialexis, A. (eds.), Duffek, A., Graveland, J., Giorgi, G., Hagebro, C., Hanke, G., Korpinen, S., Tasker, M., Tornero, V., Abaza, V., Battaglia, P., Caparis, M., Dekeling, R., Vegas, M. F., Haarich, M., Katsanevakis, S., Klein, H., Krzyminski, W., Laamanen, M., Jean, LG., Leppänen, J.-M., Urmas, L. 2014. Technical guidance on monitoring for the marine strategy framework directive. Luxembourg, European Union. 166 p. JRC Scientific and Policy Reports; 2014, 26499 EN.

Spatial scope guidance and selection of monitoring stations

This indicator is applicable in all regions provided that typical and/or characteristic species lists, including both macrozoobenthos and macrophytes, will be developed for every type of habitat, at a sub-regional scale (or bioregion within each sub-region). Benthic biotic indices are also conceptually applicable in all sub-regions but appropriate adjustments might be still needed to cover biogeographic heterogeneity.

Temporal Scope guidance

Indicator Title	*Common indicator 2: Condition of the habitat's typical species and communities*	
Natural variability in species composition in space and time must be considered for this indicator and the list of typical and/or characteristic species must be defined and updated every 6 years per habitat type in particular geographic areas. The ideal temporal scale for this indicator is once per year while the minimum required sampling frequency is at least twice per period of 6 years.		
Data analysis and assessment outputs		
Statistical analysis and basis for aggregation Data analysis for this indicator involved simple comparison of typical and/or characteristic species with respect to baseline conditions for the considered habitat in a given region. A number of tools and software have been developed for the calculation of benthic biotic indices.		
Expected assessments outputs Assessments outputs for this indicator include (1) a list of typical and/or characteristic species per habitat of a given region, recorded following a well-described methodology and/or values of the appropriate benthic biotic indices for the considered habitats and (2) comparison with baseline/past data to indicate trends in the habitat conditions/state.		
Known gaps and uncertainties in the Mediterranean Information about the typical and/or characteristic species of some habitats and their past state/conditions is often unavailable for southern and eastern sub-regions of the Mediterranean. The limited data availability may restrict the number of habitats that can be assessed with sufficient statistical confidence at present. Although benthic biotic indices are conceptually applicable in all sub-regions, adjustments might be required in order to cover biogeographic heterogeneity.		
Contacts and version Date		
Key contacts within UNEP for further information		
Version No	Date	Author
V.1	20/07/2016	SPA/RAC
V.2	14/04/2017	SPA/RAC

Common Indicator 2: Page 5/5

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Annex IV

Reproduction of Guidance Factsheet for Common Indicator 15 : Location and extent of the habitats potentially impacted by hydrographic alterations.

Ecological Objective 7	Alteration of hydrographic conditions does not adversely affect coastal and marine ecosystems.	
Indicator Title	Location and extent of the habitats potentially impacted by hydrographic alterations	
Relevant GES definition	**Related Operational Objective**	**Proposed Target(s)**
Negative impacts due to new structure are minimal with no influence on the larger scale coastal and marine system.	Alterations due to permanent constructions on the coast and watersheds, marine installations and seafloor anchored structures are minimised.	Planning of new structures takes into account all possible mitigation measures in order to minimize the impact on coastal and marine ecosystem and its services integrity and cultural/historic assets. Where possible, promote ecosystem health.

Rationale

Justification for indicator selection

After agreeing to progressively apply the ecosystem approach (EcAp) to the management of human activities in the Mediterranean at the 15th Meeting of the Contracting Parties to the Barcelona Convention (COP15, 2008), the Contracting Parties agreed, at COP17 in 2012, on an overall vision and goals for EcAp, and on 11 ecological objectives for the Mediterranean. Among these ecological objectives was the Ecological Objective 7 („Alteration of hydrographical conditions"), with its clearly outlined operational objectives and indicators. EO7 corresponds to Descriptor 7 (Permanent alteration of hydrographical conditions does not adversely affect marine ecosystems) of the European Marine Strategy Framework Directive (MSFD).

Ecological Objective 7 („Alteration of hydrographical conditions") addresses permanent alterations in the hydrographical regime of currents, waves and sediments due to new large-scale developments that have the potential to alter hydrographical conditions. An agreed common indicator - 'Location and extent of habitats impacted directly by hydrographic alterations' considers marine habitats which may be affected or disturbed by changes in hydrographic conditions (currents, waves, suspended sediment loads).

There is a clear link between EO7 and other ecological objectives, especially EO1 (Biodiversity). Such link needs to be determined on a case-by-case basis. Refer to Annex 1 for habitats to be considered in EO7. Ultimately, the assessment of impacts, including cumulative impacts, is a cross-cutting issue for EO1 and EO7.

Scientific References

EC JRC (2015). Review of Commission Decision 2010/477/EU concerning MSFD criteria for assessing good environmental status Descriptor 7: Permanent alteration of hydrographical conditions does not adversely affect marine ecosystems

EMEC Ltd (2005). Environmental impact assessment (EIA) guidance for developers at the European Marine Energy Centre.

OSPAR Commission (2012). MSFD Advice document on Good environmental status - Descriptor 7: Hydrographical conditions. A living document - Version 17 January 2012.

OSPAR Commission (2013). Report of the EIHA Common Indicator Workshop.

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Royal Haskoning DHV (2012). Environmental Impact Assessment (EIA) and Appropriate Assessment (AA) Evaluation of assessment tools and methods. Lot 2: Analysis of case studies of port development projects in European estuaries. Tidal Rover Development (TIDE) Interreg IVB

Some reference and guidance documents on EIA can be found at :
http://ec.europa.eu/environment/eia/eia-support.htm and in the „Guidance Document on how to reflect changes in hydrographical conditions in relevant assessments" (UNEP/MAP/PAP, 2015).

Policy Context and targets

Policy context description

Following the COP17 agreement on an overall vision and goals for EcAp, on 11 ecological objectives, operational objectives and indicators for the Mediterranean, a six-year cyclic review process of EcAp implementation was established (EcAp MED I 2012-2015), with the next EcAp cycle set to cover 2016-2021.

At COP18, in 2013, the targets for achieving GES of the Mediterranean Sea and its coastal zone by 2020 were adopted. In addition, through Decision IG. 21/3 (the so called "COP18 EcAp Decision") the EcAp roadmap was agreed on. The Contracting Parties also agreed to design an Integrated Monitoring and Assessment Programme (IMAP) by COP19, which would, for the first time, ensure a common assessment basis for the Mediterranean marine and coastal environment. At COP19, in 2016, the IMAP was adopted. The IMAP provides guidance to the parties on how to practically implement quantitative monitoring and assessment of the ecological status of the Mediterranean Sea and coast in line with the EcAp.

As part of the EcAp roadmap, expert-level monitoring discussions took place in the various Correspondence Groups on Monitoring (CORMONs) meetings on Biodiversity and Fisheries; Pollution and Litter; and Coast and Hydrography sub-clusters. An Integrated Correspondence Group on Monitoring Meeting (Integrated CORMON) took place on 30 March-1 April 2015, to discuss the main elements of the Integrated Monitoring and Assessment Programme.

As for Protocols of the Barcelona Convention relevant for the EO7, the Protocol Concerning Specially Protected Areas and Biological Diversity in the Mediterranean calls to Contracting Parties of the Barcelona Convection for continuous monitoring of ecological processes, population dynamics, landscapes, as well as the impacts of human activities (Article 7 b). In addition, it calls to Parties to evaluate and take into consideration the possible direct or indirect, immediate or long-term impacts, including the cumulative impact of the projects and activities, on protected areas, species and their habitats (Article 17).

Another Protocol of the Barcelona Convention, the Protocol on the Integrated Coastal Zone Management in the Mediterranean, in its Article 9, calls for Parties to minimize negative impacts on coastal ecosystems, landscapes and geomorphology, coming from infrastructure, energy facilities, ports and maritime works and structures; or where appropriate to compensate these impacts by non-financial measures. In addition, the Article 9 demands maritime activities to be conducted "in such a manner as to ensure the preservation of coastal ecosystems in conformity with the rules, standards and procedures of the relevant international conventions".

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Out of other international legislation that can be relevant for the EO7 Ecological Objective, it is essential to mention Marine Strategy Framework Directive – MSFD 2008/56/EC since EcAp's EO7 corresponds to MSFD's Descriptor 7 to large extent. The hydrographical conditions outlined under the MSFD are, to a large extent, comparable to the hydromorphological conditions referred to under the Water Framework Directive (WFD) which calls for the protection of all water resources, including coastal waters. EO7 overlaps with other policy frameworks, such as the Environmental Impact Assessment (EIA) procedure on the assessment of the environmental impacts of certain public and private projects; the Strategic Environmental Assessment (SEA) procedure on the assessment of the effects of certain plans and programs on the environment; assessments undertaken under Marine Spatial Planning (MSP); and in the context of integrated coastal zone management (ICZM).

Targets

Planning of new structures takes into account all possible mitigation measures in order to minimize the impact on coastal and marine ecosystem and its services, integrity and cultural/historic assets. Where possible, promote ecosystem health.

Policy documents

Protocol on the ICZM in the Mediterranean - http://www.pap-thecoastcentre.org/pdfs/Protocol_publikacija_May09.pdf

Protocol Concerning Specially Protected Areas and Biological Diversity in the Mediterranean - http://www.rac-spa.org/sites/default/files/protocole_aspdb/protocol_eng.pdf

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

Other EU-related documents can be found at: http://ec.europa.eu/environment/eia/eia-support.htm

Indicator analysis methods

Indicator Definition

The EO7 Common Indicator reflects location and extent of the habitats potentially impacted by the alterations and/or the circulation changes induced by them. It concerns area/habitat and the proportion of the total area/habitat where alterations of hydrographical conditions are expected to occur (estimations by modelling or semi-quantitative estimation).

Methodology for indicator calculation

Methodology used for indicator measurement encompasses elaboration on:
(i) Mapping of area where human activities may cause permanent alterations of hydrographical conditions (using i.e. existing EIA, SEA and Maritime Spatial Planning -MSP); and
(ii) Mapping of habitats of interest in this area of hydrographical changes; and
(iii) Intersection of the spatial map of the areas of hydrographical changes with spatial maps of habitats to determine the areas of individual habitat types that are impacted by hydrographical changes.

New structures to be considered under EO7 assessment:

Ecological Objective 7	Alteration of hydrographic conditions does not adversely affect coastal and marine ecosystems.
Indicator Title	Location and extent of the habitats potentially impacted by hydrographic alterations

As far as the type and dimension of structures to be taken into account: use the case by case approach depending on the nature of the coast, the function of the structure and the depth reached by the structure where appropriate threshold values are taken into account (such as absolute surface in m², range of depths where structure will be built (to avoid habitat "segmentation")). As an additional criterion it was agreed that all permanent structures, for which an EIA and/or a planning/building permit is required, should be considered.

Hydrographical conditions to be considered:

- At least, waves and currents changes (can be used to assess changes in bottom shear stress, turbulence and alike).
- For sandy sites or sites with natural sediment dynamic, changes in sediment transport processes and turbidity and induced changes in morphology of the coast.
- If the new structure involves water discharge, water extraction or changes in fresh water movements: assessment of salinity and/or temperature changes.

Steps to assess hydrographical alterations:
In case of insufficient data and resources and if the implementation of hydrodynamic modelling is not feasible, a simplified approach for assessing hydrographical alterations is proposed.
Following new decision on the MSFD (Decision 2017/048/UE, May 2017), an alternative approach proposes to assess first the hydrographical alterations as a result of physical loss (permanent changes to the seabed in term of bathymetry, morphology or nature substrate) induced by the structure itself or human activities in its surroundings.
Such approach aims to focus on:

1. The hold of the structure (location and extend on the sea floor). In this area, the presence of the structure will definitively alter the existing habitats (physical loss).
2. Permanent changes to the seabed related to the structure and due to human activities. For instance, the creation of a port often requires the digging of basins and the dumping of materials at sea. These diggings and discharges, leading to permanent bathymetric and eventually substrate changes and modifying waves and currents propagation, will also definitively alter the existing habitats.
3. Effects of the structure on hydrographical conditions in its neighbourhood. The existence of the structure will modify the regime of currents and agitation and also the coastal transit with creation of erosion and deposition zones. For instance, in a harbour, the presence of dikes attenuates the currents and the swell inside the basins and leads to decantation of suspended material (vases, organic matter, debris plants.) inducing changes in benthic settlements.

First level of assessment: assessment of physical loss induced by the structure itself (on sea floor and in water column)
The objective here is to represent by a polygon (GIS data) the exact location and extend on sea floor of the expected construction, i.e. a footprint (and not only the extent of the submerged part of the structure). These data can be taken from the construction plan of the structure that should be present in the EIA or another planning document.
A proposal for attribute's GIS data can be found in Chapter „Expected assessment outputs" below.

Second level of assessment: assessment of permanent changes to the seabed due to human activities (related to the construction and the use of the structure)
The objective here is to represent by a polygon (GIS data) the exact location and extend of dredged and disposal areas leading to permanent changes in bathymetry. These changes can happen during the

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construction of the structure (digging of basins) or for its normal use (channels dredging to maintain a certain depth).
Information relative to these activities can be found in the EIA or can be asked to the project manager responsible for its construction or to the structure owner.

Third level of assessment: assessment of hydrographical changes induced by the structure in the surrounding area

The first possibility to assess these alterations is to use the information provided by the EIA if available. Even if the EIA does not fully meet the needs of this indicator, it should at least provide some information on the main expected hydrographic changes since they may compromise the use or sustainability of the structure. For instance, in case of a port or a marina, the attenuation of agitation, being the objective, should be well studied. The same way, on a coast with strong sediment transit, the impact of the structure on erosion and sedimentation changes should be studied as they could compromise the use or the durability of the structure.

If the EIA does not provide a sufficient level of information, other available sources of information concerning similar or close sites have to be explored: historical evolution of sediment supply, analysis of the evolution of the coastline and the seabed, analysis of the impact of existing defence structures and ports on the morphodynamics of the coastline and alike.
These available data and studies are not directly applicable to assess hydrographical alterations induced by the new structure. Nevertheless, they can be used by experts to extrapolate evolution tendencies on the site of interest, thus providing a first level of characterization of expected hydrographic alterations and allowing to roughly specify their extent and location.
In the case where no information can help to characterize the extent of the expected hydrographic alterations, a buffer zone proportional to the largest dimension of the structure may be used to assess this extend (eg a buffer zone of 5 times the cross-shore length of the structure). If this approach is used to assess the extend, this must be clearly said in the attribute table relative to this GIS layer (see *Expected assessments outputs*).

For the first level of assessment, it is clear that under the hold of the structure the hydrographical conditions and the habitats will be definitively and permanently altered. On the other side, for the second and third levels of assessment, depending on the available data, the actual knowledge and the assumptions followed, there may be some degree of uncertainty in the assessment of location and extend of expected hydrographical alterations. To take into account these uncertainties and the limits of the assessments, it is proposed to notify them in the attribute table relative to these assessments (A proposal for attribute's GIS data can be found in „Expected assessment outputs“). These notifications will help to identify and subsequently improve the evaluations deemed to be the least reliable.
At the end, the results of the above assessments are integrated on one single GIS layer (i.e. hydrographical alterations GIS layer). The last step of the EO7 indicator calculation consists of overlaying hydrographical alterations GIS layer with habitats GIS maps/layer. Calculations are made with GIS tools in order to define habitats potentially impacted by hydrographic alterations.

If the assessment of hydrographic alterations presents a high level of uncertainty, a risk-based approach can be used to identify habitats that are most sensitive to expected alterations. To do this sensitivity matrix can be used (see for instance: La Rivière M. et al., 2018. *An assessment of French Mediterranean benthic habitats' sensitivity to physical pressures.* UMS PatriNat, AFB-CNRS-MNHN. Paris, 86 pp.).

Due to the ecological importance of *Posidonia* meadows in the Mediterranean Sea and their vulnerability to coastal development, a specific paragraph for this habitat is presented.

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Particular considerations for *Posidonia* meadows:

In addition to direct impacts, induced by the structure itself, which will definitively destroy the meadow by recovery, some construction techniques and then indirect impacts, following its construction, on currents and sedimentary transport, may also alter this habitat, on areas much larger than the structure footprint.

Indeed, the *Posidonia* is very sensitive to water turbidity, even transient. Also, during the construction of the structure, a turbid cloud can be generated (discharge at sea of fine materials). This turbid cloud will decrease the transparency of the water, and therefore photosynthesis, in the short term; it can also be deposited on the seagrass meadow that can cause smothering by hyper sedimentation. The thinnest sediments can also be resuspended during storms, thus decreasing the transparency of the water in the long term. Major seagrass meadow destructions due to these phenomena have been observed, for example, in France following the construction of the ports of Pointe Rouge in Marseille and Mouillon in Toulon.
Moreover, the construction machines are often fixed on the bottom, for stability reasons, directly and / or by means of anchors, which has a very negative impact on the bottoms: digging holes (feet of the machines) or furrows (chains of anchors) in the *Posidonia oceanica* meadows.

Once the structure is built, its presence can modify the sedimentary transit and induce areas of erosion and accumulation around it. These modifications will alter the equilibrium between the sedimentation rate and the vertical growth of *Posidonia*. So, if the rate of sedimentation **exceeds 5-7cm / year**, the vegetative points die; conversely, if this rate is zero or negative (sediment departure), the rhizomes are loosened; they are then very sensitive to breakage (hydrodynamism, anchors, trawling, etc.)
It should also be noted that it is extremely rare for a seagrass meadow to survive in a harbor basin in the medium or long term.

In order to avoid all these phenomena, it is therefore advisable to:

- Use materials and construction techniques that minimize the suspension of fine particles that can induce turbidity in the surrounding waters. (for example: the dumping of fine materials (diameter less than 1 mm) at sea, or of blocks mixed with fine materials, is to be excluded completely; when rockfill is installed, it is advisable to rinse the blocks of rock; geotextile protective screens must be put in place around the site to minimize turbidity induced).
- Avoid the use of construction machines located at sea by favouring the use of machines lying on the ground. if it is essential to use them at sea, they must not be anchored or relied on *Posidonia* meadows.
- Avoid carrying out construction work in summer, when the plant rebuilds its reserves for the following year
- Build a new development at several tens of meters from the closest living *Posidonia* meadow
- Avoid including *Posidonia* meadow in a port basin
- Monitor the condition of the surrounding seagrass, both during and at the end of the work.

(These elements on *Posidonia* meadows have been taken from : Boudouresque et al., 2006, Préservation des herbiers à *Posidonia oceanica*. RAMOGE pub.: 1-202, N°ISBN 2-905540-30-3)

Indicator units

Ecological Objective 7	Alteration of hydrographic conditions does not adversely affect coastal and marine ecosystems.
Indicator Title	Location and extent of the habitats potentially impacted by hydrographic alterations

- km2 of impacted habitats
- proportion (%) of the total area/habitats impacted

List of Guidance documents and protocols available

UNEP/MAP/PAP (2015). Guidance document on how to reflect changes in hydrographical conditions in relevant assessment (prepared by Spiteri, C.). Priority Actions Programme. Split, 2015.

UNEP(DEPI)/MED IG.22. UNEP(DEPI)/MED IG.22/Inf.7 (2016). Draft Integrated Monitoring and Assessment Guidance

UNEP(DEPI)/MED WG.433/1 (2017) PAP/RAC Meeting of the Ecosystem Approach Correspondence Group on Monitoring (CORMON) on Coast and Hydrography – Working Document

Advice document on hydrographical conditions (Descriptor 7) in the context of MSFD, published by OSPAR Commission (2012);

Scientific and technical review of the MSFD Commission Decision 2010/477/EU in relation to Descriptor 7 carried out by the EC JRC; etc.

Data Confidence and uncertainties

Data used or produced for the monitoring should be in agreement with Shared Environmental Information System (SEIS) principles. More on SEIS principles can be found in Draft Integrated Monitoring and Assessment Guidance.

Methodology for monitoring, temporal and spatial scope

Available Methodologies for Monitoring and Monitoring Protocols

At this stage, there is no clear available methodology and monitoring protocols (see **Known gaps and uncertainties in the Mediterranean).**
Some methodologies or protocols could be proposed, once done an inventory of existing and available data in Mediterranean Sea.

For more details, see "Guidance document on how to reflect changes in hydrographical conditions in relevant assessments".

Available data sources
Global marine data source at the scale of the Mediterranean Sea:

- EMODnet Central Portal (http://www.emodnet.eu/)
- Mediterranean Marine Data (http://www.mediterranean-marinedata.eu/)
- Copernicus, Marine environment monitoring service (http://marine.copernicus.eu/)

Available regional or local data sources (in each country) should be also identified.

Spatial scope guidance and selection of monitoring stations

The monitoring will focus on habitats of interest, around new permanent constructions (lasting more than 10 years) in coastal waters.

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The study area should depend on the footprint of the new construction considered and on the local (or regional) geographical and marine conditions. It should be large enough:

- to show all the hydrographic alterations induced by the construction, even for long term;
- to follow all the habitats of interest that could be potentially impacted.

At first, the spatial scale (in cross-shore and long-shore directions) to be used should be about 10 to 50 times the characteristic length of the structure. Depending on the first results obtained for this area, the area should be enlarged or zoomed in around the structure.

It should be highlighted if monitoring was performed in sensitive areas, such as marine protected areas, spawning, breeding and feeding areas and migration routes of fish, seabirds and marine mammals, since they are priority.

Temporal Scope guidance

To correctly assess changes in time on habitats induced by constructions, different monitoring timescales 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).

Data analysis and assessment outputs

Statistical analysis and basis for aggregation

Expected assessments outputs

All the outputs that came out of the monitoring (I.e. trend analysis, distribution maps, etc.) should be listed, along with source(s) where they can be found.

The outputs to be reported are (map and GIS data):

- The area and location where the future structure will be built;
- The area and location where alterations in hydrographical conditions are expected to occur and those areas where alterations are actually occurring;
- The area and location of the habitats of interest potentially impacted by these alterations;
- The area and location of these habitats of interest previously identified for the whole analysis unit (to assess the proportion of total habitats that are altered).

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For the area and location where the future structure will be built, additionally to the surface representation of the structure, some information has to be provided as attributes of the GIS layer. The following attributes are proposed:

Country	*Locality / District*	*ID of the structure*	*Role of structure*	*Type of structure*	*Materials*	*Extend on the sea floor (in m², ha or km²)*
Specify the country	*Specify the location of the structure*	*The ID must be unique to identify the structure. It could be a number or a numbered code using letters from the previous column*	*Harbour, coastal defense, marine energy, ...*	*Quay, groynes, wind farm,...*	*Concrete, rockfill, ...*	*Area of the structure on sea floor. The used unity has to be provided in the name of the field*

If the structure is composite (in terms of type, materials, ...), several GIS surface objects could be defined.

For the area and location of expected hydrographical alterations, additionally to the surface representation of these alterations, some information has to be provided as attributes of the GIS layer. The following attributes are proposed:

Country	*Locality / District*	*ID of the structure*	*Nature of expected hydrographic alterations*	*Data used*	*Method of alterations assessment*	*Level of assessment confidence*	*Extend of hydrographical alteration (in m², ha or km²)*
Specify the country	*Specify the location of the structure*	*The ID must be unique to identify the structure. It could be a number or a numbered*	*Waves/currents attenuation; anthropic changes of bathymetry; changes in sediment transit inducing erosion/sedimentation;*	*Data provided by EIA ; dredging/ disposal scheme ; ...*	*Modeling; expert judgment ; Analogy with similar and close site;...*	*Low/Medium/ Good*	*Area of the structure on sea floor. The used unity has to be provided in the name of the field*

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		code using letters from the previous column					

If different extend of hydrographical alterations can be identified (in terms of nature, intensity, …) several GIS surface objects could be defined.

For each GIS data layer produced, a metadata file must be added. This file must provide information on: creation date of the GIS data, GIS data author, contact information, source agency, map projection and coordinate system, scale, error, explanation of symbology and attributes, data dictionary, data restrictions, and licensing (see for instance INSPIRE Directive).

Known gaps and uncertainties in the Mediterranean

There are general difficulties, not particular to the Mediterranean context, that can be identified for this EO7:

- Lack of coherence in definitions, standard approaches in the development and application of indicators and in the assessment of impacts, together with lack of methodological standards.
- Lack of knowledge and understanding on the link between physical pressures and biological impacts and on the cumulative impacts.

Another difficulty comes from the hydrographical alterations that EO7 indicator should assess. These alterations, around a particular coastal construction, often change in intensity, in area and indeed in time, depending on the off-shore hydrographical conditions (calm weather/extreme event; seasonality of waves height and directions; local wind conditions…) and on the morphologic history of the site (the present state is due to the succession of these different conditions).
So, a work to define which hydrographical conditions and temporal scale have to be used to assess hydrographical alterations by numerical modelling must be carried out.

Like everywhere, there is certainly a lack of physical characteristics data in the Mediterranean Sea (bathymetric data, seafloor topography, current velocity, wave exposure, turbidity, salinity, temperature, etc.), that will be the main problem to implement this indicator, in particular to define the base-line conditions. To identify these lacks, a global and clear inventory of existing and available data in Mediterranean Sea should be done.

Nevertheless, data can be collected from regional models (bathymetry, hydrodynamics, salinity, temperature). These data with coarse resolution will need to be refined close to the location of the new structure.

In case of no sufficient data, the use of assessment methods needing less data (empirical formulae, expert judgment, comparison with similar sites) should be considered, as well as acquisition/monitoring of missing data, promoting regional cooperation.

Contacts and version Date

Key contacts within UNEP for further information

Ecological Objective 7	Alteration of hydrographic conditions does not adversely affect coastal and marine ecosystems.	
Indicator Title	Location and extent of the habitats potentially impacted by hydrographic alterations	
Version No	**Date**	**Author**
V.1	27/6/16	PAP/RAC
V2	11/07/16	Olivier Brivois
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V4	16/03/17	Olivier Brivois
V5	19/06/18	Olivier Brivois
V6	26/07/18	Olivier Brivois

Common Indicator 15: Page 11/11

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Annex V

Reproduction of Guidance Factsheet for Common Indicator 17 : Concentration of key harmful contaminants measured in the relevant matrix[*] (EO9).

Indicator Title	Common Indicator 17. Concentration of key harmful contaminants measured in the relevant matrix (EO9)	
Relevant GES definition	**Related Operational Objective**	**Proposed Target(s)**
Level of pollution isbelow a determined threshold defined for the area and species	Concentration of priority contaminants is kept within acceptable limits and does not increase	1. Concentrations of specific contaminants below Environmental Assessment Criteria (EACs) or below reference concentrations 2. No deterioration trend in contaminants concentrations in sediment and biota from human impacted areas, statistically defined 3. Reduction of contaminants emissions from land-based sources
Rational		
Justification for indicator selection Environmental chemical pollution is directly linked with humankind activities in all the earth's ecosystems. Marine environmental investigations have detected thousands of man-made chemicals (both inorganic and organic compounds) all over the world oceans, which have been shown to impair the health of the marine ecosystems and their ecosystem services. The study of the occurrence, transport, transformation and fate, through the different ecosystem compartments (seawater column, marine biota, sediment, etc.), as well as the study of their sources and entry routes (land-based, sea-based (marine) and atmospheric wet and dry deposition) are the first steps to assess the pressures, state and impact to the environment understand and to decide further management actions fora growing environmental problem. Currently, new man-made chemicals and emerging pollutants continue to enter the marine environment and interact with the different marine species, habitats and ecosystems (coastal, open ocean, deep-sea areas), increasing the complexity of the chemical pollution threats for the marine environment and their future sustainability to deliver its benefits. The monitoring and assessment of the harmful and noxious substances occurrence, at selected spatial and temporal scales, will determine either a chronic or acute contamination/pollution scenarios.		
Scientific References i. Clark, R.B., 1986. Marine Pollution, Oxford University Press. ii. Neff, J.M., 1979. Polycyclic aromatic hydrocarbons in the aquatic environment. Sources, fates and biological effects. Applied Science Publishers, Ltd., London. iii. Goldberg, E. D., 1975. The Musssel Watch - a first step in global marine monitoring. *Mar.Poll.Bull.*, 6, 111.		

Common Indicator 17: Page 1/7

[*] Marine Strategy Framework Directive (MSFD) Descriptor 8: Concentrations of contaminants are at levels not giving rise to pollution effects

Indicator Title	Common Indicator 17. Concentration of key harmful contaminants measured in the relevant matrix (EO9)

iv. Bricker, S., Lauenstein, G., Maruya, K., 2014. NOAA's Mussel Watch Program: Incorporating contaminants of emerging concern (CECs) into a long-term monitoring program. *Mar.Poll.Bull.*, 81, 289–290.
v. Furdek, M., Vahcic, M., Ščancar, J., Milacic, R., Kniewald, G., Mikac, N., 2012. Organotin compounds in seawater and Mytilusgalloprovincialis mussels along the Croatian Adriatic Coast. *Mar.Poll.Bull.*, 64, 189–199
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vii. Richardson, S., 2004. Environmental Mass Espectrometry: Emerging contaminants and current issues. Anal. Chem., 76, 3337-3364.
viii. Schulz-Bull, D.E., Petrick, G., Bruhn, R., Duinker, J.C., 1998. Chlorobiphenyls (PCB) and PAHs in water masses of the northern North Atlantic. Mar. Chem., 61, 101-114.

Policy Context and targets

Policy context description

In most Mediterranean countries, the monitoring of a range of hazardous chemical substances in different marine compartments are undertaken in response to the UNEP/MAP Barcelona Convention (1976) and its Land-Based Protocol, through the coordination of the UNEP/MAP MED POL Monitoring Program. For Mediterranean EU Countries, the European legislation on the Marine Environment also applies (e.g. EU WFD and EU MSFD), as well as other international and national policy drivers. A considerable amount of founding knowledge and actions are available through the pollution monitoring and assessment component of the UNEP/MAP MED POL Programme during the past decades until today. The environmental assessments have been used for the identification and confirmation of significant marine contaminants occurrence, distributions, levels and trends; as well as, for the continuous development of monitoring strategies and guidance. With respect to the Ecosystem Approach and IMAP, their implementation will continue under the benefits gained from this past knowledge and the policy and practical framework built in the Mediterranean Sea.

Targets

Initial GES targets under Common Indicator 17 will be focused on the control of environmental levels, temporal trend improvements and the reduction of emissions at sources. The monitoring of these targets will be based upon data of a relatively small number of primarily legacy pollutants, reflecting the scope of current programmes and the availability of suitable agreed assessment criteria for them, despite the measurement of other chemicals remains open and is necessary. The inclusion of contemporary and emerging chemicals of new environmental concern and their targets for GES, within IMAP Common Indicator 17, will be implemented as the scientific knowledge advances.

Policy documents

General Policy documents

i. 19th COP to the Barcelona Convention, Athens, Greece, 2016. Decision IG.22/7 - Integrated Monitoring and Assessment Programme (IMAP) of the Mediterranean Sea and Coast and Related Assessment Criteria (UNEP(DEPI)/MED IG.22/28)
ii. 19th COP to the Barcelona Convention, Athens, Greece, 2016.Draft Integrated Monitoring and Assessment Guidance (UNEP(DEPI)/MED IG.22/Inf.7)

Indicator Title	Common Indicator 17. Concentration of key harmful contaminants measured in the relevant matrix (EO9)

iii. 18th COP to the Barcelona Convention, Istanbul, Turkey, 2013.Decision IG.21/3 - Ecosystems Approach including adopting definitions of Good Environmental Status (GES) and Targets. UNEP(DEPI)/MED IG.21/9

iv. Directive 2008/56/EC of the European Parliament and of the Council of 17 June 2008 establishing a framework for community action in the field of marine environmental policy (EU Marine Strategy Framework Directive and updates in 2010).

v. COMMISSION DIRECTIVE (EU) 2017/845 amending Directive 2008/56/EC of the European Parliament and of the Council as regards the indicative lists of elements to be taken into account for the preparation of marine strategies

vi. COMMISSION DECISION (EU) 2017/848 laying down criteria and methodological standards on good environmental status of marine waters and specifications and standardised methods for monitoring and assessment, and repealing Decision 2010/477/EU.

vii. Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy (and updated revisions).

Contaminants related Policy documents

viii. UNEP/MAP, 1987. Report of the Fifth Meeting of the Contracting Parties to the Convention for the Protection of the Mediterranean Sea against pollution and its Related Protocols. UNEP/IG. 74/5. UNEP/MAP, Athens.

ix. UNEP/MAP, 2005. Fact sheets on Marine Pollution Indicators. Meeting of the UNEP/MAP MED POL National Coordinators. Barcelona, Spain, 24-27 May 2005. UNEP (DEC)/MED/ WG.264/ Inf.14. UNEP, Athens.

x. UNEP/MAP MED POL – Phase III, Programme for the Assessment and Control of Pollution in the Mediterranean Region. MAP Technical Report Series No. 120, UNEP, Athens, 1999.

xi. OSPAR Commission, 2013. Levels and trends in marine contaminants and their biological effects - CEMP Assessment Report 2012. Monitoring and Assessment Series, 2013.

xii. EEA, 2003. Hazardous substances in the European marine environment: Trends in metals and persistent organic pollutants. Topic Report 2/2003. EEA, European Environmental Agency, Copenhagen, 2003. http://www.eea.eu.int

xiii. EEA, 1999 State and pressures of the marine and coastal Mediterranean environment. Environmental issues series nº5. European Environmental Agency, Copenhagen, 1999. http://www.eea.eu.int

xiv. EEA, 2018. European Waters – Assessment of status and pressures 2018. EEA Report /No 7, 2018.

Indicator analysis methods

Indicator Definition

Concentrations of key contaminants in the following matrices (note this is a multiparameter pressure indicator):

MARINE BIOTA: In collected marine organisms, where whole soft tissues or dissected parts are processed according sampling and sample preparation protocols, and primarily, in bivalve species and/or fish the following hazardous substances should be measured:
Trace/Heavy Metals (TM): Total mercury (HgT), Cadmium (Cd) and Lead (Pb)
Organochlorinated compounds (PCBs, Hexachlorobenzene, Lindane and ΣDDTs)

Indicator Title	Common Indicator 17. Concentration of key harmful contaminants measured in the relevant matrix (EO9)

Polycyclic Aromatic Hydrocarbons (PAHs)

The lipid content and flesh fresh/dry weight ratio should be measured in biota for normalisation and reporting purposes

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), 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)

The aluminium (Al), Total Organic Carbon (TOC) in the < 2mm particle size fraction should be performed for normalization and reporting purposes for TM and OCs, respectively. The < 63µm sediment fraction is also recommended to be complementary for metals.
The liophilization ratio (dry/wet sediment ratio) should be considered for datasets reporting.

SEAWATER: the monitoring and assessment of contaminants in seawater samples collected in coastal, marine and open-sea areas presents specific challenges and higher costs. For the mid/long-term monitoring programmes, such as IMAP, these are recommended to be carried out on a country decision basis.

Sub-indicators: other relevant chemicals (such as tributyltin, TBT; low molecular weight PAHs; etc.) and emerging pollutants are recommended to be carried out on a country decision basis until a firm COP Meeting Decision will be taken.

The chemical compounds above are being used to develop the IMAP Info System and those are included in the list of contaminants of concern which accompanies the Data Dictionaries (DDs) and Data Standards (DSs) for CI17.

Methodology for indicator calculation

Trace/Heavy Metals (TM) and Aluminium: Spectrometry, Mass Spectrometry

Organic compounds: Gas or Liquid Chromatography (GC/LC) coupled to a variety of detectors, such as Electron Capture Detectors or Mass Spectrometry, atomic adsorption.

TOC: Elemental Analyser

Particle fractions: in-house mesh validated methods (for < 2 mm) and/or geological sieving methods.

Additional parameters to be recorded: biometrics (size/length, age), biological parameters such as condition index (mussels), condition factor according established protocols and scientific knowledge.

Indicator units

Indicator Title	Common Indicator 17. Concentration of key harmful contaminants measured in the relevant matrix (EO9)

Trace/Heavy Metals (TM) and Aluminium: mass/dry or wet weight mass of sample according MEDPOL Database Format Protocols. The dry/wet mass ratios should be calculated and reported.

Organic compounds (OCs): mass/dry or wet weight mass of sample according MEDPOL Database Format Protocols. The dry/wet mass ratios should be calculated and reported.

TOC: Elemental Analyser (as %)

Particle fractions (as %)

List of Guidance documents and protocols available

Refer to UNEP Methods and Protocols for Marine Pollution, as well as from other recent documents from regional conventions (e.g. OSPAR) and European Guidelines, such as the Guidance Document No. 33 ON ANALYTICAL METHODS FOR BIOTA MONITORING UNDER THE WATER FRAMEWORK DIRECTIVE, Technical Report - 2014 – 084, ISBN 978-92-79-44679-5.

Data Confidence and uncertainties

Selected analytical methods and measurements are subject to internal Quality Assurance through National Laboratories QA/QC Protocols and Laboratory accreditations, as well as external Quality Assurance by performing regional interlaboratory QA/QC exercises organized by the UNEP/MAP MED POL/IAEA MESL.
Uncertainties in marine data measurements are identified at different levels (cumulative): analytical level (by use of Certified Reference Materials), reporting level (by providing averaged values and the associated uncertainties), database flagging level (primarily according the analytical and reporting compliance, number of non-detected values and levels, fulfilment of the QA/QC Protocols and Interlaboratory Exercises).

Methodology for monitoring, temporal and spatial scope

Available Methodologies for Monitoring and Monitoring Protocols

In line with the Ecosystem Approach and the IMAP implementation, there are considerable benefits to be gained from taking advantage of previous knowledge and information developed through the UNEP/MAP MED POL. These actions include (1) the use of existing experience in the design of monitoring programmes, (2) the use of existing guidance on sampling and analytical methods to inform technical aspects of ecosystem approach monitoring, (3) the use of existing sampling station networks as a framework for the ecosystem approach monitoring networks, (4) the use of existing statistical assessment tools and work on assessment criteria as the basis for the assessments of ecosystem approach data, (5) the use of existing data to describe the distributions and levels of contaminants against EACs and reference concentrations, and (6) the use of existing time series as the basis of monitoring against a “no deterioration” target. The availability of quality assured data is of importance for the assessment of trends and levels and their comparability overtime and across spatial scales.

Available data sources

i. UNEP(DEPI)/MED WG.365/Inf.5. Analysis of the trend monitoring activities and data for the MED POL Phase III and IV (1999-2010). Consultation Meeting to Review MED POL Monitoring Activities. Athens, 22-23 November 2011.

Indicator Title	Common Indicator 17. Concentration of key harmful contaminants measured in the relevant matrix (EO9)

ii. UNEP(DEPI)/MED WG. 365/Inf.8. Development of assessment criteria for hazardous substances in the Mediterranean. Consultation Meeting to Review MED POL Monitoring Activities. Athens, 22-23 November 2011.
iii. UNEP(DEPI)/MED WG. 427/Inf.3. Background to the Assessment Criteria for Hazardous Substances and Biological Markers in the Mediterranean Sea Basin and its Regional Scales.
iv. Meeting of the Ecosystem Approach Correspondence Group on Pollution Monitoring Marseille, France, 19-21 October 2016.

Spatial scope guidance and selection of monitoring stations

The spatial scope for monitoring should include reference and coastal long-term master stations, including offshore, distributed spatially as relevant and include local spatial refinements, such as transect sampling (for sediment and/or active biomonitoring); and therefore, is a direct function of the risk-based assessments and the long-term monitoring purposes. The selection of the sampling sites for the monitoring of contaminants in the marine environment should consider:

• Risk areas of concern identified on the basis of the review of the existing information.
• Vulnerable areas of known past and/or present release of chemical contaminants.
• Offshore areas where risk warrants coverage (aquaculture, offshore oil and gas activity, dredging, mining, dumping at sea and others).
• Monitoring sites representative of other sources, such as shipping and atmospheric inputs.
•Reference monitoring sites: to establish scale-based reference values and background concentrations.
• Monitoring sites representing sensitive pollution sites/areas at national and sub regional scale.
• Monitoring sites in deep-sea sites, offshore stations (sediments) and areas of potential particular concern.

The selected sites should allow the collection of a realistic number of samples over the years (e.g. to be suitable for sediment sampling, to allow sampling a sufficient number of biota for the selected species during the duration of the programme). It is essential that the monitoring strategies are being coordinated at regional and/or sub regional level. The coordination with the monitoring networks for other Ecological Objectives is crucial for cost-effective and future IMAP integrated assessment.

Temporal Scope guidance

Sampling frequencies will be determined according the current status of the national marine monitoring.

INITIAL PHASE MONITORING: to identify key sampling sites/stations within a coastal network which should include: BIOTA samples (bivalves, e.g. *Mytilus galloprovincialis*, *Donax trunculus*, etc. (yearly collection) and fish (i.e. *Mullus barbatus* every 4 years. In this phase monitoring SEDIMENTS (coastal, platform should be collected every two years

ADVANCED PHASE MONITORING (when there is a fully completed MED POL Phase IV implementation with the ongoing reporting of datasets) should include: BIOTA (from 1 to 3 years according the trends and levels of chemicals assessed at the different stations/sites) and SEDIMENTS (from 3 to 6 years depending on the characteristics of sedimentation areas and the chemical concerned known through previous MED POL assessments).

Indicator Title	Common Indicator 17. Concentration of key harmful contaminants measured in the relevant matrix (EO9)

The temporal scope may range from seasonally variable parameters up to large time scales, e.g. sediment core monitoring (years to decades). For temporal trend determinations the sampling frequencies will depend on the ability to detect trends considering the environmental and the analytical variability (ca. total uncertainty). It can be possible to decrease the sampling frequencies and target chemicals in cases where established time trends and levels show concentrations well below levels of concern, and without any upward trend over a number of years (including the stations/sites where recurrently exhibit non-detected contaminants value; that is below detection and quantification limits).

Data analysis and assessment outputs

Statistical analysis and basis for aggregation

Monitoring should allow the necessary statistical data treatments and long-term time-trend data analysis.

Expected assessments outputs

For chemical contaminants, trends analysis and distribution levels for the assessment could be carried out on sub-regional and/or regional level, provided appropriate quality control assured datasets are available. For the assessment of GES, it would be carried out using Mediterranean data from the MEDPOL database and applying a two-level threshold classification (Background Assessment Criteria-BACs and Environmental Assessment Criteria-EACs), such as the OSPAR methodology. However, the revised Mediterranean BACs and EACs for chemical contaminants, such as trace metals (mercury, cadmium and lead) and organic contaminants (chlorinated compounds and PAHs) in sediments and biota in the Mediterranean Sea should be applied.

Known gaps and uncertainties in the Mediterranean

Important development areas in the Mediterranean Sea over the next few years will include harmonization of monitoring targets (determinants and matrices) within assessment at sub-regions scales, development of suites of assessment criteria, integrated chemical and biological assessment method developments, and review of the scope of the national monitoring programmes to ensure that those contaminants which are considered to be important within each assessment area are included. Through these and other actions, it will be possible to develop targeted and effective monitoring programmes tailored to meet the needs and conditions within each GES assessment sub-region.It has been recognized that the open and deep sea is much less covered by monitoring efforts than coastal areas. There is a need to include within monitoring programmes also areas beyond the coastal areas in a representative and efficient way (where risks warrant coverage).

Contacts and version Date

http://www.unepmap.org

Version No	**Date**	**Author**
V.2	31.05.17	MEDPOL
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Annex VI

Reproduction of Guidance Factsheet for Common Indicator 18 : Level of pollution effects of key contaminants where a cause and effect relationship has been established[†] (EO9)

Indicator Title	Common Indicator 18. Level of pollution effects of key contaminants where a cause and effect relationship has been established (EO9)	
Relevant GES definition	**Related Operational Objective**	**Proposed Target(s)**
Concentrations of contaminants are not giving rise to acute pollution events	Effects of released contaminants are minimized	Contaminants effects below threshold Decreasing trend in the operational releases of oil and other contaminants from coastal, maritime and off-shore activities.

Rational

Justification for indicator selection

Upon exposure to certain dose of harmful contaminants, marine organisms start manifesting a number of symptoms that are indicative of biological damage, the first ones appearing after a short while at the sub-cellular level. These 'sub lethal' effects, when integrated, often converge to visible harm for the organisms and possibly to the whole population at a later stage, when it will be too late to limit the extent of biological damage resulting from environmental chemical exposure and ecosystems deterioration. Most of these symptoms have been reproducibly obtained in the laboratory (at high dose) and the various biological mechanisms of response to major xenobiotics are now sufficiently well documented. In the latest decades, scientific research has been intensified towards these alternative cellular and sub-cellular methods for integrated pollution monitoring, despite it revealed a more complex panorama with samples exposed to environmental concentrations, which includes a number of confounding factors hindering the cost-effective and reliable determination of biological effects at cellular and sub-cellular levels. As a consequence, most of these methods (biomarkers), based on the chemical exposure to biological effects cause relationships, are envisaged to monitor hotpots stations, dredging materials assessments and local damage evaluations rather than for continuous long-term environmental monitoring (surveillance). Ongoing research (biomarkers, bioassays) and future research trends, such as 'omics' developments, will further define the indicators and the methodologies for these common indicators for toxicological effects.

Scientific References

i. European Commission, 2014. Technical report on aquatic effect-based monitoring tools. Technical Report - 2014 – 077.
ii. Davies, I. M. And Vethaak, A.D., 2012. Integrated marine environmental monitoring of chemicals and their effects. ICES Cooperative Research Report N).
iii. Moore, M.N. (1985), Cellular responses to pollutants. *Mar.Pollut.Bull.*, 16:134-139
iv. Moore, M.N. (1990), Lysosomal cytochemistry in marine environmental monitoring. *Histochem J.*, 22:187-191

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[†] Marine Strategy Framework Directive (MSFD) Descriptor 8: Concentrations of contaminants are at levels not giving rise to pollution effects

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

v. Scarpato, R., L. Migliore, G. Alfinito-Cognetti and R. Barale (1990), Induction of micronuclei in gill tissue of *Mytilusgalloprovincialis*exposed to polluted marine waters *Mar.Pollut.Bull.*, 21:74-80
vi. Lowe, D., M.N. Moore and B.M. Evans (1992), Contaminant impact on interactions of molecular probes with lysosomes in living hepatocytes from dab *Limandalimanda. Mar.Ecol.Progr.Ser.*, 91:135-140
vii. Lowe, D.M., C. Soverchia and M.M. Moore (1995), Lysosomal membrane responses in the blood and digestive cells of mussels experimentally exposed to fluoranthene. *Aquatic Toxicol.,* 33:105-112
viii. George, S.G. and Per-Erik Olsson (1994), Metallothioneins as indicators of trace metal pollution in Biomonitoring of Coastal Waters and Estuaries, edited by J.M. Kees. Boca Raton, FL 33431, Kramer CRC Press Inc., pp.151-171

Policy Context and targets

Policy context description

In most Mediterranean countries, the monitoring of a range of hazardous chemical substances in different marine compartments are undertaken in response to the UNEP/MAP Barcelona Convention (1976) and its Land-Based Protocol, through the coordination of the UNEP/MAP MED POL Monitoring Program. For Mediterranean EU countries, the European legislation on the Marine Environment also applies (e.g. EU WFD and EU MSFD), as well as other international and national policy drivers. A considerable amount of founding knowledge and actions are available through the pollution monitoring and assessment component of the UNEP/MAP MED POL Programme during the past decades until today, including monitoring pilot programmes (Eco-toxicological effects of contaminants). The environmental assessments have been used for the identification and confirmation of significant marine contaminants effects on biota and therefore, impacts on biodiversity; as well as, for the continuous development of monitoring strategies and guidance. With respect to the Ecosystem Approach and IMAP, their implementation will continue under the benefits gained from this past knowledge and the policy and practical framework built in the Mediterranean Sea.

Targets

Initial targets of GES under Common Indicator 18 will be based upon data of a selected biological effects parameters and biomarkers (reflecting the scope of current programmes and research, see Indicator Justification above) and the availability of suitable agreed assessment criteria.

Policy documents

General Policy documents

i. 19th COP to the Barcelona Convention, Athens, Greece, 2016. Decision IG.22/7 - Integrated Monitoring and Assessment Programme (IMAP) of the Mediterranean Sea and Coast and Related Assessment Criteria (UNEP(DEPI)/MED IG.22/28)
ii. 19th COP to the Barcelona Convention, Athens, Greece, 2016.Draft Integrated Monitoring and Assessment Guidance (UNEP(DEPI)/MED IG.22/Inf.7)
iii. 18th COP to the Barcelona Convention, Istanbul, Turkey, 2013.Decision IG.21/3 - Ecosystems Approach including adopting definitions of Good Environmental Status (GES) and Targets. UNEP(DEPI)/MED IG.21/9

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

iv. Directive 2008/56/EC of the European Parliament and of the Council of 17 June 2008 establishing a framework for community action in the field of marine environmental policy (Marine Strategy Framework Directive).

v. Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy.

Contaminants related Policy documents

vi. UNEP (1997), The MED POL Biomonitoring Programme Concerning the Effects of Pollutants on Marine Organisms Along the Mediterranean Coasts. UNEP(OCA)/MED WG.132/3, Athens, 15 p.

vii. UNEP (1997), Report of the Meeting of Experts to Review the MED POL Biomonitoring Programme. UNEP(OCA)/MED WG.132/7, Athens, 19 p.

viii. Targets: UNEP(DEPI)/MED WG.421/Inf.9. Integrated Monitoring and Assessment Guidance. Agenda item 5.7: Draft Decision on Integrated Monitoring and Assessment Programme (IMAP) of the Mediterranean Sea and Coast and Related Assessment Criteria. Meeting of the MAP Focal Points. Athens, Greece, 13-16 October 2015.

Indicator analysis methods

Indicator Definition

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.
Sub-indicators: complementary biomarkers, bioassays and histology techniques and methods are also recommended to be carried out on a country basis (such as, hepatic pathologies assessment, reduction of survival in air by Stress on Stress (SoS), larval embryotoxicity assay, Comet assay, etc.). Metallothionnein in mussels and Ethoxyresorufin-O-deethylase (EROD) activity in fish as a biomarker of chemical exposures.

The biochemical parameters and toxicological measurements above will be used to develop the IMAP Info System which will include Data Dictionaries (DDs) and Data Standards (DSs) for CI18 accordingly.

Methodology for indicator calculation

Lysosomal Membrane Stability (LMS): Biological techniques (neutral red retention), including microscopy

Acetylcholinesterase (AChE) assay: Biochemical techniques, including spectrophotometry

Micronucleus assay: Biochemical techniques, including microscopy

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Additional parameters to be recorded: biometrics (size/length, age), biological parameters such as condition index (mussels), condition factor, gonadosomatic index, hepatosomatic index (fish) and data on temperature, salinity and oxygen dissolved.

Indicator units

(retention) minutes - Lysosomal Membrane Stability (LMS)
nmol/min mg protein in gills (bivalves) - Acetylcholinesterase (AChE) assay
Number of cases, ‰ in haemocytes - Micronucleus assay

List of Guidance documents and protocols available

i. European Commission, 2014. Technical report on effect-based monitoring tools. Technical Report 2014 – 077. European Commission, 2014.
ii. UNEP/RAMOGE: Manual on the Biomarkers Recommended for the UNEP/MAP MED POL Biomonitoring Programme. UNEP, Athens, 1999.
iii. UNEP/MAP, 2005. Fact sheets on Marine Pollution Indicators. Meeting of the UNEP/MAP MED POL National Coordinators. Barcelona, Spain, 24-27 May 2005. UNEP(DEC)/MED/ WG.264/ Inf.14. UNEP, Athens.
iv. ICES Cooperative Research Report. No.315. Integrated marine environmental monitoring of chemicals and their effects. I.M. Davies and D. Vethaak Eds., November 2012.

Data Confidence and uncertainties

Selected analytical validated methods should be subject to Quality Assurance Protocols and interlaboratory exercises: QA/QC through UNEP/MAP MED POL intercalibration supported exercises in agreement with University of Piemonte Orientale (Italy).

Methodology for monitoring, temporal and spatial scope

Available Methodologies for Monitoring and Monitoring Protocols

With regard the Ecosystem Approach and IMAP implementation, there are considerable benefits to be gained from taking advantage of previous knowledge and information developed through the UNEP/MAP MED POL. These actions include (1) the use of existing experience in the design of monitoring programmes, (2) the use of existing guidance on sampling and analytical methods to inform technical aspects of ecosystem approach monitoring, (3) the use of existing sampling station networks as a framework for the ecosystem approach monitoring networks, (4) the use of existing statistical assessment tools and work on assessment criteria as the basis for the assessments of ecosystem approach data, (5) the use of existing data to describe the distributions and levels of contaminants and effects against EACs and reference concentrations , and (6) the use of existing time series as the basis of monitoring against a “no deterioration” target. The availability of quality assured data is of importance for the assessment of levels and trends, and thus, their comparability overtime and across spatial scales. Therefore, based on the work already carried out, the results of the intercalibration exercises and the scientific and technical publications within the UNEP/MAP MED POL programme on biological effects monitoring, there is a network of laboratories in the Mediterranean region with the capacity to carry out biological effects monitoring activities, in line with the monitoring requirements. Available guidelines and monitoring protocols can be found in the framework of other Regional Seas Conventions (e.g. OSPAR) as well.

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

Available data sources

i. MED POL Database.
ii. UNEP/RAMOGE: Manual on the Biomarkers Recommended for the UNEP/MAP MED POL Biomonitoring Programme. UNEP, Athens, 1999.
iii. ICES Cooperative Research Report, No 315, November 2012. Integrated marine environmental monitoring of chemicals and their effects. Ed. Ian M. Davis and Dick Vethaack.

Spatial scope guidance and selection of monitoring stations

The spatial scope for monitoring should include reference and coastal long-term master stations, including offshore, distributed spatially as relevant and include local spatial refinements, such as transect sampling, and therefore, is a direct function of the risk-based assessments and the long-term monitoring purpose. The selection of the sampling sites for the monitoring of biological effects in the marine environment should consider:

• Risk areas of concern identified on the basis of the review of the existing information.
• Vulnerable areas of known past and/or present release of chemical contaminants.
• Offshore areas where risk warrants coverage (aquaculture, offshore oil and gas activity, dredging, mining, dumping at sea and others).
• Monitoring sites representative of other sources, such as shipping and atmospheric inputs.
• Reference monitoring sites: to establish scale-based reference values and background concentrations.
• Monitoring sites representing sensitive pollution sites/areas at national and sub regional scale.
• Monitoring sites in deep-sea sites, offshore stations (sediments)and areas of potential particular concern

The selected sites should allow the collection of a realistic number of samples over the years (e.g. allow to sample sufficient number of biota for the selected species during the duration of the programme). It is essential that the monitoring strategies are being coordinated at regional and/or sub regional level, in particular with chemical monitoring. The coordination with monitoring for other Ecological Objectives is crucial for cost-effective and future integrated assessment.

Temporal Scope guidance

Sampling frequencies will be determined according the current status of the pilots and national marine monitoring programmes:

INITIAL PHASE MONITORING (PILOT): to identify monitoring stations to collect BIOTA (bivalves, such as *Mytilus galloprovincialis*,) on a yearly basis (or higher frequencies if the environmental variability study needs to be carried out), and in the same manner as for chemical monitoring, focusing on few locations such as hotspots and reference stations.
ADVANCED PHASE MONITORING: when fully completed and reported MED POL Phase IV datasets, including biological effects is achieved, then, at this stage the objective should be the integration of the chemical and biological monitoring on a efficient manner. Therefore, a refinement of the successful strategies for biological effects long-term monitoring should be implemented and maintained based on the experiences from developing pilot monitoring activities (Initial Phase).

Indicator Title	Common Indicator 18. Level of pollution effects of key contaminants where a cause and effect relationship has been established (EO9)
For trend determinations the sampling frequencies will depend on the ability to detect trends considering the environmental and the analytical variability (ca. total uncertainty). It can be possible to decrease the sampling frequencies in cases where established time trends and levels show concentrations well below levels of concern, and without any upward trend over a number of years.	
Data analysis and assessment outputs	
Statistical analysis and basis for aggregation Monitoring should allow the necessary statistical data treatments and long-term time-trend analysis.	
Expected assessments outputs For biological effects, trends analysis and distribution levels could be carried out on sub-regional level, provided appropriate quality assured datasets are available. For the integrated assessment of GES, it would be carried out using Mediterranean data from the MEDPOL database and applying a two-level threshold classification (such as the OSPAR methodology). Assessing biomarker responses against Background Assessment Criteria (BACs) and Environmental Assessment Criteria (EACs) allows establishing if the responses measured are at levels that are not causing deleterious biological effects, at levels where deleterious biological effects are possible or at levels where deleterious biological effects are likely in the long-term. In the case of biomarkers of exposure, only BAC can be estimated, whereas for biomarkers of effects both BAC and EAC can be established.	
Known gaps and uncertainties in the Mediterranean Important development areas in the Mediterranean Sea over the next few years will include harmonization of monitoring targets (determinants and matrices) within assessment sub-regions, development of suites of assessment criteria integrated chemical and biological assessment methods, and review of the scope of the monitoring programmes to ensure that those contaminants which are considered to be important within each assessment area are included in monitoring programmes. Through these and other actions, it will be possible to develop targeted and effective monitoring programmes tailored to meet the needs and conditions within each GES assessment sub-region. It has been recognized that the open and deep sea is much less covered by monitoring efforts than coastal areas. There is a need to include within monitoring programmes also areas beyond the coastal areas in a representative and efficient way, where risks warrant coverage.	
Contacts and version Date	
http://www.unepmap.org	

Version No	**Date**	**Author**
V.2	31.05.17	MEDPOL
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