UNITED NATIONS

EP

UNEP(DEPI)/MED WG.434/Inf.3

UNEP

UNITED NATIONS
ENVIRONMENT PROGRAMME
MEDITERRANEAN ACTION PLAN

3 March 2017
Original: English

First Meeting of the OFOG Sub-Group on Environmental Impact of Offshore Monitoring Programmes

Greece, 3-4 April 2017

Agenda item 3: Offshore Monitoring Programme

Revised IMAP Indicator Guidance Factsheets relevant to offshore activities

UNEP/MAP
Athens, 2016

Revised IMAP Indicator Guidance Factsheets relevant to offshore activities

Introduction

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. In its Decision IG. 22/7, a specific list of good environmental status common indicators and targets and principles of an integrated Mediterranean Monitoring and Assessment Programme, next to a clear timeline for the implementation of this Programme were detailed. 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. The IMAP aims to facilitate the implementation of article 12 of the Barcelona Convention and several monitoring related provisions under different protocols with the main objective to assess GES. Its backbone are the 11 Ecological Objectives and their 27 common indicators as presented in the decision.

The UNEP/MAP Programme of Work (PoW) adopted at COP 19, includes the 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 center to be integrated into Info/MAP platform.*

Therefore, the draft guidance factsheets within each Common Indicator have been developed for coherent monitoring, as well as their targets defined and agreed in order to deliver the achievement of Good Environmental Status (GES). In this context, this document outlines the nineteen Indicator Guidance Factsheets relevant to offshore activities:

The main purpose of this revised Indicator Guidance Factsheets is to provide an concrete guidance and references to Contracting Parties to design and support implementation of their revised national monitoring programme towards the overall goal of implementing the Ecosystem Approach (EcAp) in the Mediterranean Sea and achieving GES.

The structure of a Common Indicator Factsheets can be summarized looking at the different organization levels of the developed factsheet templates. A common set of relevant policy and science-based information is required for each Indicator (ie. Indicator Title, Definition, 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 (see scheme below).

As stated in document UNEP(DEPI)/MED WG.434/6 related to the list of IMAP indicators relevant to the Offshore Monitoring Programme and related draft guidance fact sheets, Whilst the IMAP Indicator Guidance Factsheets of the nineteen (19) Common and Candidate Indicators relevant to Offshore Monitoring have been reviewed, the scientific input, in terms of the proposed target limits, presented in Annex concerns only Candidate Indicators 26 and 27, since the proposed amendments for the other Guidance Factsheets reproduced in Annex to the present document are mainly editorial.

Annex

Revised IMAP Indicator Guidance Factsheets relevant to offshore activities

1. Common Indicator 1: Habitat distributional range, to also consider habitat extent as a relevant attribute (EO1);

<table>
<tr><td>Indicator Title</td><td colspan="2">Common Indicator 1: Habitat distributional range</td></tr>
<tr><td>Relevant GES definition</td><td>Related Operational Objective</td><td>Proposed Target(s)</td></tr>
<tr><td>Reference condition/reference state is recommended as the preferred approach to setting baselines for benthic habitats. Where possible, the reference conditions should be determined e.g. using historical maps/data, modelling results. If the determination of reference conditions is not possible, then expert judgement should be used giving particular consideration to the current state.</td><td>The ECAP Operational Objective of the indicator for habitat distributional range is that key coastal and marine habitats are not being lost.</td><td>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 of the baseline value. 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.</td></tr>
<tr><td colspan="3">Rationale</td></tr>
<tr><td colspan="3">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.</td></tr>
<tr><td colspan="3">Scientific References
List (author(s), year, Ref: journal, series, etc.) and url’s
Andersen et al., 2013
• Ban N.C., Alidina, H.M., Ardron, J.A., 2010. Cumulative impact mapping: advances, relevance and limitations to marine management and conservation, using Canada‘s Pacific waters as a case study. Mar. Policy 34, 876–886.
• 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., Christensen, V., Karpouzi, V.S., Guilhaumon, F., Mouillot, D., Paleczny, M., Palomares, M.L., Steenbeek, J., Trujillo, P., Watson, R., Pauly, D., 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., Possingham, H.P., Abdulla, A., Çinar, M.E., Dendrinos, P., Gucu, A.C., Karamanlidis, A.A., Rodic, P., Panayotidis, P., Taskin, E., Jaklin, A., Voultsiadou, E., Webster, C., Zenetos, A. & S. Katsanevakis (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., D‘Agrosa, C., Brunoa, J.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., Kontgis, C., Crain, C.M., Martone, R.G., Shearer, C., Teck, S.J., 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., Meski L., Andersen A., Laamanen M., 2012. Human pressures and their potential impact on the Baltic Sea ecosystem. Ecological Indicators, 15:105–114.
• Korpinen S., Meidinger M., Cumulative impacts on seabed habitats: An indicator Laamanen M., 2013.for assessments of GES. Mar. Poll. Bull., 74: 311–319.</td></tr>
</table>

Indicator Title	*Common Indicator 1: Habitat distributional range*

- Micheli F, Halpern BS, Walbridge S, Ciriaco S, Ferretti F, Fraschetti S., Lewison R., Nykjaer L., Rosenberg AA., 2013. Cumulative Human Impacts on Mediterranean and Black Sea Marine and coastal ecosystems: Assessing Current Pressures and Opportunities. PLoS ONE 8(12): e79889. doi:10.1371/journal.pone.0079889.
- Selkoe, K.A., Halpern, B.S., Ebert, C.M., Franklin, E.C., Selig, E.R., Casey, K.S., Bruno, J., Toonen, R.J., 2009. A map of human impacts to a pristine coral reef ecosystem, the Papahanaumokuakea Marine National Monument. Coral Reefs 28, 635–650.

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 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.

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 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 using sensitivity maps in combination with construction footprint data 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 construction and other anthropogenic pressures.

List of Guidance documents and protocols available

Coggan, R., Populis, J., White, J., Sheehan, K., Fitzpatrick, F., Peil, S. (eds) (2007) Review of standards and protocols for seabed habitat mapping, 192pp.
Recommended Operating Guidelines
(http://www.emodnet-seabedhabitats.eu/default.aspx?page=1915)

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;

Indicator Title	*Common Indicator 1: Habitat distributional range*

(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
Marine Observation and Data Network (EMODnet) : http://www.emodnet-mediterranean.eu/project/
Distribution of *Posidonia oceanica* meadows in the Mediterranean Sea (GIS shapefile) : http://lifewww-00.her.hcmr.gr:8080/medobis/resource.do?r=posidonia
Distribution of coralligenous formations in the Mediterranean Sea (GIS shapefile) : http://lifewww-00.her.hcmr.gr:8080/medobis/resource.do?r=coralligenous

Spatial scope guidance and selection of monitoring stations

The spatial basis for assessment should be according to the Mediterranean biogeographic sub-areas in order to reflect changes in the biological character of each habitat type across the Mediterranean and its sub-regions.
Each Contracting Party should assess each habitat across their national maritime waters. However, it is recommended to assess on a smaller scale if they belong to different biogeographical sub-regions or differences in pressure intensity are obvious between sub-basins.

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 each habitat type;
- Collate construction footprint data for sealed habitats and apply spatial and temporal pressure intensity data (e.g. VMS or log book data for fisheries, activity data from approved plans and projects);
- If vulnerabilities are addressed in 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 construction footprints and impact models (with ground-truthing);
- If vulnerabilities are not addressed in first three points, derive measures of habitat extent;
- 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

Indicator Title	*Common Indicator 1: Habitat distributional range*	
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

2. Common Indicator 2: Condition of the habitat's typical species and communities (EO1);

Indicator Title	*Common indicator 2: Condition of the habitat's typical species and communities*	
Relevant GES definition	**Related Operational Objective**	**Proposed Target(s)**
Typical and/or characteristic species composition should be close to baseline conditions for their habitat to be considered in natural condition.	The ECAP Operational Objective of the indicator that key coastal and marine habitats remain in natural condition, in terms of structure and functions.	The general target is to reach a ratio of typical and/or characteristic species similar to baseline conditions for all considered communities.

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

- Pearson, T. H., Rosenberg, R. 1978. Macrobenthic succession in relation to organic enrichment and pollution of the marine environment. Oceanogr. Mar. Biol. Ann. Rev. 16,229-311.
- 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.

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 application of benthic indices developed and tested under the Water Framework Directive for use by all Contracting Parties. 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's typical species, the Contracting Parties need to define lists of typical and/or characteristic 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.

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

Indicator Title	*Common indicator 2: Condition of the habitat's typical species and communities*
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 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. 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 • EN ISO 16665:2014. Water quality - Guidelines for quantitative sampling and sample processing of marine soft-bottom macrofauna. • EN ISO 19493:2007 Water quality - Guidance on marine biological surveys of hard-substrate communities • GIG, 2013a. Intercalibration of biological elements for transitional and coastal water bodies. Mediterranean Sea GIG: Coastal waters - Benthic Invertebrate fauna. https://circabc.europa.eu/sd/a/2a0a9f86-e281-4bb8-a6ba-6e659b54e554/Med-Sea_CW_Benthic-Invertebrate-Fauna.pdf • GIG, 2013b. Intercalibration of biological elements for transitional and coastal water bodies. Mediterranean Sea GIG: Coastal waters - Seagrasses. https://circabc.europa.eu/sd/a/893d2fa4-9089-4765-8d42-c914a91b71e1/Med-Sea_CW_Seagrasses.pdf • GIG, 2013c. Intercalibration of biological elements for transitional and coastal water bodies. Mediterranean Sea GIG: Coastal waters - Macroalgae. https://circabc.europa.eu/sd/a/655bf0ef-370b-4737-	

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

8a48-f4adee0f4889/Med-Sea_CW_Macroalgae.pdf

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

Available data sources
Sources and url's

- Ballesteros, E., Torras, X., Pinedo, S., Garcia, M., Mangialajo, L., de Torres, M., 2007. A new methodology based on littoral community cartography dominated by macroalgae for the implementation of the European Water Framework Directive. Marine Pollution Bulletin 55: 172–180.
- Borja, A., Franco, J., Perez, V., 2000. Marine Biotic Index to establish the ecological quality of soft bottom benthos within European estuarine and coastal environments. Mar. Poll. Bull., 40 (12): 1100-1114.
- Borja, A., Franco, J., Valencia, V., Bald, J., Muxika, I., Belzunce, M. J., Solaun, O., 2004. Implementation of the European Water Framework Directive from the Basque Country (northern Spain): a methodological approach. Marine Pollution Bulletin 48 (3–4), 209–218.
- Dauvin, J. C., Rouellet, T., 2007. Polychaete/amphipod ratio revisited. Marine Pollution Bulletin 55: 215-224.
- Gatti, G., Bianchi, C.N., Morri, C., Montefalcone, M., Sartoretto, S. (2015). Coralligenous reefs state along anthropized coasts: Application and validation of the COARSE index, based on a rapid visual assessment (RVA) approach. Ecological Indicators 52: 567-576.
- Gatti, G., Montefalcone, M., Rovere, A., Parravicini, V., Morri, C., Albertelli, G., Bianchi C.N. (2012): Seafloor integrity down the harbor waterfront: the coralligenous shoals off Vado Ligure (NW Mediterranean), Advances in Oceanography and Limnology, 3:1, 51-67.
- Gobert, S., Sartoretto, S., Rico-Raimondino, V., Andral, B., Chery, A., Lejeune, P. Boissery, P., 2009. Assessment of the ecological status of Mediterranean French coastal waters as required by the water framework directive using the *Posidonia oceanica* rapid easy index: PREI. Mar. Pol. Bull. 58: 1727–1733.
- Gowen, R.J. McQuatters-Gollop, A. Tett, P. Best, M. Bresnan, E. Castellani, C. Cook, K. Forster, R. Scherer, C. Mckinney, A. 2011. The Development of UK Pelagic (Plankton) Indicators and Targets for the MSFD, Belfast, 2011.
- Lopez y Royo C., Casazza G., Pergent-Martini C., Pergent G., 2010. A biotic index using the seagrass Posidonia oceanica (BiPo), to evaluate ecological status of coastal waters. Ecological Indicators. 10: 380–389.
- Muxika I., Borja A., Bald J., 2007. Using historical data, expert judgement and multivariate analysis in assessing reference conditions and benthic ecological status, according to the European water framework Directive. Mar. Poll. Bull., 55: 16-29.
- Oliva, S., Mascaro, O., Llagostera, I., Perez, M., Romero, J., 2011. Selection of metrics based on the seagrass *Cymodocea nodosa* and development of a biotic index (CYMOX) for assessing ecological status of coastal and transitional waters. Estuarine, Coastal and Shelf Science xx, 1–11.
- Orfanidis, S., Panayotidis, P, Ugland, K.I., 2011. Ecological Evaluation Index continuous formula (EEI-c) application: a step forward for functional groups, the formula and reference condition values. Mediterranean Marine Science, 12(2): 199–231.
- Orfanidis, S., Panayotidis, P., Stamatis, N., 2001. Ecological evaluation of transitional and coastal waters: a marine benthic macrophytes-based model. Mediterranean Mar. Res. 2 (2), 45–65.
- Orfanidis, S., Papathanasiou, V., Gounaris, S., Theodosiou, T., 2010. Size distribution approaches for monitoring and conservation of coastal *Cymodocea* habitats. Aquatic Conserv: Mar. Freshw. Ecosyst. 20: 177–188.
- Pinedo, S., Jordana, E., Ballesteros, E., 2014. A Critical analysis on the response of macroinvertebrate communities along disturbance gradients: description of MEDOCC (MEDiterranean OCCidental)

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

index.

- Rastorgueff PA, Bellan-Santini D, Bianchi CN, Bussotti S, Chevaldonné P, et al. (2015) An ecosystem-based approach to evaluate the ecological quality of Mediterranean undersea caves. Ecological Indicators, 54: 137-152.
- Romero, J., Martinez-Crego, B., Alcoverro, T., Perez, M., 2007. A multivariate index based on the seagrass *Posidonia oceanica* (POMI) to assess ecological status of coastal waters under the Water Framework Directive (WFD). Marine Pollution Bulletin 55: 196–204.
- Simboura, N., Zenetos, A., 2002. Benthic indicators to use in ecological quality classification of Mediterranean soft bottom marine and coastal ecosystems, including a new Biotic index. Mediterranean Marine Science, 3/2:77-111.
- Tett, P., Carreira, C., Mills, D.K., van Leeuwen, S., Foden, J., Bresnan, E., Gowen, R.J. 2008. Use of a phytoplankton community index to assess the health of coastal waters. ICES J. Mar. Sci. 65(8), 1475-1482.
- Orfanidis, S., Panayotidis, P., Stamatis, N., 2003. An insight to the ecological evaluation index (EEI). Ecological Indicators 3: 27-33.

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

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 recommended sampling frequency for this indicator is once per year at assessed sites and once every 5 years at reference-baseline condition sites (at least 2 replicates per monitoring station).

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

3. Common Indicator 3: Species distributional range (related to marine mammals, seabirds, marine reptiles) (EO1);

Marine Mammals:

Indicator Title	*Common indicator 3:* **species distributional range (marine mammals)**	
Relevant GES definition	**Related Operational Objective**	**Proposed Target(s)**
The species are present in all their natural distributional range	Species distribution is maintained	The distribution of marine mammals remains stable or expanding and the species are recolonising areas with suitable habitats
Rationale		

Justification for indicator selection

The objective of this indicator is to focus on the species distributional range of marine mammals within the Mediterranean waters, with a special emphasis to those species selected by the Contracting Parties.

Differences and shifts in distribution may reflect changes in the occurrence of suitable habitats, availability of food resources, selective pressures from human-related activities, as well as climate change. With increasing concern about species conservation, quantitative descriptions of species' range structure and extent of geographical distribution (both for single species or groups of species) together with detailed information on the location of breeding/feeding areas, can provide crucial information for management purposes.

Eleven species of cetaceans are considered to regularly occur in the Mediterranean area: short-beaked common dolphin (*Delphinus delphis*), striped dolphin (*Stenella coeruleoalba*), common bottlenose dolphin (*Tursiops truncatus*), harbour porpoise (*Phocoena phocoena*), long-finned pilot whale (*Globicephala melas*), rough-toothed dolphin (*Steno bredanensis*), Risso's dolphin (*Grampus griseus*), fin whale (*Balaenoptera physalus*), sperm whale (*Physeter macrocephalus*), Cuvier's beaked whale (*Ziphius cavirostris*) and killer whale (*Orcinus orca*). Two of these species have very limited ranges: the harbour porpoise, possibly representing a small remnant population in the Aegean Sea, and the killer whale, present only as a small population of a few individuals in the Strait of Gibraltar.

Knowledge about the distribution, abundance and habitat use and preferences of some of these species, (including the most abundant ones) is scant and limited to specific sectors of the Mediterranean Sea, due to the uneven distribution of research effort during the last decades. In particular, the south-eastern portion of the basin, the coasts of North Africa and the central offshore waters are amongst the areas with the most limited knowledge on cetacean presence, occurrence and distribution.

The conservation status of cetaceans in the Mediterranean Sea has been a source of concern for many years. Marine mammals living in the Mediterranean Sea find themselves in precarious conditions due to the intense human presence and activities in the region. These are the source of a variety of pressures that are threatening these species' survival. These animals are highly mobile and are usually not confined within individual nations' jurisdictions, stressing the need for basin-wide conservation and protection effort. Several threats affect marine mammals in the Mediterranean Sea and their effect on the population, distributional range and survival may act in a synergistic manner. Threats include interaction with fisheries, disturbance, injuries and fatal collisions from shipping, habitat loss and degradation, chemical pollution, anthropogenic noise, direct killings and climate change.

The geographical distribution of marine mammals in the Mediterranean Sea is affected by several factors, which should all be taken into consideration when monitoring these species. Ocean currents, abundance of food, sea temperature, morphology of the coastline, seabed topography, as well as human activities, seem to interact and influence which areas are preferred habitats for cetaceans and seals. Certain habitats have a particular value in the life cycles of different species, in that they are used as foraging grounds due to prey abundance, for breeding or as migration corridors between areas.

Scientific References

Bearzi, G. et al. 2004. The role of historical dolphin takes and habitat degradation in shaping the present status of northern Adriatic cetaceans. - Aquat. Conserv. Mar. Freshw. Ecosyst. 14: 363–379.
Coll, M. et al. 2010. The Biodiversity of the Mediterranean Sea: Estimates, Patterns, and Threats. - PLoS ONE 5: e11842.
Fossi, M. C. and Marsili, L. 2003. Effects of endocrine disruptors in aquatic mammals. - Pure Appl. Chem. 75:

Indicator Title	*Common indicator 3:* **species distributional range (marine mammals)**

2235–2247.
Fossi, M. C. et al. 2013. The Pelagos Sanctuary for Mediterranean marine mammals: Marine Protected Area (MPA) or marine polluted area? The case study of the striped dolphin (Stenella coeruleoalba). - Mar Pollut Bull 70: 64–72.
Fossi, M. C. et al. 2014. Large filter feeding marine organisms as indicators of microplastic in the pelagic environment: The case studies of the Mediterranean basking shark (Cetorhinus maximus) and fin whale (Balaenoptera physalus). - Mar. Environ. Res. 100: 17–24.
Frantzis, A. 1998. Does acoustic testing strand whales? - Nature 392: 29–29.
Gaston, K. J. 2003. The Structure and Dynamics of Geographic Ranges. - Oxford University Press.
Gómez de Segura, A. et al. 2008. Influence of environmental factors on small cetacean distribution in the Spanish Mediterranean. - J. Mar. Biol. Assoc. U. K. in press.
Hoffmann, A. A. and Blows, M. W. 1994. Species borders: ecological and evolutionary perspectives. - Trends Ecol. Evol. 9: 223–227.
IUCN 2012. Marine mammals and sea turtles of the Mediterranean and Black Seas. - IUCN.
Lawton, J. H. 1993. Range, population abundance and conservation. - Trends Ecol. Evol. 8: 409–413.
Notarbartolo di Sciara, G. and Birkun, A., Jr 2010. Conserving whales, dolphins and porpoises in the Mediterranean and Black Seas: an ACCOBAMS status report, 2010.: 212.
Notarbartolo di Sciara, G. et al. 2013. Is the Pelagos Sanctuary sufficiently large for the cetacean populations it is intended to protect? - Rapp Comm Int Mer Médit: 623.
Panigada, S. et al. 2006. Mediterranean fin whales at risk from fatal ship strikes. - Mar Pollut Bull 52: 1287–1298.
Reese, G. C. et al. 2005. Factors Affecting Species Distribution Predictions: A Simulation Modeling Experiment. - Ecol. Appl. 15: 554–564.
Simmonds, M. P. et al. 2012. Climate change effects on Mediterranean Cetaceans: Time for action. - In: Life in the Mediterranean Sea: A Look at Habitat Changes. pp. 685–701.

Policy Context and targets (other than IMAP)

Policy context description

Mediterranean fin whales and sperm whales are protected by the International Whaling Commission’s moratorium on commercial whaling that entered into force in 1986.
The Mediterranean cetaceans’ populations are also protected under the auspices of ACCOBAMS (Agreement on the Conservation of Cetaceans of the Black Sea, Mediterranean Sea and contiguous Atlantic Area), under the auspices of the UNEP Convention on the Conservation of Migratory Species of Wild Animals (UNEP/CMS). The Corso-Ligurian-Provençal Basin and the Tyrrhenian Sea, where most cetacean species find suitable habitats, lie within the Pelagos Sanctuary established by France, Italy and Monaco, thus benefitting from its conservation regime.
All cetacean species in the Mediterranean Sea are protected under the Annex II of the SPA-BD Protocol under the Barcelona Convention; under the Appendix I of the Bern Convention; under the Annex II of the Washington Convention (CITES); under the Appendix II of the Bonn Convention (CMS).
The short-beaked common dolphin, the sperm whale and the Cuvier’s beaked whale and the monk seal are also listed under the Appendix I of the Bonn Convention (CMS).
The common bottle dolphin, the harbor porpoise and the monk seal are also listed under the Annex II of the EU Habitats Directive.

Indicator/Targets

Aichi Biodiversity Target 1, 3
EU Regulation 812/2004 concerning incidental catches of cetaceans in fisheries
EU MSFD Descriptor 1 and 4
EU Habitats Directive
The obligations under ACCOBAMS

Policy documents

- Aichi Biodiversity Targets - https://www.cbd.int/sp/targets/
- EU Biodiversity Strategy - http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52011DC0244&from=EN
- EU Regulation 1143/2014 - http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32014R1143&from=EN
- Marine Strategy Framework Directive - http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32008L0056&from=EN
- Commission Decision on criteria and methodological standards on good environmental status of marine

Indicator Title	*Common indicator 3:* **species distributional range (marine mammals)**

waters - http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32010D0477(01)&from=EN

- Pan-European 2020 Strategy for Biodiversity - https://www.google.no/url?sa=t&rct=j&q=&esrc=s&source=web&cd=2&cad=rja&uact=8&ved=0ahUKEwiP1J-v_P7NAhWHjSwKHZfoBRIQFggtMAE&url=https%3A%2F%2Fcapacity4dev.ec.europa.eu%2Fsystem%2Ffiles%2Ffile%2F08%2F10%2F2012_-_1535%2Fpan-european_2020_strategy_for_biodiversity.pdf&usg=AFQjCNGa4NkkljA4x3l9WDO49uwrdYafMg
- Strategic Action Programme for the conservation of Biological Diversity (SAP BIO) in the Mediterranean Region - http://sapbio.rac-spa.org/
- Draft Updated Action Plan for the conservation of Cetaceans in the Mediterranean Sea - http://rac-spa.org/nfp12/documents/working/wg.408_08_eng.pdf
- National Biodiversity Strategies and Action Plans (NBSAPs) - https://www.cbd.int/nbsap/
  ACCOBAMS Agreement Text - http://www.accobams.org/images/stories/Accord/anglais_text%20of%20the%20agreement%20english.pdf
- ACCOBAMS STRATEGY (PERIOD 2014 – 2025) - https://accobams.org/images/stories/MOP/MOP5/Documents/Resolutions/mop5.res5.1_accobams%20strategy.pdf

Indicator analysis methods

Indicator Definition

This indicator aims at providing information about the geographical area in which marine mammal species occur. It also aims at determining the species range of cetaceans and seals that are present in Mediterranean waters, with a special focus on the species selected by the Contracting Parties.

Methodology for indicator calculation

The range of a given species is commonly represented by a distribution map. The main outputs of the monitoring under this common indicator will be maps of species presence, distribution and occurrence.

The use of Geographical Information Systems (GIS) is required for the compilation of the monitoring data collected and the elaboration of the species distributional range maps.

Information on distribution of marine mammals may be obtained through dedicated ship and aerial surveys, acoustic surveys, and platforms of opportunities (e.g., whale watching operators, ferries, cruise ships, and military ships).

Indicator units

The Integrated Monitoring and Assessment Guidance provided in document UNEP(DEPI)/MED WG.420/4 recommended the use for recording the presence/absence of each species, of the standardized 30 x 30 nautical mile grid map produced by FAO/GFCM or the 50 x 50 km grids used by the European Bird Census Council. According to specific needs, a finer scale map can be used, to provide finer information.

List of Guidance documents and protocols available

A document on ‘Monitoring Guidelines to assess Cetaceans’ Distributional Range, Population Abundance and Population Demographic Characteristics’ has been produced by ACCOBAMS and should be considered as guidance when establishing monitoring programmes.

Data Confidence and uncertainties

Distribution maps are generally qualitative. It is important to consider the highly mobility of cetaceans and the driving forces (mainly prey availability) which affect their distribution. In case of trends in distribution over time, appropriate statistical tools and analytical framework, such as habitat prediction modelling, should be applied. As an example, standard regression methods (simple linear regression, generalized linear or additive models, etc.) provide estimates of uncertainty (standard errors and confidence intervals of estimated trends). Such uncertainty estimates should accompany all reported trends.

Methodology for monitoring, temporal and spatial scope

Available Methodologies for Monitoring and Monitoring Protocols

Several protocols are available using different monitoring platforms and approaches such as:

- Dedicated ships or aerial surveys
- By-catch data
- Beached and stranded specimens monitoring
- Opportunistic data collected from platform of opportunities
- Citizen science data
- Tagging (capture-mark-recapture – artificial tags & photo-identification)
- Telemetry: satellite tracking, GPS/GSM tracking, radio tracking and the use of data loggers
- Acoustic data collection
- Automatic infrared camera

Indicator Title	*Common indicator 3:* **species distributional range (marine mammals)**

Available data sources

OBIS-SEAMAP, Ocean Biogeographic Information System Spatial Ecological Analysis of Megavertebrate Populations, is a spatially referenced online database, aggregating marine mammal, seabird, sea turtle and ray & shark observation data from across the globe. http://seamap.env.duke.edu/

Spatial scope guidance and selection of monitoring stations

The current spatial distributional range of marine mammals in the Mediterranean Sea is largely affected by available data, due to the uneven distribution of research effort during the last decades. In particular, the south-eastern portion of the basin, the coasts of North Africa and the central offshore waters are among the areas with the most limited knowledge on cetacean presence, occurrence and distribution. Priority should be given to the less known areas, using online data sources, such as Obis SeaMap and published data and reports as sources of information.

Ongoing effort by Dr. Jean-Noël DRUON, European Commission, DG Joint Research Centre, Maritime Affairs Unit on mapping potential foraging areas for fin whales in near real-time may provide baseline data and facilitate the analysis of distributional trends over time and space (https://fishreg.jrc.ec.europa.eu/fish-habitat).

Temporal Scope guidance

Fine scale distribution of cetaceans may vary on annual, seasonal or monthly basis. Ideally, seasonal monitoring programmes should be conducted. Winter and summer campaigns should provide enough information. Temporal scale is largely affected by the conservation questions and expected outputs. International regulation suggests a six-year interval between large scale monitoring programmes, but smaller intervals are also recommended. Long-term projects provide robust indications on trends in distribution over time and space in selected areas.

Data analysis and assessment outputs

Statistical analysis and basis for aggregation

Standard regression methods (simple linear regression, generalized linear or additive models), power analysis for detecting trends should be applied.

Expected assessments outputs

Trend analysis (monthly, seasonally, yearly), distribution maps, statistical frameworks applied.

Known gaps and uncertainties in the Mediterranean

Data in the Mediterranean Sea are characterized by their uneven distribution, both geographical and spatial. The summer months are the most representative ones. Very little information has been provided for the winter months, when conditions to conduct off-shore research campaigns are particularly hard due to meteorological adversity.

Ongoing effort is targeting the identification of Cetacean Critical Habitats (CCHs) and Important Marine Mammal Areas (IMMAs) in the entire Mediterranean Sea. A gap analysis is also been conducted within the Mediterranean Sea, to provide an inventory of available data and to select areas where more information should be collected.

Contacts and version Date

Key contacts within UNEP for further information

Version No	Date	Author
V.1	20/07/2016	SPA/RAC

Reptiles:

Indicator Title	*Common indicator 3: Species distributional range – Reptiles*	
Relevant GES definition	**Related Operational Objective**	**Proposed Target(s)**
The species continues to occur in all its natural range in the Mediterranean, including nesting, mating, feeding and wintering and developmental (where different to those of adults) sites	Species distribution is maintained	**State** Turtle distribution is not significantly affected by human activities Turtles continue to nest in all known nesting sites **Pressure/Response** Protection of known nesting, mating, foraging, wintering and developmental turtle sites. Human activities[1] having the potential to exclude marine turtles from their range area are regulated and controlled. The potential impact of climate change is assessed

Rationale

Justification for indicator selection

In biology, the range of a given species is the geographical area in which that occurs (i.e. the maximum extent). A commonly used representation of the total areal extent (i.e. the range) of a species is a range map (with dispersion being shown by variation in local population densities within that range). Species distribution is represented by the spatial arrangement of individuals of a given species within a geographical area.

Therefore, the objective of this indicator is to determine the species range of sea turtles that are present in Mediterranean waters, especially the species selected by the Contracting Parties. Sea turtles are an ideal model species to assess the selected indicator. As their populations are dispersed throughout the entire Mediterranean, as discrete breeding, foraging, wintering and developmental habitats, make the two sea turtle species a reliable indicator on the status of biodiversity across this region. Green turtles are primarily herbivores, whereas loggerheads are primarily omnivores, resulting in their occupying important components of the food chain. Therefore, changes to the status in sea turtles will be reflected at all levels of the food chain.

The extent of knowledge on the occurrence, distribution, abundance and conservation status of Mediterranean marine species is uneven. In general, the Mediterranean states have lists of species, but knowledge about the locations used by these species is not always complete, with major gaps existing for other associated information. Even some of the most important programmes on this topic have significant gaps (e.g. global databases do not reflect actual current knowledge in the Mediterranean region).

It is therefore necessary to establish minimum information standards to reflect the known distribution of all selected species.

Species distribution ranges can be gauged at local (i.e. within a small area like a national park) or regional (i.e. across the entire Mediterranean basin) scales using a variety of approaches.

Given the breadth of the Mediterranean, it is not feasible to obtain adequate information about the entire surface (the marine environment is also 3 dimensional, with many vertebrate species only being present at the surface briefly to breathe, e.g. sea turtles). Therefore, it is necessary to choose sampling methods that allow adequate knowledge of the distribution range of each species. Such sampling involves high effort for areas that have not been fully surveyed to-date. Monitoring effort should be long term and should cover all seasons to ensure that the information obtained is as detailed as possible.

Scientific References

Bevan E, Wibbels T, Navarro E, Rosas M, Najera BMZ, Sarti L, Illescas F, Montaro J, Pena LJ, Burchfield P. 2016. Using Unmanned Aerial Vehicle (UAV) Technology for Locating, Identifying, and Monitoring Courtship and Mating Behavior in the Green Turtle (Chelonia mydas). Herpetological Review, 47(1), 27–32.

Casale P. and Margaritoulis D. (Eds.) 2010. Sea Turtles in the Mediterranean: Distribution, Threats and Conservation Priorities. IUCN/SSC Marine Turtle Specialist Group. Gland, Switzerland: IUCN, 294 pp. http://iucn-mtsg.org/publications/med-report/

Casale P., G. Abbate, D. Freggi, N. Conte, M. Oliverio, R. Argano. 2008. Foraging ecology of loggerhead sea turtles Caretta caretta in the central Mediterranean: evidence for a relaxed life history model. Marine

[1] Uncontrolled use of turtle nesting sites, fishing, maritime traffic, etc.

Indicator Title	*Common indicator 3: Species distributional range – Reptiles*

Ecology Progress Series 372: 265-276.
Demography Working Group of the Conference. Demography of marine turtles nesting in the Mediterranean Sea: a gap analysis and research priorities - 5th Mediterranean Conference on Marine Turtles, Dalaman, Turkey, 19-23 April 2015. Document T-PVS/Inf(2015)15E Presented at the Convention on the conservation of European wildlife and natural habitats - 35th meeting of the Standing Committee - Strasbourg, 1 - 4 December 2015 (2015)
Groombridge, B. 1990. Marine turtles in the Mediterranean: distribution, population status, conservation. A report to the Council of Europe, Environment and Management Division. Nature and Environment Series, Number 48. Strasbourg 1990
Margaritoulis, D., Argano, R., Baran, I., Bentivegna, F., Bradai, M.N., Caminas, J.A., Casale, P., Metrio, G.D., Demetropoulos, A., Gerosa, G., Godley, B.J., Haddoud, D.A., Houghton, J., Laurent, L. & Lazar, B. (2003) Loggerhead turtles in the Mediterranean Sea: present knowledge and conservation perspectives. Loggerhead sea turtles (ed. by B.E. Witherington), pp. 175–198. Smithsonian Institution, Washington.
Mazaris AD, Almpanidou V, Wallace B, Schofield G. 2014. A global gap analysis of sea turtle protection coverage. 2014. Biological Conservation. 173, 17–23
Schofield, G., A. Dimadi, S. Fossette, K.A. Katselidis, D. Koutsoubas, M.K.S. Lilley, A. Luckman, J.D. Pantis, A.D. Karagouni, G.C. Hays. 2013b. Satellite tracking large numbers of individuals to infer population level dispersal and core areas for the protection of an endangered species. Diversity and Distributions doi: 10.1111/ddi.12077.

Policy Context and targets (other than IMAP)

Policy context description

Similar to the Ecosystem Approach, the EU adopted the European Union Marine Strategy Framework Directive (MSFD) on 17 June 2008, which includes GES definitions, Descriptors, Criteria, Indicators and Targets. In the Mediterranean region, the MSFD applies to EU member states. The aim of the MSFD is to protect more effectively the marine environment across Europe. In order to achieve GES by 2020, each EU Member State is required to develop a strategy for its marine waters (or Marine Strategy). In addition, because the Directive follows an adaptive management approach, the Marine Strategies must be kept up-to-date and reviewed every 6 years.

The MSFD includes Descriptor 1: Biodiversity: "The quality and occurrence of habitats and the distribution and abundance of species are in line with prevailing physiographic, geographic and climatic conditions." Assessment is required at several ecological levels: ecosystems, habitats and species. Among selected species are marine turtles and within this framework, each Member State that is within a marine turtle range, has submitted GES criteria, indicators, targets and a program to monitor them.

The MSFD will be complementary to, (and provide the overarching framework for) a number of other key Directives and legislation at the European level. Also it calls to regional cooperation meaning "cooperation and coordination of activities between Member States and, whenever possible, third countries sharing the same marine region or subregion, for the purpose of developing and implementing marine strategies" […] "thereby facilitating achievement of good environmental status in the marine region or subregion concerned".

Indicator/Targets

Commission Decision 2010/477/EU sets out the MSFD's criteria and methodological standards and under Descriptor 1 includes criteria "1.1.Species distribution" and indicators "Distributional range (1.1.1)", "Distributional pattern within the latter, where appropriate (1.1.2)", and "Area covered by the species (for sessile/benthic species) (1.1.3)".

At a country scale, the following targets have been selected by member states.

Source: [Evaluation of] National Reports on Article 12 Technical Assessment of the MSFD 2012 obligations
http://ec.europa.eu/environment/marine/eu-coast-and-marine-policy/implementation/pdf/national_reports.zip

GREECE (*page 15)*

Environmental targets:

*[…]*2) Census of marine turtle *Caretta caretta* reproducing in the Greek coasts and conservation of spawning areas.

Associated indicators:

*[…]*2) Breeding area of the Mediterranean monk seal *Monachus monachus* and the sea turtle *Caretta caretta*

ITALY (*page 18)*

Italy has provided six targets and associated indicators *[…]* The second target focuses on the loggerhead turtle, and has the aim of decreasing accidental mortalities by regulating fishing practices. *[…]* No targets or threshold values are otherwise given.

[…]

Indicator Title	*Common indicator 3: Species distributional range – Reptiles*

T2: By-catch reduction in the areas of aggregation of *Caretta caretta*
It is proposed that the operative target for the mitigation of *Caretta caretta* by-catch be articulated as follows:
1) Spatial identification of the areas with highest use of pelagic long line (southern Tyrrhenian and southern Ionian sea) and trawling (northern Adriatic)
2) Completion of the spatial definition of *Caretta caretta* aggregation areas based on an approach capable of assessing temporal and seasonal distribution differences for each aggregation area (based on indicator 1.1.2 completion) so as to provide a final definition of the operative target
3) Monitoring of accidental captures in the areas subjected to operational target
4) Application of by-catch reduction measures in areas listed in point 3), through one or more of the following activities:
- Application of methods for the mitigation of accidental capture in pelagic surface longlines and trawling nets through structural modifications to the gear (i.e. circle hooks, TEDs etc.) and application of best practices for the reduction of mortality following capture (percentage). Note: in order to allow an immediate reduction of the pressure it is advised that best practices be applied in the geographic areas where preliminary knowledge already defines the presence of an aggregation area, before defining the incidence of total capture in the specific fishing gear.
- Reduction of fishing pressure (percentage)

SPAIN (*Page 25)*
A.1.4: Reduce the main causes of mortality and of reduction of the populations of groups of species at the top of the trophic web (marine mammals, reptiles, sea birds, pelagic and demersal elasmobranchs), such as accidental capture, collisions with vessels, intaking of litter at sea, introduced terrestrial predators, pollution, habitat destruction, overfishing.
[…]
A.1.7: Establish a national coordination system of the accidental catch monitoring programmes of birds, reptiles, marine mammals, and mammal and reptile stranding and bird tracking.
[…]
A.3.4: Maintain positive or stable trends for the populations of key species or apex predators (marine mammals, reptiles, seabirds and fish) and maintain commercially exploited species within safe biological limits.
[…]
C.1.2: Promote international cooperation on studies and monitoring of populations of groups with broad geographic distribution (e.g. cetaceans and reptiles)

SLOVENIA - No information on Targets
page 10: (I. Good Environmental Status (GES), 1.1 Descriptor 1)
In the accompanying text to the GES definition, Slovenia provides a list of the species that are covered by the GES definition. This includes the bottlenose dolphin (*Tursiops truncatus*), the loggerhead sea turtle (*Caretta caretta*).
(II. Initial assessment, 2.2 Biological features)
Slovenia indicates that *[…]* turtles are covered under the reporting obligations of the Habitats Directive *[…]*. Each of these groups is briefly described and their state in relation to natural conditions is reported.

CYPRUS - No information on Targets
page 11: (II. Initial assessment, 2.2 Biological features)
[…] Chelonia mydas and *Monachus monachus* are considered stable but the situation of *Caretta caretta* is improving.

Policy documents
http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32010D0477(01)
http://ec.europa.eu/environment/marine/good-environmental-status/descriptor-1/index_en.htm
http://ec.europa.eu/environment/marine/eu-coast-and-marine-policy/implementation/reports_en.htm
http://ec.europa.eu/environment/marine/pdf/1-Task-group-1-Report-on-Biological-Diversity.pdf
http://ec.europa.eu/environment/marine/pdf/9-Task-Group-10.pdf

Indicator analysis methods

Indicator Definition
Variation in the total area (trends in the number of occupied grid cells) occupied by the selected species for breeding, wintering and feeding areas.
The distributional range of a species is an important indicator that may be obtained through the georeferencing

Indicator Title	*Common indicator 3: Species distributional range – Reptiles*

of species observations, assuming objective techniques are used. To determine the distribution range of a species, it is necessary to know where individuals of the species are located from sampling information. Therefore, it is necessary to establish minimum information standards to reflect the known distribution of all selected species. Species distribution ranges can be gauged at local (i.e. within a small area like a national park) or regional (i.e. across the entire Mediterranean basin) scales using a variety of approaches. Long-term monitoring of these areas provides information on the temporal evolution in species distribution.

Methodology for indicator calculation

The European (ETRS) 10x10km² grid is used for mapping the distribution and range, thus accounting for each known location along the Mediterranean coast. Three different maps (grids) are produced annually for each species accounting for breeding sites, wintering sites and feeding/developmental sites of loggerheads (*Caretta caretta*) and greens (*Chelonia mydas*).

For all species information on spatial distribution within the assessment would be transferred in a 10 × 10 km (or finer for smaller countries, 1 x 1 km or 5 x 5 km) grid; filled cells show presence of the species. The distribution area is the sum of area of the cells where the species is "present".

For the reporting on the range of a species, (considering that it is a suitable parameter for assessing the spatial aspects of GES), and to describe and detect changes in the extent of the distribution, a tool to calculate the range size from the map of the actual breeding (or wintering or feeding) distribution is required (i.e. occurrences). The Range Tool software and algorithm will provide a standardised process that will help to ensure repeatability of the range calculation in different reporting rounds. After automated calculation of the range it is possible to correct the gaps to obtain a complete overview of the data following a standardised protocol. The resulting range map will then be a combination of the automated procedure completed by expert judgement.

Indicator units

Number of 10 x 10 km cells (presence/absence) occupied for breeding or wintering or feeding/developmental areas along the Mediterranean (or subregional) coast and in all pelagic marine areas.
Annually – Total number of new locations (breeding, wintering, feeding); total number of 10 x 10 km newly occupied cells;

Annually – Total number of lost locations; total number of 10 x 10 km lost cells

List of Guidance documents and protocols available

Eckert, K. L., Bjorndal, K. A., Abreu-Grobois, F. A. and Donnelly, M. (Eds.) 1999. Research and Management Techniques for the Conservation of Sea Turtles. IUCN/SSC Marine Turtle Specialist Group Publication No. 4. Washington, DC: 235 pp. https://mtsg.files.wordpress.com/2010/11/techniques-manual-full-en.pdf
Gerosa, G. (1996). Manual on Marine Turtle Tagging in the Mediterranean. –Mediterranean Action Plan - UNEP, RAC/SPA, Tunis, 48 pp.
Gerosa, G. and M. Aureggi. 2001. Sea Turtle Handling Guidebook for Fishermen. UNEP Mediterranean Action Plan, Regional Activity Centre for Specially Protected Areas. Tunis. http://www.rac-spa.org
McClellan DB. 1996. Aerial surveys for sea turtles, marine mammals and vessel activity along the south east Florida coast 1992-1996. NOAA Technical Memorandum NMFS-SEFSC-390 42pp
SWOT Scientific Advisory Board. 2011. The State of the World's Sea Turtles (SWOT) Minimum Data Standards for Nesting Beach Monitoring, version 1.0. Handbook, 28 pp

Data Confidence and uncertainties
Presence/absence information is used only, because the different methods used to detect the presence/absence of turtles range from coarse to highly accurate (within metres), along with heavy sighting/detection bias to certain key regions/sites.

The quality of the source should be assigned scores (i.e. 3, Good; 2, Moderate; 1, Poor; 0, Uncertain). Following the CI for seabirds: A helpful rule for assessing the quality of the range calculation could consist of a scaling system, combining the reliability of the distribution at the time it was mapped, how recently it was mapped, and the method used to map it. The result would be 3 = reliable (accurate to within 10%); 2 = incomplete (accurate to within 50%); or 1 = poor (definitely not accurate to within 50%)

Methodology for monitoring, temporal and spatial scope

Available Methodologies for Monitoring and Monitoring Protocols
Monitoring effort should be long term and should cover all seasons to ensure that the information obtained is as

Indicator Title	*Common indicator 3: Species distributional range – Reptiles*

complete as possible.

- Aerial surveys: plane transects in marine areas (monitoring CI 3 & 4 in marine areas)
- Land based surveys: Nesting monitoring (breeding areas) and stranding monitoring (coastal areas) (CI 3-5)
- In-water surveys: Diving/snorkeling transects, capture-mark-recapture (CI 3-5 in marine areas)
- Satellite remote sensing: Nesting, in-water, bycatch surveys (CI 3-5 in marine & breeding areas)

Inwater monitoring can be done via

- Dedicated ship and aerial (plane and drone) transect surveys to confirm the presence/absence and spread of individuals in marine and coastal habitats
- Bycatch data from fisheries records and onboard researchers, which are invaluable for obtaining data in deep/open waters
- Beached and stranded specimen monitoring, with dedicated stranding networks already existing for sea turtles in several Mediterranean countries, and stranding information being confirmed to reflect distribution patterns based on satellite telemetry studies
- Opportunistic data on non-dedicated platforms (ferries, merchant marine ships or amateurs/yachts, use of citizen science), by-catch data (where dedicated research programs do not exist, for sea turtles and shearwaters in long-lines and other types of fishing gear, and small cetaceans in various types of fishing gear).
- Tagging (capture-mark-recapture – artificial tags & photo-identification). Confirmed identification of presence of individuals from different populations at different locations based on external tags (plastic/metal), PIT tags and photo-id.
- Telemetry. Satellite tracking, GPS/GSM tracking, radio tracking and the use of loggers. Provides detailed information about the movements of small numbers of individuals within a population. Increasingly small transmitter size means it can be attached to juveniles. However, at least 50 individuals from a single population must be tracked to obtain population level movement/dispersal/distribution patterns.

Beach monitoring can be done via

- Direct monitoring of nesting beaches - Detection of tracks of turtles on beaches potentially used for nesting. Aerial surveys (drones/planes) or foot patrols may be used to confirm the use of beaches for nesting activity
- Use of high resolution remote sensing satellite imagery to detect the presence/absence of tracks on difficult to access areas (i.e. due to distance from roads or lack of security)
- Use of aerial surveys by planes or drones, once key areas are identified by satellite imagery where possible or as an alternative.

Bibliographic sources: The location of sea turtle nesting beaches, wintering, feeding and developmental areas, may be achieved by checking existing bibliographic information, surveys by different groups (fishermen, NGOs, guides, articles) of already known sites, probability of occurrence models (that indicate areas where a species is likely to occur based on statistical models that relate habitat variables to the presence/absence of a species) and regional expert knowledge.

Available data sources

Adriatic Sea Turtle Database. http://www.adriaticseaturtles.eu/

Casale P. and Margaritoulis D. (Eds.) 2010. Sea Turtles in the Mediterranean: Distribution, Threats and Conservation Priorities. IUCN/SSC Marine Turtle Specialist Group. Gland, Switzerland: IUCN, 294 pp. http://iucn-mtsg.org/publications/med-report/

Halpin, P.N., Read, A.J., Fujioka, E., et al., 2009. OBIS-SEAMAP the world data center for marine mammal, sea bird, and sea turtle distributions. Oceanography 22, 104–115.

The state of the World's Sea Turtles online database: data provided by the SWOT team and hosted on OBIS-SEAMAP (Ocean Biogeographic Information System Spatial Ecological Analysis of Megavertebrate Populations). In: Oceanic Society, Conservation International, IUCN Marine Turtle Specialist Group (MTSG), and Marine Geospatial Ecology Lab, Duke University. <http://seamap.env.duke.edu/swot>.

Margaritoulis, D., Argano, R., Baran, I., Bentivegna, F., Bradai, M.N., Cami~nas, J.A., Casale, P., Metrio, G.D., Demetropoulos, A., Gerosa, G., Godley, B.J., Haddoud,D.A., Houghton, J., Laurent, L. & Lazar, B. (2003) Loggerhead turtles in the Mediterranean Sea: present knowledge and conservation perspectives. Loggerhead sea turtles (ed. by B.E. Witherington), pp. 175–198. Smithsonian Institution, Washington

Seaturtle.org – Global Sea Turtle Network. Sea turtle tracking. Sea turtle nest monitoring. http://www.seaturtle.org/

The Reptile Database: Location of juvenile loggerheads and greens in the Eastern Mediterranean. http://reptile-database.reptarium.cz/species?genus=Caretta&species=caretta

UNEP/MAP-RAC/SPA projects and publications http://www.rac-spa.org/publications

Indicator Title	*Common indicator 3: Species distributional range – Reptiles*
Mediterranean marine research centres, NGOs, universities and institutions, local and national sea turtle monitoring projects. Governmental Ministries International Union for Conservation of Nature (IUCN) specialists (Marine Turtle Specialist Group - MTSG)	
Spatial scope guidance and selection of monitoring stations The presence of the two species should be monitored all along the Mediterranean coast and in the known breeding, wintering, and feeding/developmental areas. The spatial basis for assessment should be according to the Mediterranean biogeographical sub-areas to reflect changes in the abundance of sea turtles in each habitat type across the Mediterranean and its sub-regions. Each Contracting Party should assess all marine (coastal and oceanic) and beach habitats across their national maritime waters. However, it is recommended that these areas are assessed at a smaller scale if they belong to different biogeographical sub-regions, or if differences in pressure intensity are obvious between sub-basins.	
Temporal Scope guidance Annual monitoring for each of the species and areas (breeding, wintering, feeding/developmental). Seasonality to be determined by the local experts as i.e. breeding season can vary along and across the Mediterranean. The widest known range for nesting is April/May to September/October, with the hatching period extending 45 to around 70 days after this (depending on sand composition, sand temperature and season). For wintering, this period extends from October to March/April in the Ionian/north Aegean for loggerheads, and lasts from November to March/April along the north coast of Africa for greens, and is limited to 1-2 months for loggerheads in this region. Furthermore, the quantity of wintering habitats in the northern parts of the Mediterranean may increase with climate change. Foraging and developmental sites are expected to be inhabited year-round, but with seasonal fluctuations.	
Data analysis and assessment outputs	
Statistical analysis and basis for aggregation The assessment should focus on whether the total area of a species distribution range is maintained or not. To assess the variation in breeding, wintering and feeding/developmental ranges, annual comparisons should be made with an emphasis on new or disappearing areas of use, expressing the range trends over the grids. This objective requires the use of different but widely available GIS geoprocessing techniques and geodatabases tools (ArcGis, QGis, R platform, etc). Distributional ranges should be compared annually. The trends in the number of occupied cells or area occupied is a basic and immediate parameter for which the significance may be statistically assessed.	
Expected assessments outputs • Temporal trends in distributional range. • Maps showing the evolution of the distributional range for the two species at different scales.	
Known gaps and uncertainties in the Mediterranean • Location of all breeding/nesting sites • Location of all wintering, feeding, developmental sites of adult males, females, juveniles • Connectivity among the various sites in the Mediterranean. • Vulnerability/resilience of these sites in relation to physical pressures; • Analysis of pressure/impact relationships for these sites and definition of qualitative GES; • Identification of extent (area) baselines for each site and the habitats they encompass; • Criteria for the risk-based approach to monitoring and development of harmonized sampling instructions where appropriate; • Common computing methodologies and data collection instructions, specifying the accuracy (spatial resolution or grid) of the determination of extent (area) a priori; • Appropriate assessment scales; • Standardized data flows for spatial pressure data; • GES baselines for sites that cannot be inferred from contemporary records of pressure or construction; • Harmonised sampling, cartographic, data collation and GIS protocols • Generation or updating of databases and maps of known nesting, feeding, wintering habitats in each Contracting Party	

Indicator Title	*Common indicator 3: Species distributional range – Reptiles*	
• Identification of possible baselines and index sites. • Identification of monitoring capacities and gaps in each Contracting Party • Development of a guidance manual to support the monitoring programme, which will provide more detailed information, tools, and advice on survey design, monitoring methodology and techniques that are most cost-effective and applicable to each of the selected sea turtle species, in order to ultimately ensure standardised monitoring, comparable data sets, reliable estimates and trend information. • Identification of techniques to monitor and assess the impacts of climate change. • Development of monitoring synergies in collaboration with GFCM for EO3 (Harvest of commercially exploited fish and shellfish), to collect data via sea turtle by-catch • Investigation of monitoring synergies with other relevant EOs that will include coast-based fieldwork, in relation to monitoring of new/unknown sea turtle nesting beaches, and of beached/stranded animals, to obtain more widespread information • Any minimally valid assessment of changes in species distribution or distributional pattern requires both spatially explicit reporting of animal abundances (coordinates of locations) and an estimate or measure of sampling effort. This caveat calls for careful and restrictive use of modelling at a regional scale. Locally, and when high quality data is available, it could be worth to try a density surface modelling approach such as GAM or machine learning models (MARMONI, 2015). Other common techniques used for representation of data in maps as such as Kernels are not recommended as distribution of the areas is not a continuous phenomenon.		
Contacts and version Date		
Key contacts within UNEP for further information		
Version No	**Date**	**Author**
V.1	20/7/2016	SPA/RAC

Seabirds:

Indicator Title	Common indicator 3: Species distributional range (Seabirds)	
Relevant GES definition	**Related Operational Objective**	**Proposed Target(s)**
The distribution of seabird species continues to occur in all their Mediterranean natural habitat Biological diversity is maintained. The quality and occurrence of habitats and the distribution and abundance of species are in line with prevailing physiographic, geographic and climatic conditions. (EO1, Biodiversity)	Distribution of selected species is maintained.	- No significant reduction in the population distribution in the Mediterranean in all indicator species. - New colonies are established and the population is encouraged to spread among alternative breeding sites.
Rational		
Justification for indicator selector: Species distributional range and distributional pattern. The objective of this indicator is to determine the species range of the seabirds that are present in Mediterranean waters, especially the species selected by the Parties Change of breeding/wintering distribution of population reflects the habitat changes, availability of food resources, and pressures related to human activity and climate change This indicator could be based in a set of single species indicators that reflects distribution pattern of breeding/wintering populations of the selected species. Range is defined for the reporting under de Nature Directives as 'the outer limits of the overall area in which a species is found at present. It can be considered as an envelope within which areas actually occupied occur. For the application of the IUCN Red List criteria range (EOO) is defined as the area contained within the shortest		

Indicator Title	Common indicator 3: Species distributional range (Seabirds)

continuous imaginary boundary which can be drawn to encompass all the sites of present occurrence, while distribution (AOO) is defined as the area within the EOO that is actually occupied.

The monitoring of the distribution should be accomplished over a complete scale approach to be truly reliable Since range concept does not make sense for small areas. Whereas other indicators can have a tricky approach (vg. uneven or lack of knowledge on abundance, population, patterns or trends among the different Contract Parties, henceforth CP) the distribution of breeding or wintering areas for the selected seabird species is relatively well know, at least in terms of absence / presence. We suggest the scale of "National part of subdivision" as the basis working scale, by using a grid of 10x10 km square cells in the multipurpose Pan-European mapping standard (ETRS89 Lambert Azimuthal Equal-Area 52-10 projection coordinate reference system). For the reporting of small contracting parties such as Malta or Cyprus, maps of 5x5 km or 1x1 km grids could be advised because these will then be aggregated to 10x10 km for visualisation at the Regional or subregional level.

Thus the indicator for breeding/wintering range would consist in the variation of occupied / lost areas an ETRS89-LAEA5210_10K grid in 6 years. This proposal has multiple advantages as can be easily aggregated for the analysis at a subdivision level or higher or for a differentiated analysis between functional groups.

Scientific References

Monbailliu, X. (Ed.). (2013). Mediterranean marine avifauna: population studies and conservation (Vol. 12). Springer Science & Business Media.
Life projects Spain, Malta, Greece
UNEP/MAP - RAC/SPA, 2012. Guidelines for Management and Monitoring Threatened Population of Marine and Coastal Bird Species and their Important Areas in the Mediterranean. By Joe Sultana. Ed. RAC/SPA, Tunis. 24pp.
ICES. 2016. Report of the Joint OSPAR/HELCOM/ICES Working Group on Seabirds (JWGBIRD), 9–13 November 2015, Copenhagen, Denmark. ICES CM 2015/ACOM:28. 196 pp.

Policy Context and targets

Policy context description

EU Marine Strategy Framework Directive	In order to achieve GES by 2020, each EU Member State is required to develop a strategy for its marine waters (or Marine Strategy). In addition, because the Directive follows an adaptive management approach, the Marine Strategies must be kept up-to-date and reviewed every 6 years. The MSFD will be complementary to, and provide the overarching framework for, a number of other key Directives and legislation at the European level. Also it calls to regional cooperation meaning "cooperation and coordination of activities between Member States and, whenever possible, third countries sharing the same marine region or subregion, for the purpose of developing and implementing marine strategies" […] "thereby facilitating achievement of good environmental status in the marine region or subregion concerned".	<u>Descriptor 1: Biodiversity</u> The natural range and extent of seabird species are stable in the Mediterranean, or otherwise in line with the physiographic and climatic conditions, taking into consideration the sustainable use of the marine environment. <u>Parameters and trends:</u>

Indicator Title	Common indicator 3: Species distributional range (Seabirds)	
UE Nature Directives (Birds and Habitats Directives)	The conservation status of a species “will be taken as ‘favourable’ when: 1. population dynamics data on the species concerned indicate that it is maintaining itself on a long-term basis as a viable component of its natural habitats, and 2.the natural range of the species is neither being reduced nor is likely to be reduced for the foreseeable future, and 3.there is, and will probably continue to be, a sufficiently large habitat to maintain its populations on a long-term basis”; (Article 1i) Every six years, all EU Member States are required to report on the implementation of the directives There is a methodology for the assessment of conservation status and has been widely used for the compulsory reporting by EU member states for Habitats Directive (HD). This approach has been extended also to Birds Directive (BD) reporting (N2K Group 2011).	<u>Parameters and trends:</u> Distribution (range)

Targets

EU Marine Strategy Framework Directive: National and international efforts are undertaken, applying conservation measures or procedures to ensure that the distributional range of breeding and sites of the seabirds is stable, with no loss of breeding sites due to anthropogenic disturbance.

UE Nature Directives:

Policy documents

List and url’s

1. 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) (Text with EEA relevance): http://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1401265930445&uri=CELEX:32008L0056
2. http://ec.europa.eu/environment/nature/legislation/birdsdirective/index_en.htm
3. http://ec.europa.eu/environment/nature/legislation/habitatsdirective/index_en.htm
4. Article 12 – National reporting on status and trends of bird species. http://ec.europa.eu/environment/nature/knowledge/rep_birds/index_en.htm
5. BirdLife International (2015) European Red List of Birds. Luxembourg: Office for Official Publications of the European Communities.

Indicator analysis methods

Indicator Definition

Variation in the total area (trends in the number of occupied grid cells) occupied by selected species for breeding, wintering and feeding areas.

Methodology for indicator calculation

The European (ETRS) 10x10km² grid is used for mapping the distribution and range, accounting each known location along the Mediterranean coast. Three different maps (grids) are produced yearly for each species accounting for breeding sites, wintering sites and feeding sites.

For all species information on spatial distribution within the assessment would be transferred in a 10 × 10 km (or finer for small countries, 1 x 1 km or 5 x 5 km) grid; filled cells show presence of the species. The

Indicator Title	Common indicator 3: Species distributional range (Seabirds)

distribution area is the sum of area of the cells where the species is "present".

For the reporting on the range of a species, considering that it is a suitable parameter for assessing the spatial aspects of GES, and to describe and detect changes in the extent of the distribution, a tool to calculate the range size from the map of the actual breeding (or wintering or feeding) distribution (i.e. occurrences). By using the Range Tool software and algorithm will provide of a standardised process that will help to ensure repeatability of the range calculation in different reporting rounds. After automated calculation of range it is possible to correct the gaps resulting from in completeness of data following and standardised protocol. The resulting range map will then be a combination of the automated procedure completed by expert judgement.

Indicator units

Number of 10 x 10 km cells occupied for breeding or wintering or feeding areas along the Mediterranean (or subregional) coast.

Annually – Total number of new locations (breeding, wintering, feeding); total number of 10 x 10 km newly occupied cells;

Annually – Total number of lost locations; total number of 10 x 10 km lost cells;

List of Guidance documents and protocols available

General protocols

- Article 12 – National reporting on status and trends of bird species. http://ec.europa.eu/environment/nature/knowledge/rep_birds/index_en.htm
- Auniņš, A., and Martin, G. (eds.) (2015). Biodiversity Assessment of MARMONI Project Areas. Project report, 175. Available online at: http://marmoni.balticseaportal.net/wp/project-outcomes/
- Camphuysen CJ & Garthe S 2004. Recording foraging seabirds at sea: standardised recording and coding of foraging behaviour and multi-species associations. Atlantic Seabirds 6: 1 – 32.
- http://bd.eionet.europa.eu/activities/Reporting/Article_17/reference_portal
- ICES (2013). OSPAR Special Request on Review of the Technical Specification and Application of Common Indicators under D1, D2, D4, and D6. Copenhagen: International Council for the Exploration of the Sea.
- ICES. 2015. Report of the Working Group on Marine Mammal Ecology (WGMME), 9–12 February 2015, London, UK. ICES CM 2015/ACOM: 25. 114 pp.
- MARMONI (2015). The MARMONI approach to marine biodiversity indicators. Volume II: list of indicators f or assessing the state of marine biodiversity in the Baltic Sea developed by the life MARMONI project. Estonian Marine Institute Report Series No. 16. Available online at: http://marmoni.balticseaportal.net/wp/project-outcomes/

The "Range Tool"

- ETC/BD. 2012. User Manual for Range Tool for Article 12 (Birds Directive) & Article 17 (Habitats Directive). Prepared by Brian Mac Sharry (MNHN). http://bd.eionet.europa.eu/activities/Reporting_Tool/Documents
- ETC/BD. 2011. Assessment and reporting under Article 12 of the Birds Directive. Explanatory Notes & Guidelines for the period 2008-2012 (Final version). Compiled by Compiled by the N2K Group under contract to the European Commission. Avalaible online: https://circabc.europa.eu/sd/a/4fc954f6-61e3-4a0b-8450-ca54e5e4dd53/Art.12%20guidelines%20final%20Dec%2011.pdf
- ETC/BD. 2011. Assessment and reporting under Article 17 of the Habitats Directive. Explanatory Notes & Guidelines for the period 2007-2012 (Final version). Compiled by Douglas Evans and Marita Arvela (European Topic Centre on Biological Diversity). Avalaible online: https://circabc.europa.eu/sd/a/2c12cea2-f827-4bdb-bb56-3731c9fd8b40/Art17%20-%20Guidelines-final.pdf
- Peifer, H. 2011. About the EEA reference grid. http://www.eea.europa.eu/data-and-maps/data/eea-reference-grids-2/

Data Confidence and uncertainties

Quality 3 = Good. Complete survey or a statistically robust estimate

Indicator Title	Common indicator 3: Species distributional range (Seabirds)

Quality 2 = Moderate. Estimate based on partial data with some extrapolation and/or modelling
Quality 1 = Poor. Estimate based on expert opinion with no or minimal sampling
0 = Uncertain (absent data, as in cases when newly arriving species has not yet established distribution).
A helpful rule for assessing the quality of the range calculation could consist in a judgement combining the *reliability* of the distribution at the time it was mapped, how *recently* it was mapped, and the *method* used to map it
The result would be 3 = reliable (accurate to within 10%); 2 = incomplete (accurate to within 50%) or 1 = poor (definitely not accurate to within 50%)

Methodology for monitoring, temporal and spatial scope

Available Methodologies for Monitoring and Monitoring Protocols

Distribution of breeding/wintering/feeding areas including: location of breeding colonies on the coast
Breeding distribution map and range size: Map plotted on the selected ETRS grid showing occurrence (presence/absence)
Monitoring effort should be long term and should cover all seasons to ensure that the information obtained is as complete as possible.
The location of many bird colonies, as well as their wintering, feeding and developmental areas, may be achieved by checking existing bibliographic information (which can be of particular interest is assessing the basal stage), surveys conducted by different groups, observations (fishermen, citizen science), and regional expert knowledge.
<u>For breeding / wintering areas:</u>

Data collection : using any of the standard methods designed for breeding bird surveys such as bird count data, breeding/wintering bird atlases

Dedicated ship or aerial surveys (including the use of drones), opportunistic data: sea-bird watching whale-watching observations, fisheries sightings (logbooks), surveys on non-dedicated platforms (ferries, merchant marine ships or amateurs/yachts, use of citizen science), by-catch data (where dedicated research programs do not exist, for sea turtles and shearwaters in long-lines and other types of fishing gear). Telemetry: Satellite tracking, GPS/GSM tracking, radio tracking and the use of loggers.

Available data sources *Sources and url's*

OBIS-SEAMAP, Ocean Biogeographic Information System Spatial Ecological Analysis of Megavertebrate Populations, http://seamap.env.duke.edu/
http://www.birdlife.org/datazone/home
UNEP/MAP-RAC/SPA projects and publications http://www.rac-spa.org/publications
Birdlife partners in the Mediterranean
Mediterranean marine research centres, universities and institutions
Medmaravis
Governmental ministries
IUCN specialists

Spatial scope guidance and selection of monitoring stations

The presence of the selected species should be monitored all along the Mediterranean coast and in the known breeding colonies or wintering or feeding areas.

Temporal Scope guidance

Yearly for each of the species and areas (breeding, wintering, feeding). Seasonality to be determined by the local experts as i.e. breeding season can vary along and across the Mediterranean.

Data analysis and assessment outputs

Statistical analysis and basis for aggregation

The assessment should focus on whether the total area of a species' distribution range is maintained or not. To assess the variation in breeding, wintering and feeding ranges, annual comparisons should be made with an

Indicator Title	Common indicator 3: Species distributional range (Seabirds)	
emphasis on new or disappearing colonies, expressing the range trends over the grids. This implies using different but widely available GIS geoprocessing techniques and and geodatabases tools (ArcGis, QGis, R plataform, etc). Annual comparison of distributional ranges. The trends in the number of occupied cells or area occupied is a basic and immediate parameter wich signification can be statistically assessed. The assessment of the conservation status of a bird species in the Nature 2000 Directives is defined as "Unfavorable" when they undergo a large decline estimated as the "equivalent to a loss of more than 1% per year within period specified by MS OR more than 10% below favourable reference range". As we are dealing with conspicuous species the range data (whatever would be decided size of area occupied or number of grid cells occupied) could be regressed against time with standard linear regression models. This approach assumes that the complete range is surveyed on each occasion and that the probability of detecting the species or habitat within any grid cell is one, if it is present in that grid cell. A long series (12 years?) would be necessary to detect clear tendencies. A decreased range shouldn't be a major concern as far as other indicators, in particular the species indicator abundance, shows an acceptable trend. But if the trends show a negative balance and a decrement on the occupied area, there are some techniques for change detection using grids (rasters). We suggest to explore the Map Comparison Kit (http://mck.riks.nl) a free software developed by the Netherlands Environmental Assessment Agency (MNP) which includes a range of algorithms for the comparison of raster maps similarities and dissimilarities and spatio-temporal analysis, and focus on 'categorical' or 'nominal' maps (H. Visser and T. de Nijs, 2006). References (to be checked): - Marine e-Atlas developed by the Fame Project and the Protocols of the Spanish Cetacean Society methods to analyse range trends in grids. - Visser, H., & de Nijs, T. (2006). The Map Comparison Kit. Environmental Modelling & Software, 21, 346e358.		
Expected assessments outputs Temporal trends in distributional range. Maps showing the evolution of the distributional range for the selected species at different scales and also by functional groups of species.		
Known gaps and uncertainties in the Mediterranean Any minimal valid assessment of changes in species distribution or distributional pattern requires both spatially explicit reporting of animal abundances (coordinates of locations) and an estimate or measure of sampling effort. This caveat calls for a very careful and restrictive use of modelling at a regional scale. Locally, and when high quality data is available, could be worth to try a density surface modelling approach such as GAM or machine learning models (MARMONI, 2015). Other common techniques used for representation of data in maps as such as Kernels are not recommended as distribution of the areas is not a continuous phenomenon.		
Contacts and version Date		
Key contacts within UNEP for further information		
Version No	**Date**	**Author**
V.1	20/07/2016	SPA/RAC

4. Common Indicator 4: Population abundance of selected species (related to marine mammals, seabirds, marine reptiles) (EO1);

Marine Mammals:

Indicator Title	*Common indicator 4: Species population abundance (marine mammals)*	
Relevant GES definition	**Related Operational Objective**	**Proposed Target(s)**
The species population has abundance levels allowing it to qualify for Least Concern Category of IUCN Red List	Population size of selected species is maintained, or (if depleted) it recovers to natural levels	No human-induced decrease in breeding population size or density. Populations recover towards natural levels.

Rationale

Justification for indicator selection

This indicator focuses on population abundance estimates for those marine mammal species within the Mediterranean Basin, particularly for the species selected by the Parties.

Population abundance refers to the total number of individuals of selected species in a specified area in a given timeframe, to inform about the growth or decline of a population. The systematic monitoring of the abundance and distribution of wild species constitutes a crucial element of any conservation strategy, but it is often neglected in many regions, including much of the Mediterranean. Population trends can be caused to both man-made pressures as well as natural fluctuations and environmental dynamics and climate changes. Hence, species abundance should be systematically monitored at regular intervals to inform effective conservation or review the efficacy of measures already in place.

Eleven species of cetaceans are considered to regularly occur in the Mediterranean area: short-beaked common dolphin (*Delphinus delphis*), striped dolphin (*Stenella coeruleoalba*), common bottlenose dolphin (*Tursiops truncatus*), harbour porpoise (*Phocoena phocoena*), long-finned pilot whale (*Globicephala melas*), rough-toothed dolphin (*Steno bredanensis*), Risso's dolphin (*Grampus griseus*), fin whale (*Balaenoptera physalus*), sperm whale (*Physeter macrocephalus*), Cuvier's beaked whale (*Ziphius cavirostris*) and killer whale (*Orcinus orca*). Two of these species have very limited ranges: the harbour porpoise, possibly representing a small remnant population in the Aegean Sea, and the killer whale, present only as a small population of a few individuals in the Strait of Gibraltar.

Knowledge about the distribution, abundance and habitat use and preferences of some of these species, including the most abundant ones, is in part scant and limited to specific sectors of the Mediterranean Sea, due to the uneven distribution of research effort during the last decades. In particular, the south-eastern portion of the Basin, the coasts of North Africa and the central offshore waters are amongst the areas with the most limited knowledge on cetacean presence, occurrence and distribution.

The conservation status of cetaceans in the Mediterranean Sea has been a source of concern for many years. Marine mammals living in the Mediterranean Sea find themselves in precarious conditions due to the intense human presence and activities in the region; these are the source of a variety of pressures that are threatening these species' survival. These animals are highly mobile and are usually not confined within single nations' jurisdictions, stressing the need for basin-wide conservation and protection effort. Several threats affect marine mammals in the Mediterranean Sea and their effect on the population, distributional range and survival may act in a synergistic manner. Threats include interaction with fisheries, disturbance, injuries and fatal collisions from shipping, habitat loss and degradation, chemical pollution, anthropogenic noise, direct killings and climate change.

Scientific References

Aarsland, A. et al. 2012. List of Contributors. - In: Herndon, D. N. (ed), Total Burn Care (Fourth Edition). W.B. Saunders, pp. xi–xvii.
Barlow, J. and Reeves, R. R. 2009. Population Status and Trends A2 - Thewissen, William F. PerrinBernd WürsigJ.G.M. - In: Encyclopedia of Marine Mammals (Second Edition). Academic Press, pp. 918–920.
Brown, J. H. et al. 1995. Spatial Variation in Abundance. - Ecology 76: 2028–2043.
Buckland, S. T. and York, A. E. 2009. A - Abundance Estimation A2 - Thewissen, William F. PerrinBernd WürsigJ.G.M. - In: Encyclopedia of Marine Mammals (Second Edition). Academic Press, pp. 1–5.
Butchart, S. H. M. et al. 2010. Global biodiversity: indicators of recent declines. - Science 328: 1164–1168.
Conroy, M. J. and Noon, B. R. 1996. Mapping of Species Richness for Conservation of Biological Diversity: Conceptual and Methodological Issues. - Ecol. Appl. 6: 763–773.

Indicator Title	*Common indicator 4: Species population abundance (marine mammals)*

Davidson, A. D. et al. 2012. Drivers and hotspots of extinction risk in marine mammals. - Proc. Natl. Acad. Sci. 109: 3395–3400.
Forcada, J. et al. 1995. Abundance of fin whales and striped dolphins summering in the Corso-Ligurian Basin. - Mammalia 59: 127–140.
Forcada, J. et al. 1996. Distribution and abundance of fin whales (Balaenoptera physalus) in the western Mediterranean sea during the summer. - J. Zool. 238: 23–34.
Forney, K. A. 2000. Environmental models of cetacean abundance : Reducing uncertainty in population Trends : Better policy and management decisions through explicit analysis of uncertainty: New approaches from marine conservation. - Conserv. Biol. 14: 1271–1286.
Gaston, K. J. et al. 2000. Abundance–occupancy relationships. - J. Appl. Ecol. 37: 39–59.
Gerrodette, T. 1991. Models for Power of Detecting Trends: A Reply to Link and Hatfield. - Ecology 72: 1889.
He, F. and Gaston, K. J. 2000. Estimating Species Abundance from Occurrence. - Am. Nat. 156: 553–559.
IUCN 2012. Marine mammals and sea turtles of the Mediterranean and Black Seas. - IUCN.
Kunin, W. E. 1998. Extrapolating Species Abundance Across Spatial Scales. - Science 281: 1513–1515.
Lawton, J. H. 1993. Range, population abundance and conservation. - Trends Ecol. Evol. 8: 409–413.
Lawton, J. H. 1996. Population abundances, geographic ranges and conservation: 1994 Witherby Lecture. - Bird Study 43: 3–19.
Lotze, H. K. and Worm, B. 2009. Historical baselines for large marine animals. - Trends Ecol Evol Amst 24: 254–262.
Lotze, H. K. et al. 2011. Recovery of marine animal populations and ecosystems. - Trends Ecol. Evol. 26: 595–605.
MacLeod, R. et al. 2011. Rapid monitoring of species abundance for biodiversity conservation: Consistency and reliability of the MacKinnon lists technique. - Biol. Conserv. 144: 1374–1381.
Magera, A. M. et al. 2013. Recovery Trends in Marine Mammal Populations. - PLoS ONE in press.
Martínez-Meyer, E. et al. 2013. Ecological niche structure and rangewide abundance patterns of species. - Biol. Lett. 9: 20120637.
Maynou, F. et al. 2011. Estimating Trends of Population Decline in Long-Lived Marine Species in the Mediterranean Sea Based on Fishers' Perceptions. - PLoS ONE 6: e21818.
Notarbartolo di Sciara, G. and Birkun, A., Jr 2010. Conserving whales, dolphins and porpoises in the Mediterranean and Black Seas: an ACCOBAMS status report, 2010.: 212.
Panigada, S. et al. 2011. Monitoring winter and summer abundance of cetaceans in the Pelagos Sanctuary (northwestern Mediterranean Sea) through aerial surveys. - PloS One 6: e22878.
Pauly, D. 2015. Marine Historical Ecology in Conservation: Applying the Past to Manage for the Future (JN KITTINGER, L MCCLENACHAN, KB GEDAN, and LK BLIGHT, Eds.). - University of California Press.
Pearce, J. and Ferrier, S. 2001. The practical value of modelling relative abundance of species for regional conservation planning: a case study. - Biol. Conserv. 98: 33–43.
Stier, A. C. et al. 2016. Ecosystem context and historical contingency in apex predator recoveries. - Sci. Adv. in press.
Taylor, B. L. et al. 2007. Lessons from Monitoring Trends in Abundance of Marine Mammals. - Mar. Mammal Sci. 23: 157–175.
Ureña-Aranda, C. A. et al. 2015. Using Range-Wide Abundance Modeling to Identify Key Conservation Areas for the Micro-Endemic Bolson Tortoise (Gopherus flavomarginatus). - PLoS ONE in press.
Yu, J. and Dobson, F. S. 2000. Seven forms of rarity in mammals. - J. Biogeogr. 27: 131–139.

Policy Context and targets (other than IMAP)

Policy context description

Mediterranean fin whales and sperm whales are protected by the International Whaling Commission's moratorium on commercial whaling that entered into force in 1986.

The Mediterranean cetaceans' populations are also protected under the auspices of ACCOBAMS (Agreement on the Conservation of Cetaceans of the Black Sea, Mediterranean Sea and Contiguous Atlantic Area), under the auspices of the UNEP Convention on the Conservation of Migratory Species of Wild Animals (UNEP/CMS). The Corso-Ligurian-Provençal Basin and the Tyrrhenian Sea, where most cetacean species find suitable habitats, lie within the Pelagos Sanctuary established by France, Italy and Monaco, thus benefitting from its conservation regime.

All cetacean species in the Mediterranean Sea are protected under the Annex II of the SPA-BD Protocol under the Barcelona Convention; under the Appendix I of the Bern Convention; under the Annex II of the Washington Convention (CITES); and under the Appendix II of the Bonn Convention (CMS).

The short-beaked common dolphin, the sperm whale and the Cuvier's beaked whale and the monk seal are also

Indicator Title	*Common indicator 4: Species population abundance (marine mammals)*

listed under the Appendix I of the Bonn Convention (CMS).
The common bottle dolphin, the harbor porpoise and the monk seal are also listed under the Annex II of the EU Habitats Directive.

Indicator/Targets
Aichi Biodiversity Target 1, 3
EU Regulation 812/2004 concerning incidental catches of cetaceans in fisheries
EU MSFD Descriptor 1 and 4 - Marine Strategy Framework Directive requests regular reports on the population dynamics, range and status of cetacean species in Europe's waters.
EU Habitats Directive - The European Habitat Directive not only requires the monitoring of the Good Environmental Status (GES) of species and habitats of community interest, but also requires reporting on this status every 6 years.
The obligations under ACCOBAMS.

Policy documents
- Aichi Biodiversity Targets - https://www.cbd.int/sp/targets/
- EU Biodiversity Strategy - http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52011DC0244&from=EN
- EU Regulation 1143/2014 - http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32014R1143&from=EN
- Marine Strategy Framework Directive - http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32008L0056&from=EN
- Commission Decision on criteria and methodological standards on good environmental status of marine waters - http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32010D0477(01)&from=EN
- Pan-European 2020 Strategy for Biodiversity - https://www.google.no/url?sa=t&rct=j&q=&esrc=s&source=web&cd=2&cad=rja&uact=8&ved=0ahUKEwiP1J-v_P7NAhWHjSwKHZfoBRIQFggtMAE&url=https%3A%2F%2Fcapacity4dev.ec.europa.eu%2Fsystem%2Ffiles%2Ffile%2F08%2F10%2F2012_-_1535%2Fpan-european_2020_strategy_for_biodiversity.pdf&usg=AFQjCNGa4NkkljA4x3l9WDO49uwrdYafMg
- Strategic Action Programme for the conservation of Biological Diversity (SAP BIO) in the Mediterranean Region - http://sapbio.rac-spa.org/
- Draft Updated Action Plan for the conservation of Cetaceans in the Mediterranean Sea - http://rac-spa.org/nfp12/documents/working/wg.408_08_eng.pdf
- National Biodiversity Strategies and Action Plans (NBSAPs) - https://www.cbd.int/nbsap/
- ACCOBAMS Agreement Text - http://www.accobams.org/images/stories/Accord/anglais_text%20of%20the%20agreement%20english.pdf
- ACCOBAMS STRATEGY (PERIOD 2014 – 2025) - https://accobams.org/images/stories/MOP/MOP5/Documents/Resolutions/mop5.res5.1_accobams%20strategy.pdf

Common Fisheries Policy (CFP) and its reform - http://ec.europa.eu/fisheries/cfp/index_en.htm and http://ec.europa.eu/fisheries/reform/ and http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2013:354:0022:0061:EN:PDF
Council Regulation (EC) No 812/2004 of 26.4.2004 laying down measures concerning incidental catches of cetaceans in fisheries and amending Regulation (EC) No 88/98 - http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex:32004R0812
Directive 2014/89/EU of the European Parliament and of the Council of 23 July 2014 establishing a framework for maritime spatial planning - http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv:OJ.L_.2014.257.01.0135.01.ENG
Regulatory and Governance Gaps in the International Regime for the Conservation and Sustainable Use of Marine Biodiversity in Areas beyond National Jurisdiction - https://cmsdata.iucn.org/downloads/iucn_marine_paper_1_2.pdf
International Convention for the Prevention of Pollution from Ships (MARPOL) - http://www.imo.org/en/About/Conventions/ListOfConventions/Pages/International-Convention-for-the-Prevention-of-Pollution-from-Ships-(MARPOL).aspx
United Nations Convention on the Law of the Sea - http://www.un.org/Depts/los/convention_agreements/convention_overview_convention.htm
UNEP Regional Seas Programme - http://www.unep.org/ecosystemmanagement/water/regionalseas40/
https://global.oup.com/academic/product/marine-mammal-conservation-and-the-law-of-the-sea-

Indicator Title	*Common indicator 4: Species population abundance (marine mammals)*
9780190493141?cc=us&lang=en&	
Indicator analysis methods	
Indicator Definition This indicator is aimed at providing information about the abundance of cetacean's population. It is intended to determine the abundance and density of cetaceans and seals species that are present in Mediterranean waters, with a special focus on the species selected by the Contracting Parties. The rationale behind the organisation of systematic surveys is that the knowledge of baseline information, such as abundance and density, is fundamental to address many questions of ecological importance and for the implementation of conservation measures. This is particularly true for the Mediterranean Sea, in light of the fact that most of the cetacean populations occurring in the area are threatened by human activities and their conservation status requires effective protection action.	
Methodology for indicator calculation Line transect surveys (both aerial and ship-based) have proved to be particularly effective in estimating the abundance and density of many marine mammal species, and to provide robust data with low CVs and narrow CIs. Distance Sampling comprises a family of methods to estimate natural populations' parameters, the use of which is widespread and applied to various animal and plant taxa. The principle of this method is to search for objects (individuals or groups) along pre-defined fixed routes (transects). The result is a density value for the objects, calculated by the ratio between the area surveyed and the number of observations made. Data are elaborated through dedicated software (Distance 6.x). The use of Geographical Information Systems (GIS) is required for the compilation of the monitoring data collected and the elaboration of the predictions of species density and abundance. Information on density and abundance of marine mammals may be obtained through dedicated ship and aerial surveys, acoustic surveys, platform of opportunities (e.g., whale watching operators, ferries, cruise ships, military ships), as well as mark-recapture methodologies. To ensure a comprehensive coverage of the ecosystem, the indicator species should be selected taking into account their functional role. In this context the Contracting Parties agreed to monitor the following indicator species (Decision IG.22/7): **Marine mammals**: Pinnipeds: *Monachus monachus* Baleen whales: *Balaenoptera physalus* Toothed whales: - deep diving species: *Physeter macrocephalus* *Ziphius cavirostris* - epipelagic species: *Delphinus delphis* *Tursiops truncatus* *Stenella coeruleoalba* *Globicephala melas* *Grampus griseus* Methods for estimating density and abundance are generally species-specific and ecological characteristics of a target species should be considered carefully when planning a research campaign. For example, visual surveys may be particularly appropriate for large whales, but may be inappropriate for deep diving species such as sperm whales. In this latter case, passive acoustic monitoring is by far the most robust data collection methodology.	
Indicator units The Integrated Monitoring and Assessment Guidance provided in document UNEP(DEPI)/MED WG.420/4 recommended to use for recording the presence/absence of each species, the standardized 30 x 30 nautical mile grid map produced by FAO/GFCM or the 50 x 50 km grids used by the European Bird Census Council. According to specific needs, a finer scale map can be used, to provide finer information.	
List of Guidance documents and protocols available A document on 'Monitoring Guidelines to Assess Cetaceans' Distributional Range, Population Abundance and Population Demographic Characteristics' has been produced by ACCOBAMS and should be considered as guidance when establishing monitoring programmes. Protocols for large scale surveys (Scans I, II, III, CODA) are also available.	
Data Confidence and uncertainties Estimates of density and abundance are particularly 'data-hungry' and a minimum of 40-60 sightings for each species should be available to maintain low Coefficients of Variation (CVs) and narrow Confidence Intervals Cis). This may be easy to achieve with some cetacean species, such as fin whales, striped or bottlenose dolphins,	

Indicator Title	*Common indicator 4: Species population abundance (marine mammals)*
while may be very hard to achieve for beaked or pilot whales, for example. It is important to consider the highly mobility of cetaceans and the driving forces (mainly prey availability) which affect their distribution. In case of trends over time, appropriate statistical tools and analytical framework, such as density prediction modelling and power analysis should be applied. Aerial surveys proved to be a very cost-effective methodology to collect significant data, to obtain robust abundance and density estimates for cetaceans and other large marine vertebrates, and to provide preliminary evidence of population trends over time.	
Methodology for monitoring, temporal and spatial scope	
Available Methodologies for Monitoring and Monitoring Protocols Several protocols are available using different monitoring platforms and approaches such as: • dedicated ships or aerial surveys, • beached and stranded specimens monitoring, • opportunistic data, • tagging (capture-mark-recapture – artificial tags & photo-identification), • passive acoustic data collection, • automatic infrared cameras.	
Available data sources OBIS-SEAMAP, Ocean Biogeographic Information System Spatial Ecological Analysis of Megavertebrate Populations, is a spatially referenced online database, aggregating marine mammal, seabird, sea turtle and ray & shark observation data from across the globe. http://seamap.env.duke.edu/	
Spatial scope guidance and selection of monitoring stations Current spatial distributional range of marine mammals in the Mediterranean Sea is largely affected by available data, due to the uneven distribution of research effort during the last decades. In particular, the south-eastern portion of the basin, the coasts of North Africa and the central offshore waters are amongst the areas with the most limited knowledge on cetacean presence, occurrence and distribution. Priority should be given to the less known areas, using online data sources, such as Obis SeaMap and published data and reports as sources of information. Most of the species selected as indicator species in relation to this common indicator are migratory species, whose range extends over wide areas in the Mediterranean. It is therefore recommended to consider monitoring these species at regional or sub-regional scales for the assessment of their population abundance. ACCOBAMS is currently planning to undertake a regional synoptic survey covering most of the Mediterranean waters to estimate cetacean species density and abundance. This initiative – known as the ACCOBAMS Survey Initiative (ASI) - is expected to start in 2017 and to provide useful, robust and reliable data concerning population abundance of cetaceans in the Mediterranean area. Data on all the cetacean species present in the Mediterranean will be collected.	
Temporal Scope guidance Estimates of density of abundance relate to a specific time and area, and may vary on annual, or seasonal basis. Ideally, seasonal monitoring programmes should be conducted, although winter and summer campaigns should provide enough information. Temporal scale is largely affected by the conservation questions and expected outputs. International regulation suggests a six-year interval between large scale monitoring programmes, but smaller intervals are recommended. Long-term projects provide robust indications on trends over time and space in selected areas and are important project for photo-identification programmes.	
Data analysis and assessment outputs	
Statistical analysis and basis for aggregation Values of density and abundance of cetaceans and other large marine vertebrates can be estimated using design-based and model-based methodologies. Both methods present very similar and comparable results. Power analysis for detecting trends in density or abundance should be also applied.	
Expected assessments outputs I.e. trend analysis (monthly, seasonally, yearly), density maps, statistical frameworks applied.	
Known gaps and uncertainties in the Mediterranean Data in the Mediterranean Sea are characterized by their uneven distribution, both geographical and spatial. The summer months are the most representative ones and very little information has been provided for the winter months, when conditions to conduct off-shore research campaigns are particularly hard due to meteorological adversity. Ongoing effort by ACCOBAMS will provide estimates of density and abundance for the entire Mediterranean Sea. Aerial surveys supported by the Italian Ministry of the Environment and by the French Agency for Marine	

Indicator Title	*Common indicator 4: Species population abundance (marine mammals)*	
Protected Areas targeted the seas around Italy, France, the whole Pelagos Sanctuary and the Strait of Sicily, both in winter and summer months.		
Contacts and version Date		
Key contacts within UNEP for further information		
Version No	**Date**	**Author**
V.1	20/07/2016	SPA/RAC

Reptiles:

Indicator Title	*Common Indicator 4: Population abundance (Reptiles)*	
Relevant GES definition	**Related Operational Objective**	**Proposed Target(s)**
The population size allows to achieve and maintain a favourable conservation status taking into account all life stages of the population	Population size of selected species is maintained	**State** No human induced decrease in population abundance Population recovers towards natural levels where depleted
Rationale		
Justification for indicator selection Measurements of biological diversity are often used as indicators of ecosystem functioning, as several components of biological diversity define ecosystem functioning, including richness and variety, distribution and abundance. Abundance is a parameter of population demographics, and is critical for determining the growth or decline of a population. The objective of this indicator is to determine the population status of selected species by medium-long term monitoring to obtain population trends for these species. This objective requires a census to be conducted in breeding, migratory, wintering, developmental and feeding areas.		
Scientific References Bevan E, Wibbels T, Navarro E, Rosas M, Najera BMZ, Sarti L, Illescas F, Montaro J, Pena LJ, Burchfield P. 2016. Using Unmanned Aerial Vehicle (UAV) Technology for Locating, Identifying, and Monitoring Courtship and Mating Behavior in the Green Turtle (*Chelonia mydas*). Herpetological Review, 47(1), 27–32. Broderick, A.C., F. Glen, B.J. Godley BJ, G.C. Hays. 2002. Estimating the number of green and loggerhead turtles nesting annually in the Mediterranean. Oryx 36:227-235. Broderick, A.C., M.S. Coyne, W.J. Fuller, F. Glen, B.J. Godley. 2007. Fidelity and over-wintering of sea turtles. Proceedings of the Royal Society, Vol. 274 no. 1617 1533-1539. Casale P. and Margaritoulis D. (Eds.) 2010. Sea Turtles in the Mediterranean: Distribution, Threats and Conservation Priorities. IUCN/SSC Marine Turtle Specialist Group. Gland, Switzerland: IUCN, 294 pp. http://iucn-mtsg.org/publications/med-report/ Casale P., G. Abbate, D. Freggi, N. Conte, M. Oliverio, R. Argano. 2008. Foraging ecology of loggerhead sea turtles *Caretta caretta* in the central Mediterranean: evidence for a relaxed life history model. Marine Ecology Progress Series 372: 265-276. Demography Working Group of the Conference. Demography of marine turtles nesting in the Mediterranean Sea: a gap analysis and research priorities - 5th Mediterranean Conference on Marine Turtles, Dalaman, Turkey, 19-23 April 2015. Document T-PVS/Inf(2015)15E Presented at the Convention on the conservation of European wildlife and natural habitats - 35th meeting of the Standing Committee - Strasbourg, 1 - 4 December 2015 (2015) Groombridge, B. 1990. Marine turtles in the Mediterranean: distribution, population status, conservation. A report to the Council of Europe, Environment and Management Division. Nature and Environment Series, Number 48. Strasbourg 1990 Margaritoulis, D., Argano, R., Baran, I., Bentivegna, F., Bradai, M.N., Caminas, J.A., Casale, P., Metrio, G.D., Demetropoulos, A., Gerosa, G., Godley, B.J., Haddoud, D.A., Houghton, J., Laurent, L. & Lazar, B. (2003) Loggerhead turtles in the Mediterranean Sea: present knowledge and conservation perspectives. Loggerhead sea turtles (ed. by B.E. Witherington), pp. 175–198. Smithsonian Institution, Washington. Schofield, G., K.A. Katselidis, P. Dimopoulos, J.D. Pantis. 2008. Investigating the viability of photo-identification as an objective tool to study endangered sea turtle populations. Journal of Experimental Marine Biology & Ecology 360:103-108		
Policy Context and targets (other than IMAP)		
Policy context description Similar to the Ecosystem Approach, the EU adopted the European Union Marine Strategy Framework Directive		

Indicator Title	*Common Indicator 4: Population abundance (Reptiles)*

(MSFD) on 17 June 2008, which includes GES definitions, Descriptors, Criteria, Indicators and Targets. In the Mediterranean region, the MSFD applies to EU member states. The aim of the MSFD is to protect more effectively the marine environment across Europe. In order to achieve GES by 2020, each EU Member State is required to develop a strategy for its marine waters (or Marine Strategy). In addition, because the Directive follows an adaptive management approach, the Marine Strategies must be kept up-to-date and reviewed every 6 years.

The MSFD includes Descriptor 1: Biodiversity: "The quality and occurrence of habitats and the distribution and abundance of species are in line with prevailing physiographic, geographic and climatic conditions." Assessment is required at several ecological levels: ecosystems, habitats and species. Among selected species are marine turtles and within this framework, each Member State that is within a marine turtle range, has submitted GES criteria, indicators, targets and a program to monitor them.

The MSFD will be complementary to, and provide the overarching framework for, a number of other key Directives and legislation at the European level. Also it calls to regional cooperation meaning "cooperation and coordination of activities between Member States and, whenever possible, third countries sharing the same marine region or subregion, for the purpose of developing and implementing marine strategies" […] "thereby facilitating achievement of good environmental status in the marine region or subregion concerned".

Indicator/Targets

Commission Decision 2010/477/EU sets out the MSFD's criteria and methodological standards and under Descriptor 1 includes criteria 1.2. Population size and indicator "Population abundance and/or biomass, as appropriate (1.2.1)".

At a country scale, the following targets have been selected by member states.

Source: [Evaluation of] National Reports on Article 12 Technical Assessment of the MSFD 2012 obligations
http://ec.europa.eu/environment/marine/eu-coast-and-marine-policy/implementation/pdf/national_reports.zip

GREECE (*page 15)*

Environmental targets:

*[…]*2) Census of marine turtle *Caretta caretta* reproducing in the Greek coasts and conservation of spawning areas.

Associated indicators:

*[…]*2) Breeding area of the Mediterranean monk seal *Monachus monachus* and the sea turtle *Caretta caretta*

ITALY (*page 18)*

Italy has provided six targets and associated indicators *[…]* The second target focuses on the loggerhead turtle, and has the aim of decreasing accidental mortalities by regulating fishing practices. *[…]* No targets or threshold values are otherwise given.

[…]

T2: By-catch reduction in the areas of aggregation of *Caretta caretta*

It is proposed that the operative target for the mitigation of *Caretta caretta* by-catch be articulated as follows:

1) Spatial identification of the areas with highest use of pelagic long line (southern Tyrrhenian and southern Ionian sea) and trawling (northern Adriatic)

2) Completion of the spatial definition of *Caretta caretta* aggregation areas based on an approach capable of assessing temporal and seasonal distribution differences for each aggregation area (based on indicator 1.1.2 completion) so as to provide a final definition of the operative target

3) Monitoring of accidental captures in the areas subjected to operational target

4) Application of by-catch reduction measures in areas listed in point 3), through one or more of the following activities:

- Application of methods for the mitigation of accidental capture in pelagic surface longlines and trawling nest through structural modifications to the gear (i.e. circle hooks, TEDs etc.) and application of best practices for the reduction of mortality following capture (percentage). Note: in order to allow an immediate reduction of the pressure it is advised that best practices be applied in the geographic areas where preliminary knowledge already defines the presence of an aggregation area, before defining the incidence of total capture in the specific gear.
- Reduction of fishing pressure (percentage)

SPAIN (*Page 25)*

A.1.4: Reduce the main causes of mortality and of reduction of the populations of groups of species at the top of the trophic web (marine mammals, reptiles, sea birds, pelagic and demersal elasmobranchs), such as accidental capture, collisions with vessels, intaking of litter at sea, introduced terrestrial predators, pollution, habitat destruction, overfishing.

[…]

A.1.7: Establish a national coordination system of the accidental catch monitoring programmes of birds, reptiles,

Indicator Title	*Common Indicator 4: Population abundance (Reptiles)*

marine mammals, and mammal and reptile stranding and bird tracking.

[…]

A.3.4: Maintain positive or stable trends for the populations of key species or apex predators (marine mammals, reptiles, seabirds and fish) and maintain commercially exploited species within safe biological limits.

[…]

C.1.2: Promote international cooperation on studies and monitoring of populations of groups with broad geographic distribution (e.g. cetaceans and reptiles)

SLOVENIA - No information on Targets

page 10: (I. Good Environmental Status (GES), 1.1 Descriptor 1)

In the accompanying text to the GES definition, Slovenia provides a list of the species that are covered by the GES definition. This includes the bottlenose dolphin (*Tursiops truncatus*), the loggerhead sea turtle (*Caretta caretta*).

(II. Initial assessment, 2.2 Biological features)

Slovenia indicates that *[…]* turtles are covered under the reporting obligations of the Habitats Directive *[…]*. Each of these groups is briefly described and their state in relation to natural conditions is reported.

CYPRUS - No information on Targets

page 11: (II. Initial assessment, 2.2 Biological features)

[…] Chelonia mydas and *Monachus monachus* are considered stable but the situation of *Caretta caretta* is actually improving.

Policy documents

http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32010D0477(01)
http://ec.europa.eu/environment/marine/good-environmental-status/descriptor-1/index_en.htm
http://ec.europa.eu/environment/marine/eu-coast-and-marine-policy/implementation/reports_en.htm
http://ec.europa.eu/environment/marine/pdf/1-Task-group-1-Report-on-Biological-Diversity.pdf
http://ec.europa.eu/environment/marine/pdf/9-Task-Group-10.pdf

Indicator analysis methods

Indicator Definition

The index of population abundance reflects the variation over time of the total population size (counted or estimated) of selected species. Population size is the number of individuals present in a population at the appropriate scale.

Population Size:

The number of individuals within a population (population size) is defined as the number of individuals present in an animal aggregation (permanent or transient) in a subjectively designated geographical range.

Population density:

Population density is the size of a population in relation to the amount of space that it occupies, and represents a complementary description of population size. Density is usually expressed as the number of individuals per unit area.

Index of population abundance:

The index of population abundance is a single species indicator that reflects the temporal variation in the breeding or the non-breeding (wintering/feeding/developmental) population of selected species compared to a base year (or reference level). This indicator can be added into multi-species indices to reflect the variation over time of functional groups of species.

Methodology for indicator calculation

The choice of the most appropriate methodology to calculate the index of population abundance will depend on the temporal pattern of the available data. The methods to obtain the data used in the calculations are described in the monitoring methods below.

For data available on an annual basis, site and year, specific counts of individuals of the two species can be related to site and year effects (factors) and missing values can be imputed from the data of all surveyed sites.

Indicator units

The index of population abundance is a numerical value of species population abundance relative to the population size at base time. The average breeding population size during at least a decade is suggested as the

Indicator Title	*Common Indicator 4: Population abundance (Reptiles)*

base level (based on International Union for Conservation of Nature Red List minimal criteria for sea turtles). However, the breeding population in a given year excludes non-breeding adults and all juveniles. Therefore, a more comprehensive database is required.

For the base data used to calculate the index of population abundance, the following units are suggested:

- for population size at breeding colonies, number of females, number of nests or number of tracks, with appropriate modelling to extrapolate population numbers depending on the method used
- for total number of nesting sites, number of sites (n)
- for average nesting site size, size of the nesting area versus number of females, number of nests or number of tracks, with appropriate modelling to extrapolate population numbers depending on the method used (i.e. to obtain density/km) (n)
- for non-breeding animals at wintering/foraging/developmental sites, number of individuals (n) with appropriate modelling to extrapolate population numbers taking into account individuals that are not observed due to low surfacing frequency in the marine environment.
- For all size/age classes that are being injured/killed, the number of individuals (n) will be documented via the stranding network/bycatch data

Marine area surveys
Numbers of individuals based on the number of individuals, separated where possible according to:
1. Size class categories (as the sex of juveniles can only be determined by laparoscopy)
2. Sex of adult individuals: males can generally be distinguished from females by a longer tail

Beach area surveys
1. Counts of the number of females that emerge on the beach using identifiers (external flipper tags/PIT tags/Photo id) where possible
2. Counts of the numbers of tracks and/or nests on nesting beaches, from which an estimate of female population size can be made

List of Guidance documents and protocols available

Bevan E, Wibbels T, Rosas M, Najera BMZ, Sarti L, Montano J, Pena LJ, Burchfield P. Herpetological Review, 2016, 47(1), 27–32.

Eckert, K. L., Bjorndal, K. A., Abreu-Grobois, F. A. and Donnelly, M. (Eds.) 1999. Research and Management Techniques for the Conservation of Sea Turtles. IUCN/SSC Marine Turtle Specialist Group Publication No. 4. Washington, DC: 235 pp. https://mtsg.files.wordpress.com/2010/11/techniques-manual-full-en.pdf

Gerosa, G. (1996). Manual on Marine Turtle Tagging in the Mediterranean. –Mediterranean Action Plan - UNEP, RAC/SPA, Tunis, 48 pp.

Gerosa, G. and M. Aureggi. 2001. Sea Turtle Handling Guidebook for Fishermen. UNEP Mediterranean Action Plan, Regional Activity Centre for Specially Protected Areas. Tunis. http://www.rac-spa.org

McClellan DB. 1996. Aerial surveys for sea turtles, marine mammals and vessel activity along the south east Florida coast 1992-1996. NOAA Technical Memorandum NMFS-SEFSC-390 42pp

Schofield, G., K.A. Katselidis, P. Dimopoulos, J.D. Pantis. 2008. Investigating the viability of photo-identification as an objective tool to study endangered sea turtle populations. Journal of Experimental Marine Biology & Ecology 360:103-108

SWOT Scientific Advisory Board. 2011. The State of the World's Sea Turtles (SWOT) Minimum Data Standards for Nesting Beach Monitoring, version 1.0. Handbook, 28 pp

Data Confidence and uncertainties

Reliable index population abundance requires good census data, obtained regularly over a pre-defined spatial scale that is maintained through time. The index calculation methods allow for some gaps in the data series, but it is important to maintain the spatial scale so that data can be comparable across years.

The calculation methods provide a confidence interval which, in turn, is dependent on the level of confidence of the original census data. To reduce uncertainty, it is important that the individuals obtaining the data have received proper training and are maintained over extensive periods.

In-water surveys
It is not possible to count all individuals in a given habitat/population. Transects must be corrected for the likelihood of observing surfacing animals, according to species. For instance, sea turtles are much smaller

Indicator Title	*Common Indicator 4: Population abundance (Reptiles)*
(particularly juveniles) and spend less time at the surface than sea birds or mammals. Furthermore, animals are more likely to be sighted in shallow waters (<10 m depth) versus deeper waters. All of these issues need to be incorporated into the survey techniques and subsequent extrapolation/analyses. Male numbers can only be inferred from in-water surveys. Beach-based surveys It is not possible to count all females that nest in a nesting area, as some may emerge before the onset of monitoring or may emerge on beaches that are not monitored. Thus, it is important to document tracks too. On beaches where remote techniques are used to count tracks/nests, there is a risk of double counting the same tracks if monitoring is infrequent. Frequent monitoring could use the proximity of the track to the sea to guide track freshness. This issue needs careful consideration. Extrapolating female numbers from track/nest counts must be treated with caution, as the number of nests laid by females varies with the sea temperature (i.e. fewer nests are laid by the same females at <25 °C versus >25 °C). Various models exist to extrapolate this information. However, ultimately track/nest counts should be used to infer female numbers and inter-annual changes in female numbers with extreme caution. Male numbers cannot be obtained from beach surveys, as they do not emerge on beaches.	
Methodology for monitoring, temporal and spatial scope	

Available Methodologies for Monitoring and Monitoring Protocols

To estimate and monitor the number of breeding turtles, the proposed field methods are:

a) direct counts of females at the nesting sites at the appropriate time in the breeding season to estimate the total number of breeding females

b) when performing the surveys above, the number and distribution of nesting colonies should be recorded so as to be able to estimate the total number of breeding nuclei, and their average size

To estimate and monitor the number of turtles in-water at breeding, wintering, foraging, and developmental sites, the following methodologies are proposed:

a) direct counts of individuals during the appropriate seasons (potentially year-round at certain foraging/developmental sites), with appropriate modeling to estimate the number of missed individuals not counted due to low surfacing intervals.

To estimate and monitor the number of animals that are injured or die in areas near or within breeding, wintering, foraging and developmental sites

a) direct counts of individuals caught by fishing vessels as bycatch or stranded on beaches throughout the Mediterranean, with appropriate modelling to estimate the site where the animal was traumatized (i.e. how it was carried by sea currents) in cases of stranding, and how these losses impact the Mediterranean sea turtle population as a whole, along with individual population and sub-population units.

Existing techniques include:

- Aerial or boat surveys (line transects) under specific circumstances, with the appropriate modelling techniques to account for missed animals (i.e. due to low surfacing time and low frequency of time spent at the surface)
- Artificial external flipper tagging (metal and plastic on flippers),
- Photo-identification
- PIT tagging of flippers, Telemetry (satellite, GPS/GSM, radio telemetry) and loggers, capture-mark-recapture studies
- Shipboard, aerial (including drone), or diver-based/video (potential)
- Swimming/snorkelling surveys with photo-id and GPS in densely populated areas (e.g. certain breeding sites)
- CPUE (bycatch), Direct mortality rate, Post-release mortality rate
- Nest counts, Photo-id of individuals, Time-Depth-Recorder tags
- Beach stranding

Breeding areas census (rookeries):
Once breeding areas have been identified it is possible to obtain counts (individuals, nests, etc.) during the most appropriate period. The method used depends on the species and their characteristics. Counting the number of nests or crawls during the early morning is used to infer the number of females in a seasonal sea turtle breeding

Indicator Title	*Common Indicator 4: Population abundance (Reptiles)*

population, but does not provide information on the number of males present. In water photo-id or drone surveys can be used to detect males (males swim with their tails protruded).
Wintering areas census: To determine the state of populations during the winter, it is necessary to use a standardized sampling method. For sea turtles, wintering areas of adults (but not juveniles) could be identified from existing and new satellite tracking studies, allowing focused effort at these sites. However, as wintering turtles surface less frequently than during breeding or foraging, underwater survey techniques may need to be developed (or drone survey techniques). In addition, for sea turtles, juvenile wintering grounds are not necessarily in the same location as those of adults; therefore, dedicated surveys of areas used by juvenile life stages are also required.
Foraging census: Once identified, individuals in feeding areas are counted at different periods throughout the year. For most species, feeding areas may be located by aerial surveys, bycatch data, telemetry data and the study of the distribution of prey species. For sea turtles, direct counts at foraging areas may require the development of underwater techniques, due to their low surfacing frequency, in parallel to emerging (drone) techniques. This would be particularly important in major feeding areas that are not coastal, such as in the central Adriatic, Gulf of Gabes, etc. In addition, for sea turtles, juvenile foraging grounds are not necessarily in the same location as those of adults. Therefore, dedicated surveys of areas used by juvenile life stages are also required.
Migration monitoring: For sea turtles, it is difficult to make counts of migratory animals. However, opportunistic counts from sightings may be made of resident/passing turtles, which could be followed up in areas where turtles have not previously been documented from stranding/tracking studies.
Ship and aerial surveys (from ships, planes, helicopters or drones): Visual census (sightings) by a stratified/linear transect method. Two types of sampling techniques are proposed: in coastal (neritic) waters and in remote oceanic (pelagic) waters. Coastal transects consistently cover the same area of coastline uniformly (but transects linking caves along the coastline would be selected for monk seal boat surveys), while pelagic surveys would be variable, but generally straight and perpendicular to the coast. Transects should be conducted at different times of the year, to cover all aspects of marine animal phenology. When sea turtles are located, as much information is recorded as possible about the species, position, number of individuals and social structure. These techniques may be used for sea turtles. However, due to their small size (particularly for juvenile stages) and brief surfacing time, the appropriate statistical analyses would be required to assess the collected data objectively. These techniques are best applied in shallow areas where sea turtles are known to aggregate and where they could be detected underwater, too.
Platforms-of-opportunity (POP) surveys: Trained observers would be placed on host ships and aircraft to survey remote pelagic waters. In such cases, data must be extrapolated to infer trends in abundance, as sightings become opportunistic.
Tagging (capture-mark-recapture – artificial tags & photo-identification): at focal coastal marine areas where turtles aggregate in the water (breeding, foraging, wintering, developmental areas) or of females on the nesting beaches.
Telemetry: Tracked individuals can be used to identify hotspots to make counts of aggregated populations.
Beached and stranded specimens monitoring
Creating a network of stranding and beached individual census' to obtain important information, usually with the help of volunteers and officials. This is a good indicator of seabirds after storms. It is also a good indicator for the presence/absence of cetaceans, seals and dolphins in different geographical regions. Dedicated stranding networks already exist for sea turtles/marine mammals in several Mediterranean countries, with stranding information being confirmed to reflect distribution patterns based on satellite telemetry studies. Sea turtle stranding represent a useful index of population abundance and can be used if data are appropriately collected and standardized. Specific tracts of coast can be selected as index zones for this purpose, or coastlines may be opportunistically surveyed with the assistance of the general public.
Beach-based surveys
Counts of females on beaches and/or tracks/nests are used to infer population size in many sea turtle populations. Foot patrols are limited to specific areas, whereas drones/planes can be used to survey vast tracts of beach repeatedly to obtain counts of tracks (with methods existing to extrapolate approximate turtle numbers). High resolution remote sensing satellite imagery could also be used to count tracks on difficult to access beaches. However, this remains extremely expensive.
Sea turtles: telemetry (satellite, GPS/GSM, radio), artificial flipper tags, PIT tags, photo-identification (facial scute patterns, notches and scars). Epibionts should not be used, as they can fall off after very short periods.

Available data sources
Adriatic Sea Turtle Database. http://www.adriaticseaturtles.eu/

Indicator Title	*Common Indicator 4: Population abundance (Reptiles)*

Casale P. and Margaritoulis D. (Eds.) 2010. Sea Turtles in the Mediterranean: Distribution, Threats and Conservation Priorities. IUCN/SSC Marine Turtle Specialist Group. Gland, Switzerland: IUCN, 294 pp. http://iucn-mtsg.org/publications/med-report/
Halpin, P.N., Read, A.J., Fujioka, E., et al., 2009. OBIS-SEAMAP the world data center for marine mammal, sea bird, and sea turtle distributions. Oceanography 22, 104–115.
I3S. Sea turtle photo identification database. http://www.reijns.com/i3s/
The state of the World's Sea Turtles online database: data provided by the SWOT team and hosted on OBIS-SEAMAP (Ocean Biogeographic Information System Spatial Ecological Analysis of Megavertebrate Populations). In: Oceanic Society, Conservation International, IUCN Marine Turtle Specialist Group (MTSG), and Marine Geospatial Ecology Lab, Duke University. <http://seamap.env.duke.edu/swot>.
Margaritoulis, D., Argano, R., Baran, I., Bentivegna, F., Bradai, M.N., Cami~nas, J.A., Casale, P., Metrio, G.D., Demetropoulos, A., Gerosa, G., Godley, B.J., Haddoud,D.A., Houghton, J., Laurent, L. & Lazar, B. (2003) Loggerhead turtles in the Mediterranean Sea: present knowledge and conservation perspectives. Loggerhead sea turtles (ed. by B.E. Witherington), pp. 175–198. Smithsonian Institution, Washington
PITMAR. Sea turtle photo-identification database. http://www.pitmar.net/index.php/en/
Seaturtle.org – Global Sea Turtle Network. Sea turtle tracking. Sea turtle nest monitoring. http://www.seaturtle.org/
The Reptile Database: Location of juvenile loggerheads and greens in the Eastern Mediterranean. http://reptile-database.reptarium.cz/species?genus=Caretta&species=caretta
Mediterranean marine research centres, NGOs, universities and institutions, local and national sea turtle monitoring projects.
Governmental Ministries
IUCN specialists (MTSG)

Spatial scope guidance and selection of monitoring stations

For counts carried out on an annual basis, a number of sites should be selected that represent a sufficiently large proportion of the subregional or national population, with criteria being delineated by expert groups.[1]

The "Demography Working Group" suggests that comprehensive surveys should be carried out every 5 years, with the aim of covering all breeding, foraging, wintering and developmental sites. However, here, it is recommended that the whole coastal and marine area is covered on a national or subregional scale to take into account changes in population distribution (and hence counts) in relation to climate change.

[1]*Demography Working Group of the Conference. (2015) Demography of marine turtles nesting in the Mediterranean Sea: a gap analysis and research priorities - 5th Mediterranean Conference on Marine Turtles, Dalaman, Turkey, 19-23 April 2015. Document T-PVS/Inf(2015)15E Presented at the Convention on the conservation of European wildlife and natural habitats - 35th meeting of the Standing Committee - Strasbourg, 1 - 4 December 2015*

Temporal Scope guidance

Annual – breeding surveys at selected sites to estimate the number of breeding females from nest counts (April to September) and the number of breeding males and females from direct counts of in-water surveys (April-July)

Annual – winter censuses at selected sites to estimate number of wintering individuals (October to April)

Annual – foraging/developmental censuses at selected sites to estimate number of foraging/developmental individuals (January-December)

Every year – comprehensive breeding surveys at index beaches (included all beaches that are monitored annually through various programs) to estimate the no. of breeding individuals, number of breeding sites and average size. Monitoring every 5 years[1] of the entire coastline of all countries to detect changes in sporadic beach use or the use of new sites driven by climate change or changes to the habitat at existing sites (e.g. erosion or development)

Every year – comprehensive censuses of index winter, foraging, developmental sites to estimate no. of wintering, foraging and developmental individuals at coastal and marine sites. At present, knowledge of these sites remains limited, particularly identifying those that are likely to have the greatest impact on multiple breeding populations. Thus, in the first two years, all oceanic and coastal areas must be uniformly monitored, followed by a meeting of experts to decide index sites for the different categories (foraging, wintering, developmental) within each country (the marine area all countries of the Mediterranean are used by sea turtles, so a set number per country should be selected). At this point, index sites should be monitored annually, while

Indicator Title	*Common Indicator 4: Population abundance (Reptiles)*

all other sites should be monitored every 5 years.

[1]*Demography Working Group of the Conference. (2015) Demography of marine turtles nesting in the Mediterranean Sea: a gap analysis and research priorities - 5th Mediterranean Conference on Marine Turtles, Dalaman, Turkey, 19-23 April 2015. Document T-PVS/Inf(2015)15E Presented at the Convention on the conservation of European wildlife and natural habitats - 35th meeting of the Standing Committee - Strasbourg, 1 - 4 December 2015*

Data analysis and assessment outputs

Statistical analysis and basis for aggregation

It is not possible to survey all individuals in a turtle population either through in-water or beach-based surveys; thus, various models must be established and validated for the different targets (breeding, foraging, wintering and developmental sites).

At present a number of analyses exist to infer population size based on the metric being counted, e.g. on nesting beaches, different groups count female numbers, nest numbers or track numbers from which population size is inferred. In the water, turtles do not surface regularly, so a number of individuals are always missed from population surveys. The statistics used depends on the monitoring method used, as well as the seabed depths surveyed and in-water visibility.

A number of models are available for estimating population abundance based on nest-counts or sighting information; however, limitations exist, with various complimentary methods being required to improve robustness.
The assessment of the conservation status of a sea turtle species by the IUCN is defined “endangered” and “critically endangered” when there is over 50% and 80% decline in a population, respectively, over the most recent 10 year period (or 3 generations). These decisions are actually based on extrapolations nest-associated data, either counts of females, their nests or tracks, and do not actually take into account adult males or the juvenile component of the population. Thus, the level of detectability in different habitats (coastal and oceanic) and under different conditions (sea depths, sea state, sea visibility) needs to be incorporated into analyses. A long series (at least 10 years, to conform with IUCN criteria) would be necessary to detect clear tendencies.

Expected assessments outputs

This indicator will be largely built on establishing counts of sea turtles of different size/age classes and sexes (adults only) at nesting (breeding), wintering, and foraging/developmental habitats. The main output of the monitoring will be therefore:
- Models providing estimates of abundance in all areas where turtle presence is detected
- Changes (trends) in the number of individuals in each habitat over time

In addition to national or subregional indices, trends can be computed to indicate whether long term changes in turtle populations are strongly increasing, moderately increasing, stable, uncertain, moderately declining or steeply declining.

Known gaps and uncertainties in the Mediterranean

- Number of males and females frequenting all breeding/nesting sites each year (operational sex ratio), and the total number of individuals in the breeding populations.
- Number of adults and juveniles frequenting wintering, feeding, developmental sites, along with how numbers vary across the season as individuals enter and leave different sites.
- Vulnerability/resilience of these populations/sub-populations in relation to physical pressures;
- Analysis of pressure/impact relationships for populations/sub-populations and definition of qualitative GES;
- Identification of extent (area) baselines for each population/subpopulation and the habitats they encompass;
- Criteria for the risk based approach to monitoring and develop harmonized sampling instructions where appropriate;
- Common computing methodologies and data collection instructions, specifying the accuracy (spatial resolution or grid) of the determination of extent (area) a priori;
- Appropriate assessment scales;

Indicator Title	*Common Indicator 4: Population abundance (Reptiles)*	
• Standardized data flows for spatial pressure data; • GES baselines for sites that cannot be inferred from contemporary records of pressure or construction; • Harmonised sampling, cartographic, data collation and GIS protocols • Generate or update databases and maps of known nesting, feeding, wintering habitats in each Contracting Party • Identify possible baselines and index sites. • Identify monitoring capacities and gaps in each Contracting Party • Develop a guidance manual to support the monitoring programme, which will provide more detailed information, tools, and advice on survey design, monitoring methodology and techniques that are most cost-effective and applicable to each of the selected sea turtle species, in order to ultimately ensure standardised monitoring, comparable data sets, reliable estimates and trend information. • Identify techniques to monitor and assess the impacts of climate change. • Develop monitoring synergies in collaboration with GFCM for- EO3 (Harvest of commercially exploited fish and shellfish), to collect data via sea turtle by-catch • Investigate monitoring synergies with other relevant EOs that will include coast-based fieldwork, in relation to monitoring of new/unknown sea turtle nesting beaches, and of beached/stranded animals, to obtain more widespread information • Neither turtle populations nor monitoring capacity are distributed equally across the Mediterranean and, for this reason, it may be advisable to plan a phased development of pan-Mediterranean indices of population abundance for sea turtles. The best approach is to build on the existing national biodiversity monitoring units, and to homogenise methodologies as initial steps. The extension of equivalent programmes across the whole of the Mediterranean region may be achieved in a second phase.		
Contacts and version Date		
Key contacts within UNEP for further information		
Version No	**Date**	**Author**
V.1	20/7/2016	SPA/RAC

Seabirds:

Indicator Title	*Common indicator 4: Species population abundance (Seabirds)*	
Relevant GES definition	**Related Operational Objective**	**Proposed Target(s)**
Population size of selected species (of seabirds) is maintained. The species population has abundance levels allowing to qualify to Least Concern Category of IUCN (less than 30% variation over a time period equivalent to 3 generation lengths)	Breeding population size of selected species is maintained or, where depleted, it recovers to natural levels	No human-induced decrease in breeding population size or density. Breeding populations recover towards natural levels where depleted. The total number of individuals is sparse enough in different spots. Local declines are balanced out by increases elsewhere, so that overall numbers of breeding birds are maintained at the appropriate scale
Rational		
Justification for indicator selector Abundance is a parameter of population demographics, and is critical for determining the growth or decline of a population. The number of individuals within a population (population size) is defined as the number of individuals present		

Indicator Title	*Common indicator 4: Species population abundance (Seabirds)*	
in an animal aggregation (permanent or transient) in a subjectively designated geographical range. Population density is the size of a population in relation to the amount of space that it occupies, and represents a complementary description of population size. Density is usually expressed as the number of individuals per unit area. The index of population abundance is a single species indicator that reflects the temporal variation in the breeding or the non-breeding (wintering) population of selected species compared to a base year (or reference level). This indicator can be added into multi-species indices to reflect the variation over time of functional groups of species. The objective of this indicator is to determine the population status of selected species by medium-long term monitoring to obtain population trends for these species. This objective requires a census to be conducted in breeding, migratory, wintering, developmental and feeding areas.		
Scientific References *Parsons, M., Mitchell, I., Butler, A., Ratcliffe, N., Frederiksen, M., Foster, S., & Reid, J. B. (2008). Seabirds as indicators of the marine environment. ICES Journal of Marine Science: Journal du Conseil, 65(8), 1520-1526.*		
Policy Context and targets		
Policy context description EU MSFD; UE Nature Directives; Red List, AEWA		
EU Marine Strategy Framework Directive	In order to achieve GES by 2020, each EU Member State is required to develop a strategy for its marine waters (or Marine Strategy). In addition, because the Directive follows an adaptive management approach, the Marine Strategies must be kept up-to-date and reviewed every 6 years. The MSFD will be complementary to, and provide the overarching framework for, a number of other key Directives and legislation at the European level. Also it calls to regional cooperation meaning “cooperation and coordination of activities between Member States and, whenever possible, third countries sharing the same marine region or subregion, for the purpose of developing and implementing marine strategies” […] “thereby facilitating achievement of good environmental status in the marine region or subregion concerned”.	Descriptor 1: Biodiversity The population abundance of key marine species is stable and their population dynamics are indicative of long-term viability Parameters and trends:

Indicator Title	*Common indicator 4: Species population abundance (Seabirds)*	
UE Nature Directives (Birds and Habitats Directives)	The conservation status of a species "will be taken as 'favourable' when: 1. population dynamics data on the species concerned indicate that it is maintaining itself on a long-term basis as a viable component of its natural habitats […]. Every six years, all EU Member States are required to report on the implementation of the directives. There is a methodology for the assessment of conservation status and has been widely used for the compulsory reporting by EU member states for Habitats Directive (HD). This approach has been extended also to Birds Directive (BD) reporting (N2K Group 2011).	<u>Parameters and trends:</u> Distribution (range)
UICN Red List		

Targets

EU Marine Strategy Framework Directive: Population abundance of breeding seabirds is stable over a period of twelve years, taking into consideration the natural variability of the species population and their ecology.

UE Nature Directives: Population(s) not lower than 'favourable reference population' AND reproduction, mortality and age structure not deviating from normal (if data available)

IUCN: The overall target must be to prevent any significant decline in the population abundance of any of the selected species. For species in a Least Concern (LC) IUCN status, the specific target must be to maintain them within the stable category (no significant increase or decline, and most probable trends are less than 5% per year). For globally threatened species (IUCN: VU, EN or CR), the conservation objective must be to restore them to LC status so the population abundance target must be for the population to achieve a significant increase before levelling off at a higher (safer) population level.

Policy documents

List and url's

6. 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) (Text with EEA relevance): http://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1401265930445&uri=CELEX:32008L0056
7. http://ec.europa.eu/environment/nature/legislation/birdsdirective/index_en.htm
8. http://ec.europa.eu/environment/nature/legislation/habitatsdirective/index_en.htm
9. Article 12 – National reporting on status and trends of bird species. http://ec.europa.eu/environment/nature/knowledge/rep_birds/index_en.htm
10. BirdLife International (2015) European Red List of Birds. Luxembourg: Office for Official Publications of the European Communities.

Indicator analysis methods

Indicator Definition

The index of population abundance reflects the variation over time of the total population size (counted or estimated) of selected species. Population size is the number of individuals present in a population at the appropriate scale.

Indicator Title	*Common indicator 4: Species population abundance (Seabirds)*

Methodology for indicator calculation

The choice of the most appropriate methodology to calculate the index of population abundance will depend on the temporal pattern of the available data. The methods to obtain the data used in the calculations are described in the monitoring methods below.

For data available on an annual basis, site and year specific counts of individuals of particular species can be related to site and year effects (factors) and missing values can be imputed from the data of all surveyed sites.

To calculate an index of population abundance, the Species Trends Analysis Tool for birds (BirdSTATs) is the standard software used across Europe by the European Bird Census Council (EBCC). This is an open source Microsoft Access database for the preparation and statistical analysis of bird counts data in a standardised way. The BirdSTATs tool is programmed to use and automatically run the program TRIM (TRends and Indices for Monitoring data) in batch mode to perform the statistical analysis for series of bird counts in the dataset. In this way it is suitable for use in all European countries participating in the Pan European Common Bird Monitoring Scheme (PECBMS). The BirdSTATs tool is developed at the request of the Pan European Common Bird Monitoring Scheme (PECBMS) by Bioland Informatie. Designing and programming of the tool is funded by the European Commission through British Royal Society for the Protection of Birds (RSPB).

The BirdSTATs tool is an open source database that can downloaded from the European Bird Census Council website (http://www.ebcc.info/wpimages/video/BirdSTATS21.zip); it allows users to adapt or expand the tool to their own demands. The tool is also usable for other species groups.

For data available at lower frequencies (e.g., every 6 years), a linear trend can be estimated using simple arithmetic methods. This option increases the level of uncertainty, so an extra warning of caution must be added when making interpretations based on this kind of data.

Indicator units

The index of population abundance is a numerical value of species population abundance relative to the population size at base time. The average breeding population size during at least a decade is suggested as the base level.

For the base data used to calculate the index of population abundance, the following units are suggested:

- for population size at nesting colonies, number of breeding pairs (bp)
- for total number of nesting colonies, number of colonies (n)
- for average colony size, number of individuals (n)
- for non-breeding birds at wintering sites, number of individuals (n)
- for total number of birds estimated on migration, number of individuals (n)

List of Guidance documents and protocols available

- Article 12 – National reporting on status and trends of bird species. http://ec.europa.eu/environment/nature/knowledge/rep_birds/index_en.htm
- Auniņš, A., and Martin, G. (eds.) (2015). Biodiversity Assessment of MARMONI Project Areas. Project report, 175. Available online at: http://marmoni.balticseaportal.net/wp/project-outcomes/
- Bibby, C., Jones, M., Marsden, S. (1998): Expedition Field Techniques. Bird Surveys. Expedition Advisory Centre, Royal Geographical Society, London. PDF
- Bibby, C.J., Burgess, N.D. et Hill, D.A. (2000): Bird Census Techniques. Academic Press, London, 2nd edition.
- Buckland, S.T., Anderson, D.R., Burnham, K.P., Laake, J.L. et Borchers, D.L. (2001): Introduction to Distance sampling: estimating abundance of biological populations. Oxford University Press, Oxford.
- Camphuysen CJ & Garthe S 2004. Recording foraging seabirds at sea: standardised recording and coding of foraging behavior and multi-species associations. Atlantic Seabirds 6: 1 – 32.
- Cardoso, A. C., Cochrane, S., Doerner, H., Ferreira, J. G., Galgani, F., Hagebro, C., ... & Olenin, S. (2010).

Indicator Title	*Common indicator 4: Species population abundance (Seabirds)*

Scientific Support to the European Commission on the Marine Strategy Framework Directive. Management Group Report. EUR, 24336, 57. http://www.ices.dk/news-and-events/Documents/Themes/MSFD/Management%20Group%20Report_Final_vII.pdf

- ETC/BD. 2011. Assessment and reporting under Article 17 of the Habitats Directive. Explanatory Notes & Guidelines for the period 2007-2012 (Final version). Compiled by Douglas Evans and Marita Arvela (European Topic Centre on Biological Diversity). Available online: https://circabc.europa.eu/sd/a/2c12cea2-f827-4bdb-bb56-3731c9fd8b40/Art17%20-%20Guidelines-final.pdf
- Gibbons, D.W. et Gregory, R.D. (2005): Birds. In: Sutherland W.J. [ed.]: Ecological Census Techniques: a handbook. Cambridge University Press, Cambridge, 2nd edition.
- Gilbert, G., Gibbons, D.W. et Evans, J. (1998): Bird Monitoring Methods - a manual of techniques for key UK species. RSPB, Sandy.
- Greenwood, J.J.D. (2005): Basic techniques. In: Sutherland W.J. [ed.]: Ecological Census Techniques: a handbook. Cambridge University Press, Cambridge, 2nd edition.
- Gregory, R.D., Gibbons, D.W. et Donald, P.F. (2004): Bird census and survey techniques. In: Sutherland W.J., Newton I. et Green R. E. [eds.]: Bird Ecology and Conservation; a Handbook of Techniques. Oxford University Press, Oxford: 17-56. PDF
- http://bd.eionet.europa.eu/activities/Reporting/Article_17/reference_portal
- ICES (2013). OSPAR Special Request on Review of the Technical Specification and Application of Common Indicators Under D1, D2, D4, and D6. Copenhagen: International Council for the Exploration of the Sea.
- ICES. 2015. Report of the Working Group on Marine Mammal Ecology (WGMME), 9–12 February 2015, London, UK. ICES CM 2015/ACOM:25. 114 pp.
- IUCN. (2009). Seabird Indicator (Caucasus). Edited by IUCN Programme Office for the Southern Caucasus. http://www.iucn.org/sites/dev/files/import/downloads/seabird_indicator_caucasus.pdf
- Javed, S. et Kaul, R. (2002): Field methods for bird surveys. Bombay Natural History Society, Deparment of Wildlife Sciences, Aligarh Muslim University and World Pheasant Association, New Delhi India.
- Komdeur, J., Bertelsen, J. et Cracknell, G. (1992): Manual for aeroplane and ship surveys of waterfowl and seabirds. IWRB Special Publication 19. Slimbridge, U.K.
- MARMONI (2015). The MARMONI approach to marine biodiversity indicators. Volume II: list of indicators f or assessing the state of marine biodiversity in the Baltic Sea developed by the life MARMONI project. Estonian Marine Institute Report Series No. 16. Available online at: http://marmoni.balticseaportal.net/wp/project-outcomes/
- Robinson, R. A., & Ratcliffe, N. (2010). The Feasibility of Integrated Population Monitoring of Britain's Seabirds. British Trust for Ornithology.
- Steinkamp, M., Peterjohn, H., Bryd, V., Carter, H. et Lowe, R. (2003): Breeding season survey techniques for seabirds and colonial waterbirds throughout North America
- Underhill, L. et Gibbons, D. (2002): Mapping and monitoring bird populations; their conservation uses. In: Norris K. et Pain D. [eds.]: Conserving bird biodiversity; general principles and their application. Cambridge University Press, Cambridge: 34-60.
- Van Strien, A.J., Soldaat, L.L., Gregory, R.D. (2011): Desirable mathematical properties of indicators for biodiversity change. Ecological Indicators 14: 202-208. PDF
- Walsh, P.M., Halley, D.J., Harris, M.P., del Nevo, A., Sim, I.M.W. et Tasker, M.L. (1995): Seabird Monitoring Handbook for Britain and Ireland. - JNCC, Peterborough.

Data Confidence and uncertainties

Reliable index population abundance requires good census data, obtained regularly over a pre-defined spatial scale that is maintained through time. The index calculation methods allow for some gaps in the data series, but

Indicator Title	*Common indicator 4: Species population abundance (Seabirds)*

it is important to maintain the spatial scale so that data can be comparable across years.

The calculation methods provide a confidence interval which, in turn, is dependent on the level of confidence of the original census data. To reduce uncertainty, it is important that the individuals obtaining the data have received proper training and are maintained over extensive periods.

Methodology for monitoring, temporal and spatial scope

Available Methodologies for Monitoring and Monitoring Protocols

In order to estimate and monitor the number of breeding birds, the proposed field methods are:

a) direct counts at the nesting colonies at the appropriate time in the breeding season to estimate the total number of breeding birds

b) when performing the surveys above, the number and distribution of nesting colonies should be recorded so as to be able to estimate the total number breeding nuclei, and their average size

To estimate and monitor the number of birds during the non-breeding (wintering) season, the following methodologies are proposed for coastal species:direct counts at known wetland and coastal sites during the peak of the wintering season (for example, as part of the well-established International Waterbird Census, IWC, coordinated by Wetlands International) to estimate the total number of wintering birds

In addition, monitoring the numbers of birds passing through migration bottlenecks or prominent headlands can be used to estimate the total size of the populations entering or leaving the region or subregions, and their trends over time:

- Direct counts at known migration bottlenecks or prominent headlands (e.g., in the areas of Gibraltar, Bosphorus, Dardanelles, northern Tunisia, strait of Otranto, etc.) to estimate the total number of birds flying through or past those areas on a yearly basis.

Available data sources

OBIS-SEAMAP, Ocean Biogeographic Information System Spatial Ecological Analysis of Mega Vertebrate Populations, http://seamap.env.duke.edu/
http://www.birdlife.org/datazone/home
UNEP/MAP-RAC/SPA projects and publications http://www.rac-spa.org/publications
Birdlife partners in the Mediterranean
Mediterranean marine research centres, universities and institutions
Medmaravis
Governmental ministries
IUCN specialists

Spatial scope guidance and selection of monitoring stations

For counts carried out on an annual basis as described below, a number of sites should be selected that represent a sufficiently large proportion of the subregional or national population; this should be at least 40% and in no case less than 10%.

The comprehensive surveys to be carried out every 6 years should aim at covering the whole area on a national or subregional scale.

Temporal Scope guidance

Annual – breeding surveys at selected sites to estimate the number of breeding pairs
Annual – winter censuses at selected coastal & wetland sites to estimate no. of wintering individuals
Annual – mid-winter census (IWC) at important wintering sites
Annual – migration counts at key bottlenecks or prominent headlands
Every 6 years – comprehensive breeding surveys to estimate no. of breeding pairs, no. of colonies and average size
Every 6 years – comprehensive winter censuses to estimate no. of wintering individuals at coastal & wetland

Indicator Title	*Common indicator 4: Species population abundance (Seabirds)*
sites	
Data analysis and assessment outputs	

Statistical analysis and basis for aggregation

The multiplicative overall slope estimate in TRIM is converted into one of the following categories. The category depends on the overall slope as well as its 95% confidence interval (= slope +/- 1.96 times the standard error of the slope).

- **Strong increase** - increase significantly more than 5% per year (5% would mean a doubling in abundance within 15 years). Criterion: lower limit of confidence interval > 1.05.
- **Moderate increase** - significant increase, but not significantly more than 5% per year. Criterion: 1.00 < lower limit of confidence interval < 1.05.
- **Stable** - no significant increase or decline, and most probable trends are less than 5% per year. Criterion: confidence interval encloses 1.00 but lower limit > 0.95 and upper limit < 1.05.
- **Uncertain** - no significant increase or decline, and unlikely trends are less than 5% per year. Criterion: confidence interval encloses 1.00 but lower limit < 0.95 or upper limit > 1.05.
- **Moderate decline** - significant decline, but not significantly more than 5% per year. Criterion: 0.95 < upper limit of confidence interval < 1.00.
- **Steep decline** - decline significantly more than 5% per year (5% would mean a halving in abundance within 15 years). Criterion: upper limit of confidence interval < 0.95.

Expected assessments outputs

The outputs of BirdSTATs are imputed yearly indices and totals for each species, together with their standard errors and covariance.

In addition to national or subregional indices, trends can be computed to indicate whether long term changes in bird populations are strongly increasing, moderately increasing, stable, uncertain, moderately declining or steep declining.

Known gaps and uncertainties in the Mediterranean

Neither bird populations nor monitoring capacity are distributed equally across the Mediterranean and, for this reason, it may be advisable to plan a phased development of pan-Mediterranean indices of population abundance for seabirds. The best approach is to build on the existing national biodiversity monitoring units, and to homogenise methodologies as initial steps. The extension of equivalent programmes across the whole of the Mediterranean region may be achieved in a second phase.

In terms of methodology, surveying colonies of nocturnal species situated in areas of difficult access may prove challenging. In these cases, it may be advisable to select certain areas or subsections of the total colony in order to obtain data on their abundance.

Contacts and version Date		
Key contacts within UNEP for further information		
Version No	**Date**	**Author**
V.1	07/2016	SPA/RAC

5. Common Indicator 5: Population demographic characteristics (e.g. body size or age class structure, sex ratio, fecundity rates, survival/mortality rates related to marine mammals, seabirds, marine reptiles) (EO1);

Marine Mammals:

Indicator Title	*Common Indicator 5: Population demographic characteristics*	
Relevant GES definition	**Related Operational Objective**	**Proposed Target(s)**
Cetaceans: species populations are in good condition: low human induced mortality, balanced sex ratio and no decline in calf production. Monk seal: species populations are in good condition: low human induced mortality, appropriate pupping seasonality, high annual pup production, balanced reproductive rate and sex ratio.	Population condition of selected species is maintained	Cetaceans: appropriate measures are implemented to mitigate incidental catch, prey depletion and other human induced mortality. Monk seal: decreasing trends in human induced mortality (e.g., direct killings).

Rationale

Justification for indicator selection

The objective of this indicator is to focus on the population demographic characteristics of marine mammals within the Mediterranean waters, with a special emphasis to those species selected by the Contracting Parties.

Demographic characteristics of a given population may be used to assess its conservation status by analysing demographic parameters, such as the age structure, age at sexual maturity, sex ratio and rates of birth (fecundity) and of death (mortality). These data are particularly difficult to obtain for marine mammals, (hence the reliance on demographic models, which imply several assumptions that may be violated).

The populations of long-lived and slow reproducing cetaceans are among the most critical conservation units. Therefore, a demographic approach can be very useful for their management and conservation.

Eleven species of cetaceans regularly occur in the Mediterranean area: short-beaked common dolphin (*Delphinus delphis*), striped dolphin (*Stenella coeruleoalba*), common bottlenose dolphin (*Tursiops truncatus*), harbour porpoise (*Phocoena phocoena*), long-finned pilot whale (*Globicephala melas*), rough-toothed dolphin (*Steno bredanensis*), Risso's dolphin (*Grampus griseus*), fin whale (*Balaenoptera physalus*), sperm whale (*Physeter macrocephalus*), Cuvier's beaked whale (*Ziphius cavirostris*) and killer whale (*Orcinus orca*). Two of these species have very limited numbers: the harbour porpoise, possibly representing a small remnant population in the Aegean Sea, and the killer whale, present only as a small population of a few individuals in the Strait of Gibraltar.

Knowledge about the distribution, abundance and habitat use and preferences of some of these species, (including the most abundant ones) is scant and limited to specific sectors of the Mediterranean Sea, due to the uneven distribution of research effort during the last decades. In particular, the south-eastern portion of the basin, the coasts of North Africa and the central offshore waters are among the areas with the most limited knowledge on cetacean presence, occurrence and distribution.

The conservation status of cetaceans in the Mediterranean Sea has been a source of concern for many years. Marine mammals living in the Mediterranean Sea find themselves in precarious conditions due to the intense human presence and activities in the region. These are the source of a variety of pressures that are threatening these species' survival. These animals are highly mobile and are usually not confined within single nations' jurisdictions, stressing the need for basin-wide conservation and protection efforts. Several threats affect marine mammals in the Mediterranean Sea and their effect on the population, distributional range and survival may act in a synergistic manner. Threats include interaction with fisheries, disturbance, injuries and fatal collisions from shipping, habitat loss and degradation, chemical pollution, anthropogenic noise, direct slaughter killings and climate change.

Scientific References

Chiquet, R. A. et al. 2013. Demographic analysis of sperm whales using matrix population models. - Ecol. Model. 248: 71–79.

Coll, M. et al. 2010. The Biodiversity of the Mediterranean Sea: Estimates, Patterns, and Threats. - PLoS ONE

Indicator Title	*Common Indicator 5: Population demographic characteristics*

5: e11842.
Estes, J. A. et al. 2009. Causes and consequences of marine mammal population declines in southwest Alaska: a food-web perspective. - Philos Trans R Soc Lond B Biol Sci 364: 1647–1658.
Fossi, M. C. and Marsili, L. 2003. Effects of endocrine disruptors in aquatic mammals. - Pure Appl. Chem. 75: 2235–2247.
Fossi, M. C. et al. 2014. Large filter feeding marine organisms as indicators of microplastic in the pelagic environment: The case studies of the Mediterranean basking shark (Cetorhinus maximus) and fin whale (Balaenoptera physalus). - Mar. Environ. Res. 100: 17–24.
Fujiwara, M. and Caswell, H. 2001. Demography of the endangered North Atlantic right whale. - Nature 414: 537–541.
Gaston, K. J. 2003. The Structure and Dynamics of Geographic Ranges. - Oxford University Press.
Hoffmann, A. A. and Blows, M. W. 1994. Species borders: ecological and evolutionary perspectives. - Trends Ecol. Evol. 9: 223–227.
Horning, M. and Mellish, J.-A. E. 2012. Predation on an Upper Trophic Marine Predator, the Steller Sea Lion: Evaluating High Juvenile Mortality in a Density Dependent Conceptual Framework. - PLoS ONE in press.
IUCN 2012. Marine mammals and sea turtles of the Mediterranean and Black Seas. - IUCN.
Jackson, J. A. et al. 2016. An integrated approach to historical population assessment of the great whales: case of the New Zealand southern right whale. - Open Sci. 3: 150669.
Lande, R. 1988. Genetics and demography in biological conservation. - Science 241: 1455–1460.
Lawton, J. H. 1993. Range, population abundance and conservation. - Trends Ecol. Evol. 8: 409–413.
McDonald-Madden, E. et al. 2016. Using food-web theory to conserve ecosystems. - Nat. Commun. in press.
New, L. F. et al. 2013. Using Energetic Models to Investigate the Survival and Reproduction of Beaked Whales (family Ziphiidae). - PLoS One 8(7): e68725. doi:10.1371/journal.pone.0068725.
Notarbartolo di Sciara, G. and Birkun, A., Jr 2010. Conserving whales, dolphins and porpoises in the Mediterranean and Black Seas: an ACCOBAMS status report, 2010: 212.
Phillips, C. D. et al. 2012. Molecular insights into the historic demography of bowhead whales: understanding the evolutionary basis of contemporary management practices. - Ecol. Evol. 3: 18–37.
Reese, G. C. et al. 2005. Factors Affecting Species Distribution Predictions: A Simulation Modeling Experiment. - Ecol. Appl. 15: 554–564.
Saracco, J. F. et al. 2013. Population Dynamics and Demography of Humpback Whales in Glacier Bay and Icy Strait, Alaska. - Northwest. Nat. 94: 187–197.
Schick, R. S. et al. 2013. Estimating resource acquisition and at-sea body condition of a marine predator. - J Anim Ecol 82(6):1300-15.
Schwarz, L. K. et al. 2013. Top-down and bottom-up influences on demographic rates of Antarctic fur seals Arctocephalus gazella. - J. Anim. Ecol. 82: 903–911.
Torres, L. G. et al. 2016. Demography and ecology of southern right whales Eubalaena australis wintering at sub-Antarctic Campbell Island, New Zealand. - Polar Biol.: 1–12.
van den Hoff, J. et al. 2014. Bottom-up regulation of a pole-ward migratory predator population. - Proc. Biol. Sci. 281: 20132842.
Villegas-Amtmann, S. et al. 2015. A bioenergetics model to evaluate demographic consequences of disturbance in marine mammals applied to gray whales. - Ecosphere 6: 1–19.
Wang, J. et al. 2016. A framework for the assessment of the spatial and temporal patterns of threatened coastal delphinids. - Sci. Rep. in press.
Whitehead, H. and Gero, S. 2014. Using social structure to improve mortality estimates: an example with sperm whales. - Methods Ecol. Evol. 5: 27–36.
Whitehead, H. and Gero, S. 2015. Conflicting rates of increase in the sperm whale population of the eastern Caribbean: positive observed rates do not reflect a healthy population. - Endanger. Species Res. 27: 207–218.

Policy Context and targets (other than IMAP)

Policy context description

Mediterranean fin whales and sperm whales are protected by the International Whaling Commission's moratorium on commercial whaling that entered into force in 1986.

The Mediterranean cetaceans' populations are also protected under the auspices of ACCOBAMS (Agreement on the Conservation of Cetaceans of the Black Sea, Mediterranean Sea and contiguous Atlantic Area), under the auspices of the Convention on the Conservation of Migratory Species of Wild Animals (UNEP/CMS). The Corso-Ligurian-Provençal Basin and the Tyrrhenian Sea, where most cetacean species find suitable habitats, lie within the Pelagos Sanctuary established by France, Italy and Monaco, thus benefitting from its conservation regime.

Indicator Title	*Common Indicator 5: Population demographic characteristics*

All cetacean species in the Mediterranean Sea are protected under the Annex II of the SPA-BD Protocol under the Barcelona Convention; under the Appendix I of the Bern Convention; under the Annex II of the Washington Convention (CITES); under the Appendix II of the Bonn Convention (CMS).
The short-beaked common dolphin, the sperm whale and the Cuvier's beaked whale and the monk seal are also listed under the Appendix I of the Bonn Convention (CMS).
The common bottle dolphin, the harbor porpoise and the monk seal are also listed under the Annex II of the EU Habitats Directive.

Indicator/Targets
Aichi Biodiversity Target 1, 3
EU Regulation 812/2004 concerning incidental catches of cetaceans in fisheries
EU MSFD Descriptor 1 and 4
EU Habitats Directive
The obligations under ACCOBAMS

Policy documents
- Aichi Biodiversity Targets - https://www.cbd.int/sp/targets/
- EU Biodiversity Strategy - http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52011DC0244&from=EN
- EU Regulation 1143/2014 - http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32014R1143&from=EN
- Marine Strategy Framework Directive - http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32008L0056&from=EN
- Commission Decision on criteria and methodological standards on good environmental status of marine waters - http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32010D0477(01)&from=EN
- Pan-European 2020 Strategy for Biodiversity - https://www.google.no/url?sa=t&rct=j&q=&esrc=s&source=web&cd=2&cad=rja&uact=8&ved=0ahUKEwiP1J-v_P7NAhWHjSwKHZfoBRIQFggtMAE&url=https%3A%2F%2Fcapacity4dev.ec.europa.eu%2Fsystem%2Ffiles%2Ffile%2F08%2F10%2F2012_-_1535%2Fpan-european_2020_strategy_for_biodiversity.pdf&usg=AFQjCNGa4NkkljA4x3l9WDO49uwrdYafMg
- Strategic Action Programme for the conservation of Biological Diversity (SAP BIO) in the Mediterranean Region - http://sapbio.rac-spa.org/
- Draft Updated Action Plan for the conservation of Cetaceans in the Mediterranean Sea - http://rac-spa.org/nfp12/documents/working/wg.408_08_eng.pdf
- National Biodiversity Strategies and Action Plans (NBSAPs) - https://www.cbd.int/nbsap/
- ACCOBAMS –Agreement Text - http://www.accobams.org/images/stories/Accord/anglais_text%20of%20the%20agreement%20english.pdf
- ACCOBAMS STRATEGY (PERIOD 2014 – 2025) - https://accobams.org/images/stories/MOP/MOP5/Documents/Resolutions/mop5.res5.1_accobams%20strategy.pdf

Indicator analysis methods

Indicator Definition
This indicator is aimed at providing information about the population demographic characteristics of marine mammals in the Mediterranean Sea. It is intended to assess trends in abundance and density over time and space of cetaceans and monk seals that are present in Mediterranean waters, with a special focus on the species selected by the Parties.
Monitoring effort should be directed to collect long-term data series covering the various life stages of the selected species. This would involve the participation of several teams using standard methodologies and covering sites of particular importance for the key life stages of the target species.
While some demographic studies have been conducted using industrial whaling data on Northeast Atlantic populations, little is known about the demography of their counterparts in the Mediterranean, where industrial whaling has never occurred.
The preliminary classical tools for demographic analyses are life tables, accounting for the birth rates and probabilities of death for each vital stage or age class in the population. A life table can be set out in different ways:
1) following an initial age class (i.e. cohort) from birth to the death of the last individual. This approach allows to set out a cohort life table and is generally applied on sessile and short-lived populations;
2) counting population individuals grouped by age or by stages in a given time period. This approach allows the compilation of a static life table that is appropriate with long-lived or mobile species;

Indicator Title	*Common Indicator 5: Population demographic characteristics*

3) analysing the age or stage distribution of individuals at death. This approach allows the development of a mortality table, using carcasses from stranding data.

Methodology for indicator calculation

The monitoring effort to address this Common Indicator is expected to provide data allowing the assessment at regional or sub-regional scales of the selected species. The main outputs of the monitoring will be data on:

- Age structure
- Sex ratio
- Fecundity
- Mortality

Photo-identification is one of the most powerful techniques to investigate cetacean populations. Information on group composition, area distribution, inter-individual behaviour and short and long-term movement patterns can be obtained by the recognition of individual animals. Long-term datasets on photo-identified individuals can provide information on basic life-history traits, such as age at sexual maturity, calving interval, reproductive and total life span. The mark-recapture technique can also be applied to obtain estimates of population size.

Indicator units

The main demographic parameters are defined in the following units:

- adult survival probability: range between 0 and 1
- juvenile survival probability: range between 0 and 1
- fecundity, or breeding productivity: average no. of young produced per breeding pair per year
- age class distribution: percentage of each age class
- sex ratio: percentage

List of Guidance documents and protocols available

- A document on 'MONITORING GUIDELINES TO ASSESS CETACEANS' DISTRIBUTIONAL RANGE, POPULATION ABUNDANCE AND POPULATION DEMOGRAPHIC CHARACTERISTICS' has been produced by ACCOBAMS and should be considered for guidance when establishing monitoring programmes.
- Guidelines for monitoring threatened population of marine and coastal bird species in the Mediterranean[2].
- RAC/SPA-ACCOBAMS Guidelines for the Development of National Networks of Cetacean Strandings Monitoring[3].

Data Confidence and uncertainties

Sex and length at death may come from stranded animals. This information may be uneven, since in many cases sex and exact size measurements may be unprecise due animal decomposition.

Dealing with stranded data implies several assumptions, the main one being that stranding data represent a faithful description of the real mortality by different life stages. This assumption, however, is true only if the probability of stranding is equal in all life stages.

Estimating age and length from free-ranging individuals may be rather difficult and increase the uncertainties in the models. Long-term data sets on known individuals through photo-identification may overcome some of the biases.

Methodology for monitoring, temporal and spatial scope

Available Methodologies for Monitoring and Monitoring Protocols

Several protocols are available using different monitoring platforms and approaches such as:

- Direct observation
- Stranded animal monitoring
- Dedicated ships surveys
- By-catch data
- Photo-identification (mark-recapture models)
- Automatic infrared camera

Available data sources

- OBIS-SEAMAP, Ocean Biogeographic Information System Spatial Ecological Analysis of Megavertebrate Populations, is a spatially referenced online database, aggregating marine mammal, seabird, sea turtle and ray & shark observation data from across the globe. http://seamap.env.duke.edu/

[2] UNEP/MAP - RAC/SPA, 2012. Guidelines for Management and Monitoring Threatened Population of Marine and Coastal Bird Species and their Important Areas in the Mediterranean. By Joe Sultana. Ed. RAC/SPA, Tunis. 24pp.

[3] http://www.rac-spa.org/sites/default/files/doc_cetacean/stranding.pdf

Indicator Title	*Common Indicator 5: Population demographic characteristics*
• When existing, the databases from the National Stranding Networks, such as in Italy the CSC (Cetacean Study Centre) database, available online at http://www-3.unipv.it/cibra/spiaggiamenti.html or in France, the Pelagis Observatory database (http://www.observatoire-pelagis.cnrs.fr/les-donnees/). • The Mediterranean Database of Cetacean Strandings (MEDACES), has been established to co-ordinate all national and regional efforts for riparian countries. Cetacean stranding data are organized into a spatially referenced database of public access. • International Whaling Commission List of Stranding Networks (as at 13 April 2011) https://iwc.int/private/downloads/fECe-nYMEKa7G5C8RRCqKg/WHALE%20STRANDING%20NETWORKS%20LIST_2011.pdf	
Spatial scope guidance and selection of monitoring stations Current knowledge of spatial distributional range of marine mammals in the Mediterranean Sea is largely affected by available data, due to the uneven distribution of research effort during the last decades. In particular, the south-eastern portion of the basin, the coasts of North Africa and the central offshore waters are amongst the areas with the most limited knowledge on cetacean presence, occurrence and distribution. Priority should be given to the less known areas, using online data sources, such as Obis SeaMap and published data and reports as sources of information.	
Temporal Scope guidance Demographic studies on marine mammals, which are long-living species, require long-term projects, to allow robust indications on trends in population size and demographic parameters over time.	
Data analysis and assessment outputs	
Statistical analysis and basis for aggregation Simple demographic models based on the pre-defined life-tables can be used to create a complete mortality table for the population under examination. Continuous age distribution and constant mortality rates within each stage, under the assumption of population stationarity (i.e. the population is assumed to be constant in number and age structure over time) can be used.	
Expected assessments outputs Demographic studies can supply useful tools to the management and the conservation of threatened and overexploited species. Population models (based on life-history tables and transition matrices), allow the assessment of population performance, the projection of population trends overtime, thus fostering the conservation of the studied populations, suggesting specific measures for their protection.	
Known gaps and uncertainties in the Mediterranean Data in the Mediterranean Sea are characterized by their uneven distribution, both geographical and spatial. The summer months are the most representative ones. Very little information has been provided for the winter months, when conditions to conduct off-shore research campaigns are particularly hard due to meteorological adversity. Ongoing effort is targeting the identification of Cetacean Critical Habitats (CCHs) and Important Marine Mammal Areas (IMMAs) in the entire Mediterranean Sea. A gap analysis is also being conducted within the Mediterranean Sea, to provide an inventory of available data and to select areas where more information should be collected.	
Contacts and version Date	
Key contacts within UNEP for further information	

Version No	**Date**	**Author**
V.1	20/07/2016	SPA/RAC

Reptiles:

Indicator Title	*Common indicator 5: Population demographic characteristics (Reptiles)*	
Relevant GES definition	**Related Operational Objective**	**Proposed Target(s)**
Low mortality induced by incidental catch, Favorable sex ratio and no decline in hatching rate	Population condition of selected species is maintained	**Response** Measures to mitigate incidental catches in turtles implemented
Rationale		
Justification for indicator selection Demography is used in ecology (particularly population and evolutionary ecology) as the basis for population studies. Demography information: - helps to identify the stage(s) in the life cycle that affect(s) most population growth.		

Indicator Title	*Common indicator 5: Population demographic characteristics (Reptiles)*

- may be applied to conservation/exploitation (e.g. fisheries management).
- may be used to assess potential competitive abilities, colonization.
- may be used as a basis for understanding the evolution of life history traits.
- may be used to indicate fitness with respect to the surrounding environment

Scientific References

Bevan E, Wibbels T, Navarro E, Rosas M, Najera BMZ, Sarti L, Illescas F, Montaro J, Pena LJ, Burchfield P. 2016. Using Unmanned Aerial Vehicle (UAV) Technology for Locating, Identifying, and Monitoring Courtship and Mating Behavior in the Green Turtle (*Chelonia mydas*). Herpetological Review, 47(1), 27–32.

Casale, P., D. Freggi, R. Basso, R. Argano. 2005. Size at male maturity, sexing methods and adult sex ratio in loggerhead turtles (*Caretta caretta*) from Italian waters investigated through tail measurements. J. Herpetol. 15, 145–148

Casale P. 2010. Sea turtle by-catch in the Mediterranean. Fish and Fisheries. doi:10.111/j. 1467-2979.2010.00394

Demography Working Group of the Conference. Demography of marine turtles nesting in the Mediterranean Sea: a gap analysis and research priorities - 5th Mediterranean Conference on Marine Turtles, Dalaman, Turkey, 19-23 April 2015. Document T-PVS/Inf(2015)15E Presented at the Convention on the conservation of European wildlife and natural habitats - 35th meeting of the Standing Committee - Strasbourg, 1 - 4 December 2015 (2015)

Gerosa, G. and P. Casale. 1999. Interaction of marine turtles with fisheries in the Mediterranean. UNEP/MAP, RAC/SPA: Tunis, Tunisia. 59pp

Groombridge, B. 1990. Marine turtles in the Mediterranean: distribution, population status, conservation. A report to the Council of Europe, Environment and Management Division. Nature and Environment Series, Number 48. Strasbourg 1990

Hays GC, Mazaris AD, Schofield G. 2014. Different male versus female breeding periodicity helps mitigate offspring sex ratio skews in sea turtles. Frontiers in Marine Science 1, 43 doi: 10.3389/fmars.2014.00043

Laurent, L., E. M. Abd El-Mawla, M. N. Bradai, F. Demirayak, A. Oruc. 1996. Reducing sea turtle mortality induced by Mediterranean fisheries. Trawling activity in Egypt, Tunisia and Turkey. Report for the WWF International Mediterranean Program. WWF project 9E0103.

Laurent, L., P. Casale, M.N. Bradai, B.J. Godley, G. Gerosa, A.C. Broderick, W. Schroth, B. Schierwater, A.M. Levy, D. Freggi, E.M. Abd El-Mawla, D.A. Hadoud, H.E. Gomati, M. Domingo, M. Hadjichristophorou, L. Kornaraky, F. Demirayak and Ch. Gautier. 1998. Molecular resolution of marine turtle stock composition in fishery bycatch: a case study in the Mediterranean. Mol. Ecol., 7: 1529-1542.

Rees, A.F., D. Margaritoulis, R. Newman, T.E. Riggall, P. Tsaros, J.A. Zbinden, B.J Godley. 2013. Ecology of loggerhead marine turtles *Caretta caretta* in a neritic foraging habitat: movements, sex ratios and growth rates. MarBiol 160:519-529.

Policy Context and targets (other than IMAP)

Policy context description

Similar to the Ecosystem Approach, the EU adopted the European Union Marine Strategy Framework Directive (MSFD) on 17 June 2008, which includes GES definitions, Descriptors, Criteria, Indicators and Targets. In the Mediterranean region, the MSFD applies to EU member states. The aim of the MSFD is to protect more effectively the marine environment across Europe. In order to achieve GES by 2020, each EU Member State is required to develop a strategy for its marine waters (or Marine Strategy). In addition, because the Directive follows an adaptive management approach, the Marine Strategies must be kept up-to-date and reviewed every 6 years.

The MSFD includes Descriptor 1: Biodiversity: “The quality and occurrence of habitats and the distribution and abundance of species are in line with prevailing physiographic, geographic and climatic conditions.” Assessment is required at several ecological levels: ecosystems, habitats and species. Among selected species are marine turtles and within this framework, each Member State that is within a marine turtle range, has submitted GES criteria, indicators, targets and a program to monitor them.

The MSFD will be complementary to, and provide the overarching framework for, a number of other key Directives and legislation at the European level. Also it calls to regional cooperation meaning “cooperation and coordination of activities between Member States and, whenever possible, third countries sharing the same marine region or subregion, for the purpose of developing and implementing marine strategies” […] “thereby facilitating achievement of good environmental status in the marine region or subregion concerned”.

Indicator/Targets

Commission Decision 2010/477/EU sets out the MSFD’s criteria and methodological standards and under Descriptor 1 includes criteria “1.3. Population condition” and indicators “Population demographic

Indicator Title	*Common indicator 5: Population demographic characteristics (Reptiles)*

characteristics (e.g. body size or age class structure, sex ratio, fecundity rates, survival/mortality rates) (1.3.1)" and "Population genetic structure, where appropriate (1.3.2)".

At a country scale, Descriptor 1 criteria have been applied:

Greece

*page 15: (Section 3. D1, D4 and D6 (Biodiversity), III. Environmental targets, 1. Descriptor 1*Environmental targets:

*[…]*2) Census of marine turtle *Caretta caretta* reproducing in the Greek coasts and conservation of spawning areas.

Associated indicators:

*[…]*2) Breeding area of the Mediterranean monk seal *Monachus monachus* and the sea turtle *Caretta caretta*

Italy

page 18: (Section 3.D1, D4 and D6 (Biodiversity), III. Environmental targets, 3.1 Descriptor 1

Italy has provided six targets and associated indicators *[…]* The second target focuses on the loggerhead turtle, and has the aim of decreasing accidental mortalities by regulating fishing practices. The target has several components which aim to acquire increased knowledge and to implement regulatory practices (it is not clear whether these practices are already in place). No targets or threshold values are otherwise given. The target is stated as being based on the completion of indicator 1.1.2 (which is not addressed for GES but is included in the initial assessment).

[…]

T2: By-catch reduction in the areas of aggregation of *Caretta caretta*

It is proposed that the operative target for the mitigation of *Caretta caretta* by-catch be articulated as follows:

1) Spatial identification of the areas with highest use of pelagic longline (southern Tyrrhenian and southern Ionian sea) and trawling (northern Adriatic)

2) Completion of the spatial definition of *Caretta caretta* aggregation areas based on an approach capable of assessing temporal and seasonal distribution differences for each aggregation area (based on indicator 1.1.2 completion) so as to provide a final definition of the operative target

3) Monitoring of accidental captures in the areas subjected to operational target

4) Application of by-catch reduction measures in areas listed in point 3), through one or more of the following activities:

- Application of methods for the mitigation of accidental capture in pelagic surface longlines and trawling nest through structural modifications to the gear (i.e. circle hooks, TEDs etc.) and application of best practices for the reduction of mortality following capture (percentage). Note: in order to allow an immediate reduction of the pressure it is advised that best practices be applied in the geographic areas where preliminary knowledge already defines the presence of an aggregation area, before defining the incidence of total capture in the specific gear.
- Reduction of fishing pressure (percentage)

Spain

Page 25: Section 3. D1, D4 and D6 (Biodiversity), III. Environmental targets

A.1.4: Reduce the main causes of mortality and of reduction of the populations of groups of species at the top of the trophic web (marine mammals, reptiles, sea birds, pelagic and demersal elasmobranchs), such as accidental capture, collisions with vessels, intaking of litter at sea, introduced terrestrial predators, pollution, habitat destruction, overfishing.

[…]

A.1.7: Establish a national coordination system of the accidental catch monitoring programmes of birds, reptiles, marine mammals, and mammal and reptile stranding and bird tracking.

[…]

A.3.4: Maintain positive or stable trends for the populations of key species or apex predators (marine mammals, reptiles, seabirds and fish) and maintain commercially exploited species within safe biological limits.

[…]

C.1.2: Promote international cooperation on studies and monitoring of populations of groups with broad geographic distribution (e.g. cetaceans and reptiles)

Slovenia

No information on Targets

page 10: (Section 3. D1, D4 and D6 (Biodiversity), I. Good Environmental Status (GES), 1.1 Descriptor 1)

Indicator Title	*Common indicator 5: Population demographic characteristics (Reptiles)*

In the accompanying text to the GES definition, Slovenia provides a list of the species that are covered by the GES definition. This includes the bottlenose dolphin (*Tursiops truncatus*), the loggerhead sea turtle (*Caretta caretta*).
Section 3. D1, D4 and D6 (Biodiversity), II. Initial assessment, 2.2 Biological features)
Species/functional groups
Slovenia indicates that *[…]* turtles are covered under the reporting obligations of the Habitats Directive *[…]*. Each of these groups is briefly described and their state in relation to natural conditions is reported.

Cyprus
No information on Targets
page 11: (Section 3. D1, D4 and D6 (Biodiversity), II. Initial assessment, 2.2 Biological features)
[…] Chelonia mydas and *Monachus monachus* are considered stable but the situation of *Caretta caretta* is actually improving.

Source: National Reports on Article 12 Technical Assessment of the MSFD 2012 obligations
http://ec.europa.eu/environment/marine/eu-coast-and-marine-policy/implementation/pdf/national_reports.zip

Policy documents
http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32010D0477(01)
http://ec.europa.eu/environment/marine/good-environmental-status/descriptor-1/index_en.htm
http://ec.europa.eu/environment/marine/eu-coast-and-marine-policy/implementation/reports_en.htm
http://ec.europa.eu/environment/marine/pdf/1-Task-group-1-Report-on-Biological-Diversity.pdf
http://ec.europa.eu/environment/marine/pdf/9-Task-Group-10.pdf

Indicator analysis methods

Indicator Definition
Demography is the study of various population parameters. Demography provides a mathematical description of how such parameters change over time. Demographics may include any statistical factors that influence population growth or decline, but several parameters are particularly important: population size, density, age structure, fecundity (birth rates), mortality (death rates), and sex ratio.

Methodology for indicator calculation
The same methods should be used as those described in "*Common Indicator 4: Population abundance (Reptiles)*"; however, additional data are required to assess demography, such as age at sexual maturity, growth rate and age structure, fecundity (clutch size and numbers of hatchlings that emerge from nests and then reach the sea), mortality (death rates) for each stage/age class, sex ratios (in turtles: hatchling, juveniles, and adults), number of offspring (e.g. eggs and hatchlings).

The choice of the most appropriate methodology to calculate the different types of demographic information will depend on the temporal pattern of the available data. The methods to obtain the data used in the calculations are described in the monitoring methods below.

For data available on an annual basis, site and year specific data of each species can be related to site and year effects (factors) and missing values can be imputed from the data of all surveyed sites.

Indicator units

A variety of population demography values will be compiled for different components of the populations of the two species. Analyses should be based on at least a decade of information as the base level (following International Union for Conservation of Nature Red List minimal criteria for sea turtles).

Number of individuals in relation to population estimates per population range or management unit, per year, per age and per sex
- Mortality rate from by-catch, stranding
- Breeding success/failure of marine turtles (Number of eggs that fail to hatch at marine turtle nesting sites per year. Number of emergences versus successful nests)
- Annual survival probability of adults and juveniles (i.e. different age/size classes) at different sites (breeding, feeding, wintering, developmental)

Indicator Title	*Common indicator 5: Population demographic characteristics (Reptiles)*

- Sex ratio of turtles of all age/size classes from hatchings to juveniles to breeding and non breeding adults at wintering, breeding, foraging and developmental sites.

Sex ratios within different components of a population
Physical health indicators
Genetic health indicators
Numbers of individuals entering and leaving different components of populations through dispersal/migration or birth/mortality.
Numbers of individuals killed through causes that are not natural in parallel to information on the age/size class of individuals and sex to determine sex/age/size specific mortality.

List of Guidance documents and protocols available

Bevan E, Wibbels T, Rosas M, Najera BMZ, Sarti L, Montano J, Pena LJ, Burchfield P. Herpetological Review, 2016, 47(1), 27–32.

Eckert, K. L., Bjorndal, K. A., Abreu-Grobois, F. A. and Donnelly, M. (Eds.) 1999. Research and Management Techniques for the Conservation of Sea Turtles. IUCN/SSC Marine Turtle Specialist Group Publication No. 4. Washington, DC: 235 pp. https://mtsg.files.wordpress.com/2010/11/techniques-manual-full-en.pdf

Gerosa, G. (1996). Manual on Marine Turtle Tagging in the Mediterranean. –Mediterranean Action Plan - UNEP, RAC/SPA, Tunis, 48 pp.

Gerosa, G. and M. Aureggi. 2001. Sea Turtle Handling Guidebook for Fishermen. UNEP Mediterranean Action Plan, Regional Activity Centre for Specially Protected Areas. Tunis. http://www.rac-spa.org

McClellan DB. 1996. Aerial surveys for sea turtles, marine mammals and vessel activity along the south east Florida coast 1992-1996. NOAA Technical Memorandum NMFS-SEFSC-390 42pp

Phelan, Shana M. and Karen L. Eckert. 2006. Marine Turtle Trauma Response Procedures: A Field Guide. Wider Caribbean Sea Turtle Conservation Network (WIDECAST) Technical Report No. 4. Beaufort, North Carolina.71 pp

Schofield, G., K.A. Katselidis, P. Dimopoulos, J.D. Pantis. 2008. Investigating the viability of photo-identification as an objective tool to study endangered sea turtle populations. Journal of Experimental Marine Biology & Ecology 360:103-108

SWOT Scientific Advisory Board. 2011. The State of the World's Sea Turtles (SWOT) Minimum Data Standards for Nesting Beach Monitoring, version 1.0. Handbook, 28 pp

Data Confidence and uncertainties

Life history studies and demographic analyses need extensive and, often, long-term data accumulation from either carcass collection or capture-mark-recapture (tagging or photo-id) histories, or a combination of several different techniques. In general, these studies may be implemented by different research teams that use different sampling and analysing processes. However, demographic parameters must be collected in a standard way among different research groups.

Methodology for monitoring, temporal and spatial scope

Available Methodologies for Monitoring and Monitoring Protocols

- Shipboard, aerial (including drone), or diver-based/video/acoustic (potential). Aerial or boat line transects surveys under specific circumstances, with the appropriate modelling techniques to account for missed animals (i.e. due to low surfacing time and low frequency of time spent at the surface)
- Artificial external flipper tagging (metal and plastic on flippers),
- Photo-identification
- Genetic sampling identification within the metapopulation
- PIT tagging of flippers, Telemetry (satellite, GPS/GSM, radio telemetry) and loggers, capture-mark-recapture studies
- Swimming/snorkeling surveys with photo-id and GPS in densely populated areas (e.g. certain breeding sites)
- CPUE (bycatch), Direct mortality rate Post-release mortality rate
- Nest counts, Photo-id of individuals, Time-Depth-Recorder tags
- Stranding on beaches

Aerial or boat surveys (line transects) under specific circumstances, with the appropriate modelling techniques to account for missed animals (i.e. due to low surfacing time and low frequency of time spent at the surface)
Artificial external flipper tagging (metal and plastic on flippers),
Photo-identification
PIT tagging of flippers, Telemetry (satellite, GPS/GSM, radio telemetry) and loggers, capture-mark-recapture

Indicator Title	*Common indicator 5: Population demographic characteristics (Reptiles)*

studies
Shipboard, aerial (including drone), or diver-based/video/acoustic (potential)
Swimming/snorkelling surveys with photo-id and GPS in densely populated areas (e.g. certain breeding sites)

Stranding and beached individual census':
Provide biometrics, tissue sampling and analysis (necropsies or biopsies). Such studies may determine the cause of mortality, contamination, age, sex, health and size measurement. Live and (fresh) dead animals that are captured/located should be subjected to a standardised program to confirm sex (laparoscopy where necessary, e.g. non-adult stages of sea turtles), collect blood, skin and tissue samples for genetic analyses and determine origin within the meta-population, the health and presence of any contaminants in animals, along with other micro-biological techniques. Such information would help determine the genetic origin and diversity. This is particularly important to prioritise populations, because turtles from different rookeries in the Mediterranean belong to several genetically isolated groups, leading to some being highly isolated and at threat of loss. Also, stranded animals potentially serve as indicators of ocean health due to the effects of toxins building in the bodies of animals from higher trophic classes.

Biometrics**:**
Body size of sea turtles can be indicative of the health status or age structure of populations. For adult sea turtles, tail length may be used as an indicator of sex. Measurements are obtained by:
Estimates made from photos.
Measurement of stranded specimens.
Measurement in case of capture-recapture.
For turtles, also, measurements of females during nesting on beaches, or of all size classes during capture at in water or by-catch surveys at breeding/foraging/wintering/developmental grounds, which also allows individuals to be sexed.

Age structure:
Individuals could be sorted into age-specific categories called cohorts or age/stage classes (such as "juveniles" or "sub-adults"). Then, a profile of the abundance and different age classes can be created. The demographic structure may provide an estimate of the annual survival probability and/or reproductive potential of that population, which is critical information along with other parameters, from which current and future growth may be estimated.

- Age class identification in censuses and transects (based on size class estimates).
- Aging of stranded specimens (skeletochronology and/or age-size correlation sea turtles).
- Aging of beached specimens (skeletochronology and/or age-size correlation sea turtles).
- Aging of tagged (capture and recapture) specimens: size correlation for sea turtles.

Sex ratio:
The sex ratio is the ratio between the number of males and females within a population and across all age (size) classes, and may help researchers predict population growth or decline. Much like population size, sex ratio is a simple concept with major implications for population dynamics.

- Sex identification of adults in census and transects (juveniles and sub-adults require other techniques such as laparoscopy, blood analysis, genetic analysis).
- Sexing of stranded specimens (size, blood or genetic analysis, laparoscopy).
- Sexing of tagged (capture and recapture) (size, blood or genetic analysis, laparoscopy).
- Sexing of offspring before leaving the nest, and at different growth stages until maturity (blood or genetic analysis)

Fecundity (birth/hatch rates):
This parameter describes the number of offspring an individual or a population is able to produce during a given period of time. Fecundity is calculated in age-specific birth/hatch rates, which may be expressed as the number of births per unit of time, the number of births/hatchlings per female per unit of time, or the number of births/hatchlings per individuals per unit of time.
For sea turtles, the ability of females to create nests also serves as an indicator of female fitness; thus, the number of emergences versus successful nests on beaches also represents an important indicator.

Mortality (death rates):

Indicator Title	*Common indicator 5: Population demographic characteristics (Reptiles)*

This parameter is the measure of individual deaths in a population and serves as the counterbalance to fecundity, and is usually expressed as the number of individuals that die in a given period (deaths per unit time) or the proportion of the population or an age-class group that dies in a given period (percent deaths per unit time). The parameter should also give an indication on the type of mortality if it is natural, due to fishing or bycatch etc. In cases of collecting and analysing biological samples to determine sex and health status, studies should be coordinated with the proposed sampling for EO10.

Available data sources

Adriatic Sea Turtle Database. http://www.adriaticseaturtles.eu/

Casale P. and Margaritoulis D. (Eds.) 2010. Sea Turtles in the Mediterranean: Distribution, Threats and Conservation Priorities. IUCN/SSC Marine Turtle Specialist Group. Gland, Switzerland: IUCN, 294 pp. http://iucn-mtsg.org/publications/med-report/

Halpin, P.N., Read, A.J., Fujioka, E., et al., 2009. OBIS-SEAMAP the world data center for marine mammal, sea bird, and sea turtle distributions. Oceanography 22, 104–115.

I3S. Sea turtle photo identification database. http://www.reijns.com/i3s/

The state of the World's Sea Turtles online database: data provided by the SWOT team and hosted on OBIS-SEAMAP (Ocean Biogeographic Information System Spatial Ecological Analysis of Megavertebrate Populations). In: Oceanic Society, Conservation International, IUCN Marine Turtle Specialist Group (MTSG), and Marine Geospatial Ecology Lab, Duke University. http://seamap.env.duke.edu

Margaritoulis, D., Argano, R., Baran, I., Bentivegna, F., Bradai, M.N., Caminas, J.A., Casale, P., Metrio, G.D., Demetropoulos, A., Gerosa, G., Godley, B.J., Haddoud,D.A., Houghton, J., Laurent, L. & Lazar, B. (2003) Loggerhead turtles in the Mediterranean Sea: present knowledge and conservation perspectives. Loggerhead sea turtles (ed. by B.E. Witherington), pp. 175–198. Smithsonian Institution, Washington

PITMAR. Sea turtle photo-identification database. http://www.pitmar.net/index.php/en/

Seaturtle.org – Global Sea Turtle Network. Sea turtle tracking. Sea turtle nest monitoring. http://www.seaturtle.org/

The Reptile Database: Location of juvenile loggerheads and greens in the Eastern Mediterranean. http://reptile-database.reptarium.cz/species?genus=Caretta&species=caretta

Mediterranean marine research centres, NGOs, universities and institutions, local and national sea turtle monitoring projects. Governmental Ministries

IUCN specialists (MTSG)

Sea Turtle Tag Inventory. Archie Carr Center for Sea Turtle Research, University of Florida https://accstr.ufl.edu/resources/tag-inventory

Marine Turtle DNA Sequences Database. Archie Carr Center for Sea Turtle Research, University of Florida. https://accstr.ufl.edu/resources/mtdna-sequences

Spatial scope guidance and selection of monitoring stations

A number of sites should be selected that represent a sufficiently large proportion of the subregional or national population for demographic data to be collected (reflecting the breeding, wintering, foraging and developmental populations that are representative of the region). If possible, populations should be selected where animals have been tracked with a sufficient number of units (i.e. >50 individuals), from which the connectivity among these different habitat types can be established. The selected breeding sites should aim to be genetically diverse, so as this diversity can be detected at foraging/wintering/developmental grounds where different populations diverge. This will facilitate the selection of marine areas for protection that support the highest genetic diversity (i.e. the greatest accumulation of different breeding populations), as well as those that support single breeding populations, which may be of equal importance.

Opportunistic data should be collected from all possible sources, wherever possible, and compiled into a single database, which might be used to provide an overview of the entire area.

Temporal Scope guidance

Annual – breeding surveys at selected sites to determine adult male and female sex ratios (operational sex ratios), recruitment, mortality and longevity of breeding, as well as genetic structure and physical health indices (April-July). In parallel, data on offspring should also be collected (July to October), to determine the number of individuals and ratio of offspring entering the population. This is the only point until adulthood that the offspring are in a single place and not mixed with other breeding populations at developmental/feeding sites.

Annual – winter censuses at selected sites to estimate the age/size class, sex ratio of adults, recruitment and dispersal of individuals, as well as genetic structure and physical health indices (expect mixing of turtles from different breeding populations) of individuals (October to April)

Indicator Title	*Common indicator 5: Population demographic characteristics (Reptiles)*
Annual – foraging/developmental censuses at selected sites to estimate the age/size class, sex ratio of adults, recruitment and dispersal of individuals, as well as genetic structure and physical health indices (expect mixing of turtles from different breeding populations) of individuals (January-December).	
Data analysis and assessment outputs	
Statistical analysis and basis for aggregation At present, specific demographic parameters are not regularly assessed to a similar level of female/nest counts, due to the data intensive nature of this component. Many programs assess clutch success (i.e. the number of eggs that hatch from a clutch); however, this represents a small component. Research on offspring sex ratios, juvenile sex ratios, adult (operational) sex ratios is intermittent and based on different fieldwork approaches/methods and analytical techniques depending on the objective (usually, aiming towards a journal publication). Most studies that do exist are focused on the breeding areas; thus, greater focus is required at foraging, wintering and developmental areas, with in-water limitations needing to be accounted for in analyses. Therefore, set analyses need to be established that are applicable within and/or across the different habitat types to allow comparison at the Mediterranean level.	
Expected assessment outputs Knowledge about the sex, health and genetic structure of the different populations/subpopulations will be obtained, by understanding recruitment and mortality within different parts of a population and across populations. This information is important to understand whether there are sex-specific mortality risks at different age/size classes, which is important towards aiding population recovery. Also, knowledge on the physical health and genetic health of populations will be obtained, which will indicate the capacity for resilience to human activities, including climate change.	
Known gaps and uncertainties in the Mediterranean • Knowledge on the sex ratios within different components (breeding, foraging, wintering, developmental habitats), age classes and overall within and across populations. • Knowledge about the physical and genetic health status of these groups. • Vulnerability/resilience of these populations/sub-populations in relation to physical pressures; • Analysis of pressure/impact relationships for populations/sub-populations and definition of qualitative GES; • Identification of extent (area) baselines for each population/subpopulation and the habitats they encompass; • Criteria for the risk based approach to monitoring and develop harmonized sampling instructions where appropriate; • Common computing methodologies and data collection instructions, specifying the accuracy (spatial resolution or grid) of the determination of extent (area) a priori; • Appropriate assessment scales; • Standardized data flows for spatial pressure data; • GES baselines for sites that cannot be inferred from contemporary records of pressure or construction; • Harmonised sampling, cartographic, data collation and GIS protocols • Generation or update of databases and maps of known nesting, feeding, wintering habitats in each Contracting Party • Identify possible baselines and index sites. • Identify monitoring capacities and gaps in each Contracting Party • Develop a guidance manual to support the monitoring programme, which will provide more detailed information, tools, and advice on survey design, monitoring methodology and techniques that are the most cost-effective and applicable to each of the selected sea turtle species, in order to ultimately ensure standardized monitoring, comparable data sets, reliable estimates and trend information. • Identification techniques to monitor and assess the impacts of climate change. • Development monitoring synergies in collaboration with GFCM for- EO3 (Harvest of commercially exploited fish and shellfish), to collect data via sea turtle by-catch • Investigation monitoring synergies with other relevant EOs that will include coast-based fieldwork, in relation to monitoring of new/unknown sea turtle nesting beaches, and of beached/stranded animals, to obtain more widespread information • Neither turtle populations nor monitoring capacity are distributed equally across the Mediterranean and, for this reason, it may be advisable to plan a phased development of pan-Mediterranean indices of	

Indicator Title	*Common indicator 5: Population demographic characteristics (Reptiles)*	
population demography for sea turtles. The best approach is to build on the existing national biodiversity monitoring units, and to homogenise methodologies as initial steps. The extension of equivalent programmes across the whole of the Mediterranean region may be achieved in a second phase.		
Contacts and version Date		
Key contacts within UNEP for further information		
Version No	**Date**	**Author**
V.1	20/7/2016	SPA/RAC

Seabirds:

Indicator Title	*Common indicator 5: Population demographic characteristics (Seabirds)*	
Relevant GES definition	**Related Operational Objective**	**Proposed Target(s)**
Species populations are in good conditions: Natural levels of breeding success & acceptable levels of survival of young and adult birds prevail.	Population condition of selected species is maintained	Populations of all taxa, particularly those with IUCN threatened status are maintained long-term and their average growth rate (λ) is equal or higher than 1 as estimated by population models. Incidental catch mortality is at negligible levels, particularly for species with IUCN threatened status.
Rational		

Justification for indicator selector

Demography is the study of various population parameters and it is used in ecology (particularly population and evolutionary ecology) as the basis for population studies. Demography provides a mathematical description of how such parameters change over time. Demographics may include any statistical factors with a potential to influence population growth or decline, with several parameters being particularly important: population size, density, age structure, fecundity (birth rates), mortality (death rates), and sex ratios. When applied in population viability models, demographic parameters allow estimating the extinction risk of any given population.

Successful analysis of population conditions requires the implementation of standardised protocols, to enable valid assessments at the appropriate spatial scale. The data obtained must provide reliable information not only on the parameters sought but also on demographic anomalies such as failures in recruitment, age-specific mortality and other uncommon events. The detection of breeding failures is a warning sign for changes in the environmental conditions, regardless of their natural or anthropogenic origin.

Some population demographic parameters such as survival require long-term monitoring. There is a lack of such accumulated information for several species and/or groups. This kind of monitoring is highly demanding on training and personnel, so it is probably unrealistic to expect widespread implementation on a regional scale. However, demographic data from near, equivalent (sub) populations can be used by analogy when local data are not available. Equally, initiatives for long-term monitoring of seabirds in the region should be welcomed and supported across the Mediterranean.

The most important demographic parameters are individual survival and fecundity (no. of young produced per female of breeding age per year), as they provide the essential information to be used in population viability analysis (PVA).

In other biogeographical regions, information on events of complete breeding failure is also compiled, but such phenomena are relatively rare in the Mediterranean. Instead, good information on average breeding success spanning a sufficient number of years is probably more appropriate.

Scientific References

List and url's

Indicator Title	*Common indicator 5: Population demographic characteristics (Seabirds)*

Genovart, M., Arcos, J. M., Álvarez, D., McMinn, M., Meier, R., B. Wynn, R., Guilford, T. and Oro, D. (2016), Demography of the critically endangered Balearic shearwater: the impact of fisheries and time to extinction. J Appl Ecol, 53: 1158–1168. doi:10.1111/1365-2664.12622

Tavecchia, G., Pradel, R., Genovart, M. and Oro, D. (2007), Density-dependent parameters and demographic equilibrium in open populations. Oikos, 116: 1481–1492. doi: 10.1111/j.0030-1299.2007.15791.x

Sanz-Aguilar, A., Igual, J. M., Oro, D., Genovart, M., & Tavecchia, G. (2016). Estimating recruitment and survival in partially monitored populations. *Journal of Applied Ecology*, 53(1), 73-82.

Fernández-Chacón, A., Genovart, M., Pradel, R., Tavecchia, G., Bertolero, A., Piccardo, J., Forero, M. G., Afán, I., Muntaner, J. and Oro, D. (2013), When to stay, when to disperse and where to go: survival and dispersal patterns in a spatially structured seabird population. Ecography, 36: 1117–1126. doi: 10.1111/j.1600-0587.2013.00246.x

Parsons, M., Mitchell, I., Butler, A., Ratcliffe, N., Frederiksen, M., Foster, S., and Reid, J. B. 2008. Seabirds as indicators of the marine environment. – ICES Journal of Marine Science, 65: 1520–1526.

Cook, A. S., Dadam, D., Mitchell, I., Ross-Smith, V. H., & Robinson, R. A. (2014). Indicators of seabird reproductive performance demonstrate the impact of commercial fisheries on seabird populations in the North Sea. Ecological indicators, 38, 1-11.

ICES. 2016. Report of the Joint OSPAR/HELCOM/ICES Working Group on Seabirds (JWGBIRD), 9–13 November 2015, Copenhagen, Denmark. ICES CM 2015/ACOM:28. 196 pp.

UNEP - MAP (RAC-SPA), 2006. Proceedings of the joint MEDMARAVIS - S.E.O. - UNEP-MAP Symposium on the Mediterranean Action Plan for the Conservation of Marine and Coastal Birds, held at Vilanova i la Geltru, Spain. Aransay M, Ed. UNEP RAC-SPA, Tunis. 103 pages.

Yésou, P., Sultana, J., Walmsley, J. and Azafzaf, H. (Eds.) 2016. Conservation of Marine and Coastal Birds in the Mediterranean. Proceedings of the UNEP-MAP-RAC/SPA Symposium, Hamammet 20 to 22 February 2015, Tunisia. 176 P

Policy Context and targets

Policy context description

	Birds Directive 2009/147/EC	Bern Convention	Barcelona Convention	Bonn Convention	African-Eurasian Migratory Waterbird Agreement (AEWA)
Inshore Benthic feeders					
Phalacrocorax aristotelis (Linnaeus, 1761)	Annex I	App.II	Annex II	-	-
Offshore surface feeders					
Larus audouinii (Payraudeau, 1826)	Annex I	App. II	Annex II	App. I & II	Annex II
Inshore surface feeders					
Sterna albifrons (Pallas, 1764)	Annex I	App. II	Annex II	App. I & II	Annex II
S. nilotica (Gmelin, JF, 1789)	Annex I	App. II	Annex II	App. I & II	Annex II
S. sandvicensis, (Latham, 1878)	Annex I	App. II	Annex II	App. I & II	Annex II
Offshore feeders					
Puffinus mauretanicus (Lowe, PR, 1921)	Annex I	-	-	App. I & II	-
Puffinus yelkouan (Brünnich,	Annex I	App. II	Annex II	-	-

<table>
<tr><td colspan="2">Indicator Title</td><td>Common indicator 5: Population demographic characteristics (Seabirds)</td></tr>
<tr><td colspan="3">1764)</td></tr>
<tr><td>EU Marine Strategy
Framework Directive</td><td>In order to achieve GES by 2020, each EU Member State is required to develop a strategy for its marine waters (or Marine Strategy). In addition, because the Directive follows an adaptive management approach, the Marine Strategies must be kept up-to-date and reviewed every 6 years.

The MSFD will be complementary to, and provide the overarching framework for, a number of other key Directives and legislation at the European level. Also it calls for regional cooperation meaning “cooperation and coordination of activities between Member States and, whenever possible, third countries sharing the same marine region or subregion, for the purpose of developing and implementing marine strategies” […] “thereby facilitating achievement of good environmental status in the marine region or subregion concerned”.</td><td><u>Descriptor 1: Biodiversity</u>

The population abundance of key marine species is stable and their <u>population dynamics</u> are indicative of long-term viability

Criteria: population condition

<u>Parameters and trends:</u>

Population demographic characteristics (e. g. body size or age class structure, sex ratio, fecundity rate, survival and mortality rates)

Population genetic structure, where appropriate</td></tr>
<tr><td>UE Nature Directives
(Birds and Habitats Directives)</td><td>The conservation status of a species “will be taken as ‘favourable’ when:

Article 1(i)). Population dynamics data on the species concerned indicate that it is maintaining itself on a long-term basis as a viable component of its natural habitats […].

[…] to take measures to maintain the population of wild bird species at a level which corresponds in particular to ecological, scientific and cultural requirements, while taking account of economic and recreational requirements or to adapt the population of these species to that level. (Birds Directive, Art.2).

Every six years, all EU Member States are required to report on the implementation of the directives.

There is a methodology for the assessment of conservation status and has been widely used for the compulsory reporting by EU member states for Habitats Directive (HD). This approach has been extended also to Birds Directive (BD) reporting (N2K Group 2011).</td><td><u>Parameters and trends:</u>

<u>Favourable</u>: Population of the species above 'favourable reference population’ AND reproduction, mortality and age structure not deviating from normal (if data available)

<u>Unfavourable – Inadequate</u>: Any combination other than those described under ‘Green’ or ‘Red’.

<u>Unfavourable – Bad</u>: Large decline in population (equivalent to a loss of more than 1% per year within the period specified by Member State (MS); other thresholds can be used but must be explained on Annex B) AND below ‘favourable reference population

OR population more than 25% below ‘favourable reference population’

OR reproduction, mortality and age structure strongly deviating from normal (if data available)

Unknown: No or insufficient reliable information available.</td></tr>
<tr><td colspan="3">Targets</td></tr>
</table>

Indicator Title	*Common indicator 5: Population demographic characteristics (Seabirds)*

EU Marine Strategy Framework Directive: Population abundance of breeding seabirds is stable over a period of twelve years, taking into consideration the natural variability of the species population and their ecology.

***EU Nature Directives*:** The result will be "favourable" if population of the species above 'favourable reference population' AND reproduction, mortality and age structure not deviating from normal (if data available).

IUCN: The overall target must be to prevent any significant decline in the population abundance of any of the selected species. For species in a Least Concern (LC) IUCN status, the specific target must be to maintain them within the stable category (no significant increase or decline, and most probable trends are less than 5% per year). For globally threatened species (IUCN: VU, EN or CR), the conservation objective must be to restore them to LC status so the population abundance target must be for the population to achieve a significant increase before levelling off at a higher (safer) population level

Policy documents

List and url's

11. 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) (Text with EEA relevance): http://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1401265930445&uri=CELEX:32008L0056
12. http://ec.europa.eu/environment/nature/legislation/birdsdirective/index_en.htm
13. http://ec.europa.eu/environment/nature/legislation/habitatsdirective/index_en.htm
14. Article 12 – National reporting on status and trends of bird species. http://ec.europa.eu/environment/nature/knowledge/rep_birds/index_en.htm
15. McConville, A.J. & Tucker, G.M. 2015. Review of Favourable Conservation Status and Birds Directive Article 2 interpretation within the European Union. Natural England Commissioned Reports, Number 176.
16. BirdLife International (2015) European Red List of Birds. Luxembourg: Office for Official Publications of the European Communities.
17. Links between the Marine Strategy Framework Directive (MSFD 2008 /56/EC) and the Nature Directives (Birds Directive 2009/ 147 /EEC (BD) and Habitats Directive 92/43/EEC (HD).
18. Cochrane, S.K.J., Connor, D.W., Nilsson, P., Mitchell, I., Reker, J., Franco, J., Valavanis, V., Moncheva, S., Ekebom, J., Nygaard, K., Santos, R.S., Naberhaus, I., Packeiser, T., Bund, W. Van De & A.C. Cardoso. 2010. Marine Strategy Framework Directive. Guidance on the interpretation and application of Descriptor 1: Biological diversity. Report by Task Group 1 on Biological diversity for the European Commission's Joint Research Centre. Ispra, Italy,
19. BirdLife International (2015) European Red List of Birds. Luxembourg: Office for Official Publications of the European Communities

Indicator analysis methods

Indicator Definition

The indicator is population growth. Its simplest conceptual model is the equation

$N(t+1) = \lambda N(t)$,

Where $N(t)$ is the number of individuals in the population in year t, and λ is the population growth rate, or the amount by which the population multiplies each year (the Greek symbol "lambda" is commonly used). If there is no variation in the environment from year to year, then the population growth rate λ is a constant, and only three qualitative types of population growth are possible: if λ is greater than one, the population grows geometrically; if λ is less than one, the population declines geometrically to extinction; and if λ exactly equals one, the population neither increases nor declines, but remains at its initial size in all subsequent years.

In the real world, variation in the environment causes survival and reproduction to vary from year to year, so the population growth rate λ tends to vary over some range of values as a result. Moreover, if the environmental

Indicator Title	*Common indicator 5: Population demographic characteristics (Seabirds)*

fluctuations driving changes in population growth include an element of unpredictability (as factors such as rainfall and temperature are likely to do), it is not possible to predict with certainty what the exact sequence of future population growth rates will be.

Population growth λ results from the combined effects of reproduction (which adds individuals to the population), survival (which determines how many individuals remain in the population from one year to the next) and mortality (which subtracts individuals from the population). Survival and mortality are mutually inverse, so if we can estimate survival, mortality can be calculated by subtraction.

Methodology for indicator calculation

Individual (interannual) survival is a principal component of any demographic study. It is based on the individual life histories of marked animals, almost invariably through the use of capture-recapture methods. To calculate the parameters, Lebreton et al. (1992) recommend the following procedure:

(1) start from a global model compatible with the biology of the species studied and with the design of the study, and assess its fit;

(2) select a more parsimonious model using Akaike's Information Criterion (AIC) to limit the number of formal tests;

(3) test for the most important biological questions by comparing this model with neighbouring ones using likelihood ratio tests; and

(4) obtain maximum likelihood estimates of model parameters with estimates of precision.

Computer software is critical, as few of the models available have parameter estimators that are in closed form. The most widely used software program is MARK (available for download at http://warnercnr.colostate.edu/~gwhite/mark/mark.htm), which provides parameter estimates from marked animals when they are re-encountered at a later time. Re-encounters can be from dead recoveries (e.g., the animal is harvested), live recaptures (e.g., the animal is re-trapped or re-sighted), radio tracking, or from some combination of these sources of re-encounters. The basic input to program MARK is the encounter history for each animal.

Program MARK computes the estimates of model parameters via numerical maximum likelihood techniques. The number of estimable parameters is used to compute the quasi-likelihood AIC value (QAICc) for the model.

To estimate fecundity, it is necessary to compile breeding data in order to calculate the average number of young produced annually per female of breeding age. It is difficult to estimate the number of females that do not attempt breeding in any given year, so the default calculation will be based on the average annual breeding success, i.e. the number of fledged young per breeding attempt (≈ no. of fledged young per nest).

Complementary information, such as detailed data on direct mortality (e.g., through by-catch or beach strandings) can be obtained directly in the field and calculated using simple arithmetic methods.

Indicator units

The main demographic parameters are defined in the following units:

- adult survival probability: range between 0 and 1
- juvenile survival probability: range between 0 and 1
- fecundity, or breeding productivity: average no. of young produced per breeding pair per year
- age class distribution: percentage of each age class
- sex ratio: percentage

List of Guidance documents and protocols available

- http://www.phidot.org/, especially the online discussion forum *Analysis of Data from Marked Individuals* found at: http://www.phidot.org/forum/index.php

Indicator Title	*Common indicator 5: Population demographic characteristics (Seabirds)*

- http://warnercnr.colostate.edu/~gwhite/mark/mark.htm
- http://www.capturerecapture.co.uk/

Data Confidence and uncertainties

Seabirds are long-lived, and any robust study on their demography must include enough individuals in order to be representative of the whole population and it must extend over a sufficient number of years to account for any natural variability in the environment. The average study involves several hundreds, if not thousands, of individually-marked birds, and it extends over one or several decades. A large sample size and a long time series provide the best confidence in the estimation of the parameters.

Where certain data are not available for the population under study, it is common practice to use parameter values estimated elsewhere. However, this must be taken into account when drawing conclusions or proposing management measures, as it is possible that local factors affect the results.

Methodology for monitoring, temporal and spatial scope

Available Methodologies for Monitoring and Monitoring Protocols

Perrins, C.M., Lebreton, J.D., and Hirons, G.J.M. (eds.) (1991). *Bird population studies: relevance to conservation and management*, New York: Oxford University Press

Beissinger, Steven R. and McCullough, Dale R. (2002). *Population Viability Analysis*, Chicago: University of Chicago Press.

Morris, W., Doak, D., Groom, M., Kareiva, P., Fieberg, J., Gerber, L., & Thomson, D. (1999). *A practical handbook for population viability analysis*. The Nature Conservancy.

Sanderson, F.J., Pople, R.G., Ieronymidou, C., Burfield, I.J., Gregory, R.D., Willis, S.G., Howard, C., Stephens, P.A., Beresford, A.E. and Donald, P.F., 2015. Assessing the performance of EU nature legislation in protecting target bird species in an era of climate change. *Conservation Letters*. , May/June 2016, 9(3), 172–180

Article 12 – National reporting on status and trends of bird species.
http://ec.europa.eu/environment/nature/knowledge/rep_birds/index_en.htm

ETC/BD. 2011. Assessment and reporting under Article 17 of the Habitats Directive. Explanatory Notes & Guidelines for the period 2007-2012 (Final version). Compiled by Douglas Evans and Marita Arvela (European Topic Centre on Biological Diversity). Avalaible online: https://circabc.europa.eu/sd/a/2c12cea2-f827-4bdb-bb56-3731c9fd8b40/Art17%20-%20Guidelines-final.pdf

Available data sources
Sources and url's:
OBIS-SEAMAP, Ocean Biogeographic Information System Spatial Ecological Analysis of Mega Vertebrate Populations, http://seamap.env.duke.edu/
BirdLife Datazone: http://www.birdlife.org/datazone/home
Seabirds at sea survey methods: http://jncc.defra.gov.uk/page-4514
UNEP/MAP-RAC/SPA projects and publications http://www.rac-spa.org/publications
Birdlife partners in the Mediterranean
Mediterranean marine research centres, universities and institutions
Medmaravis
Governmental ministries
IUCN specialists: http://www.iucn.org/species/ssc-specialist-groups/about/ssc-specialist-groups-and-red-list-authorities-directory/birds

Spatial scope guidance and selection of monitoring stations

The study of demography requires a long-term commitment and it must be done where this essential condition can be met with confidence. Ideally, data must be collected over the same time period from a few colonies that are representative of the environmental and anthropogenic conditions encountered by the species across its range. This includes sites with protected status, where conditions are likely to be favourable and more stable,

Indicator Title	*Common indicator 5: Population demographic characteristics (Seabirds)*

and those with the lowest levels of protection. Practical aspects, such as accessibility and potential impact of the presence of the researchers, must also be taken into account when selecting the study sites.

Temporal Scope guidance

As discussed above, demographic studies of seabird species should ideally extend over several decades. This way, the period of study has a better chance of encompassing most of the environmental and stochastic variability in the system. For the study of survival, the absolute minimum length is 4 study seasons; this provides the minimum 3 data points required to draw a curve of interannual survival.

Every year, a survey season is needed to obtain capture-recapture data on the presence of the individually-marked birds and to mark a new cohort of individuals. In parallel, data on breeding performance must be obtained for every breeding season (not necessarily at the same site).

Where additional data (e.g., on by-catch mortality or beach stranding) are compiled, it is important to do so on an annual basis as well.

Data analysis and assessment outputs

Statistical analysis and basis for aggregation

Where detailed demographic information is available, PVA most often rely upon population projection matrices based on data from individuals of known age and origin. Matrix models predict long-term population growth rates, transient population dynamics, and probabilities of extinction over time.

Projection matrix models make it possible to assess the influence that the vital rates of particular classes have on the growth of the population as a whole. They also allow predicting future population trends for long-lived species that have undergone either recent changes in one or more vital rates (e.g. due to a novel human impact, or a recently-imposed management plan) or a perturbation in the population structure (i.e. the distribution of individuals among classes). They are particularly well suited to evaluating management alternatives, provided demographic data from contrasting situations exist.

The most laborious and time-intensive step in matrix-based modelling is the collection of demographic data on known individuals over a number of years. Once enough raw data on individuals is available, the basic steps to produce a projection matrix and to use the matrix to predict future population sizes are:

1. Determine what feature of individuals (age, size, or life stage) best predicts differences in vital rates. Then divide the population into classes based upon the feature chosen.
2. Use demographic data on known individuals to estimate the vital rates for each class, and use them to construct a population matrix.
3. Construct a population vector by specifying the initial number of individuals in each class in the population. A population vector is a list of the number of individuals in each class; the sum of the elements in the vector equals the total population size.
4. Use the matrix and the population vector to project the population forward in time, thus predicting the future size of the population, the long-term population growth rate, λ, and the risk of future extinction. This step involves simple rules of linear algebra.

Expected assessments outputs

The most commonly used way to present the results of PVA is to display both the average population size and the 95% confidence limits for a series of population realizations over some time interval of interest, say the next 20, 50 or 100 years. In this way, population size projections can be compared with new data from ongoing population censuses. Deviations between actual and predicted trajectories would then suggest that changes in vital rates or population structure have occurred, or that there are errors in the model that need to be corrected.

In addition to projecting future population size, stochastic matrix models can also be used to quantify extinction risk. For a deterministic matrix model, only three outcomes are possible (population remains stable, it grows to infinity or it declines to extinction). If the population is declining deterministically, it is a simple matter to

Indicator Title	*Common indicator 5: Population demographic characteristics (Seabirds)*	
project the population until the number of individuals falls below the threshold, thus determining the predicted time to extinction. For models that incorporate variation in vital rates, extinction is a stochastic event, and its probability will be related both to the average value of λ and to its variance. Just as in the simpler count models, when λ is more variable the risk of extinction tends to rise, even in populations whose average growth rate is greater than 1.		
Known gaps and uncertainties in the Mediterranean The Mediterranean region is far from homogeneous and, as a result, the distribution of some seabird species is very asymmetric. Despite occurring throughout the Mediterranean, the numbers of species like Audouin´s Gull *Larus audouinii* and Eleonora´s Falcon *Falco eleonorae*, for example, are highly concentrated on a subregional scale. Local densities are much higher in those core areas compared to rest of the Mediterranean, and the demographical processes studied in dense colonies will probably be affected by different processes from those in areas of low density. It is therefore recommended that demographic studies are carried out in parallel in colonies with different characteristics, and that their results are compared.		
Contacts and version Date		
Key contacts within UNEP for further information		
Version No	**Date**	**Author**
V.1	20/07/2016	SPA/RAC

6. Common Indicator 6: Trends in abundance, temporal occurrence, and spatial distribution of non-indigenous species, particularly invasive, non-indigenous species, notably in risk areas (EO2, in relation to the main vectors and pathways of spreading of such species);

Indicator Title	*Common Indicator 6: Trends in abundance, temporal occurrence, and spatial distribution of non-indigenous species (NIS)*	
Relevant GES definition	**Related Operational Objective**	**Proposed Target(s)**
Decreasing abundance of introduced NIS in risk areas	Invasive non-indigenous species introductions are minimized	Abundance of NIS introduced by human activities reduced to levels giving no detectable impact

Rationale

Justification for indicator selection

Marine invasive species are regarded as one of the main causes of biodiversity loss in the Mediterranean (Galil, 2007; Coll et al., 2010), potentially modifying all aspects of marine and other aquatic ecosystems. They represent a growing problem due to the unprecedented rate of their introduction (Zenetos et al., 2010) and the unexpected and harmful impacts that they have on the environment, economy and human health (Galil, 2008; Katsanevakis et al. 2014). According to the latest regional reviews, more than 6% of the marine species in the Mediterranean are now considered non-native species as around 1000 alien marine species having been identified (Zenetos et al., 2012), while their number is increasing at a rate of one new record every 2 weeks (Zenetos et al., 2012). Of these species, 13.5% are classified as being invasive in nature, with macrophytes (macroalgae and seagrasses) the dominant group in the western Mediterranean and Adriatic Sea, and polychaetes, crustaceans, molluscs and fishes in the eastern and central Mediterranean (Galil, et al., 2009; Zenetos et al., 2010, 2012). Although the highest alien species richness occurs in the eastern Mediterranean, ecological impact shows strong spatial heterogeneity with hotspots in all Mediterranean sub-basins (Katsanevakis et al. 2016).

To mitigate the impacts of invasive alien species on biodiversity, human health, ecosystem services and human activities there is an increasing need to take action to control biological invasions. With limited funding, it is necessary to prioritise actions for the prevention of new invasions and for the development of mitigation measures. This requires a good knowledge of the impact of invasive species on ecosystem services and biodiversity, their current distributions, the pathways of their introduction, and the contribution of each pathway to new introductions (Katsanevakis et al. 2013, 2014; Galil et al. 2014).

Common indicator 6 is an indicator that summarizes data related to biological invasions in the Mediterranean into simple, standardized and communicable figures and is able to give an indication of the degree of threat or change in the marine and coastal ecosystem. Furthermore, it can be a useful indicator to assess in the long-run the effectiveness of management measures implemented for each pathway but also, indirectly, the effectiveness of the different existing policies targeting alien species in the Mediterranean Sea.

Scientific References

Coll, M., Piroddi, C., Steenbeek, J., Kaschner, K., Ben Rais Lasram, F., et al., 2010. The Biodiversity of the Mediterranean Sea: Estimates, Patterns, and Threats. PLoS ONE 5(8): e11842.

Galil, B.., 2007. Loss or gain? Invasive aliens and biodiversity in the Mediterranean Sea. Marine Pollution Bulletin 55, 314–322.

Galil, B.S., 2008. Alien species in the Mediterranean Sea - which, when, where, why? Hydrobiologia 597(1): 105-116.

Galil BS, Marchini A, Occhipinti-Ambrogi A, Minchin D, Narščius A, Ojaveer H, Olenin S (2014) International arrivals: widespread bioinvasions in European Seas. Ethology Ecology and Evolution 26(2-3): 152–171.

Katsanevakis, S., Zenetos, A., Belchior, C., Cardoso, A.C., 2013. Invading European Seas: assessing pathways of introduction of marine aliens. Ocean and Coastal Management 76, 64–74.

Katsanevakis, S., Wallentinus, I., Zenetos, A., Leppäkoski, E., Çinar, M.E., Oztürk, B., Grabowski, M., Golani, D., Cardoso, A.C., 2014. Impacts of marine invasive alien species on ecosystem services and biodiversity: a pan-European review. Aquatic Invasions 9(4), 391–423.

Katsanevakis, S., Tempera, F., Teixeira, H., 2016. Mapping the impact of alien species on marine ecosystems: the Mediterranean Sea case study. Diversity and Distributions 22, 694–707.

Zenetos A., Gofas, S., Verlaque, M., Cinar, M. E., García Raso, E., et al., 2010. Alien species in the Mediterranean Sea by 2010. A contribution to the application of European Union‘s Marine Strategy Framework Directive (MSFD). Part I. Spatial distribution. Mediterranean Marine Science, 11, 2, 381-493.

Indicator Title	*Common Indicator 6: Trends in abundance, temporal occurrence, and spatial distribution of non-indigenous species (NIS)*
Zenetos A., Gofas, S., Morri, C., Rosso, A., Violanti, D., et al., 2012. Alien species in the Mediterranean Sea by 2012. A contribution to the application of European Union's Marine Strategy Framework Directive (MSFD). Part 2. Introduction trends and pathways. Mediterranean Marine Science, 13/2, 328-352.	
Policy Context and targets (other than IMAP)	
Policy context description The Convention on Biological Biodiversity (CBD) recognised the need for the "compilation and dissemination of information on alien species that threaten ecosystems, habitats, or species to be used in the context of any prevention, introduction and mitigation activities", and calls for "further research on the impact of alien invasive species on biological diversity" (CBD, 2000). The objective set by Aichi Biodiversity Target 9 is that "by 2020, invasive alien species and pathways are identified and prioritized, priority species are controlled or eradicated, and measures are in place to manage pathways to prevent their introduction and establishment". This is also reflected in Target 5 of the EU Biodiversity Strategy (EU 2011). The new EU Regulation 1143/2014 on the management of invasive alien species seeks to address the problem of IAS in a comprehensive manner so as to protect native biodiversity and ecosystem services, as well as to minimize and mitigate the human health or economic impacts that these species can have. The Regulation foresees three types of interventions; prevention, early detection and rapid eradication, and management. The Marine Strategy Framework Directive (MSFD), which is the environmental pillar of EU Integrated Maritime Policy, sets as an overall objective to reach or maintain "Good Environmental Status" (GES) in European marine waters by 2020. It specifically recognizes the introduction of marine alien species as a major threat to European biodiversity and ecosystem health, requiring Member States to include alien species in the definition of GES and to set environmental targets to reach it. Hence, one of the 11 qualitative descriptors of GES defined in the MSFD is that "non-indigenous species introduced by human activities are at levels that do not adversely alter the ecosystem" (Descriptor 2). Among the indicators adopted to assess this descriptor are "trends in abundance, temporal occurrence and spatial distribution in the wild of non-indigenous species, particularly invasive non-indigenous species, notably in risk areas, in relation to the main vectors and pathways of spreading of such species". Ecological Objective 2 and the Common Indicator 6 are in agreement with the MSFD objectives and targets.	
Indicator/Targets Aichi Biodiversity Target 9 EU Biodiversity Strategy Target 5 EU Regulation 1143/2014 targets MSFD Descriptor 2 and related criteria and indicators	
Policy documents Aichi Biodiversity Targets - https://www.cbd.int/sp/targets/ EU Biodiversity Strategy - http://eurlex.europa.eu/legalcontent/EN/TXT/PDF/?uri=CELEX:52011DC0244&from=EN EU Regulation 1143/2014 - http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32014R1143&from=EN Marine Strategy Framework Directive - http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32008L0056&from=EN Commission Decision on criteria and methodological standards on good environmental status of marine waters - http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32010D0477(01)&from=EN	
Indicator analysis methods	
Indicator Definition For the needs of Common Indicator 6, the following definitions apply: 'Trend in abundance' is defined as the interannual change in the estimated total number of individuals of a non-indigenous species population in a specific marine area. 'Trend in temporal occurrence' is defined as the interannual change in the estimated number of new introductions and the total number of non-indigenous species in a specific country or preferably the national part of each subdivision, preferably disaggregated by pathway of introduction. 'Trend in spatial distribution' is defined as the interannual change of the total marine 'area' occupied by a non-indigenous species.	
Methodology for indicator calculation To estimate Common Indicator 6, a trend analysis (time series analysis) of the available monitoring data needs to be performed, aiming to extract the underlying pattern, which may be hidden by noise. A formal regression analysis is the recommended approach to estimate such trends. This can be done by a simple linear regression	

Indicator Title	*Common Indicator 6: Trends in abundance, temporal occurrence, and spatial distribution of non-indigenous species (NIS)*
analysis or by more complicated modelling tools (when rich datasets are available), such as generalized linear or additive models. To monitor trends in temporal occurrence, two parameters [A] and [B] should be calculated on a yearly basis. Parameter [A] provides an indication of the introductions of "new" species (in comparison with the prior year), and parameter [B] gives an indication of the increase or decrease of the total number of non-indigenous species: [A]: The number of non-indigenous species at T_n that was not present at T_{n-1}. To calculate this parameter the non-indigenous species lists of both years are compared to check which species were recorded in year *n*, but were not recorded in year *n-1* regardless of whether or not these species was present in earlier years. To calculate this parameter the total number of non-indigenous species is used in the comparison. [B]: The total number of known non-indigenous species at T_n minus the corresponding number of non-indigenous species at T_{n-1}. Hereby T_n stands for the year of reporting.	
Indicator units 'Trends in abundance': % change per year 'Trends in temporal occurrence': % change in new introductions or % change in the total number of alien species per year or per decade 'Trends in spatial distribution': % change in the total marine surface area occupied or % change in the length of the occupied coastline (in the case of shallow-water species that are present only in the coastal zone)	
List of Guidance documents and protocols available There are no established standard protocols for the monitoring of NIS. However, sampling methods are used by monitoring activities implemented in many Mediterranean countries, in particular in relation to the Ballast Water Convention, the EU Water Framework Directive, and the Marine Strategy Framework Directive. These methods may be useful for the estimation of Common Indicator 6. Some guidance on the monitoring of biodiversity (including non-indigenous species) for the needs of the MSFD is provided in: *Zampoukas et al. (2014) Technical guidance on monitoring for the Marine Stategy Framework Directive. JRC Scientific and Policy Reports (EUR collection), Publications Office of the European Union, EUR 25009 EN – Joint Research Centre, doi: 10.2788/70344, ISBN: 978-92-79-35426-7, 166p.*	
Data Confidence and uncertainties The trend analysis should be accompanied by an evaluation of confidence and uncertainties. Standard regression methods (simple linear regression, generalized linear or additive models, etc) provide estimates of uncertainty (standard errors and confidence intervals of estimated trends). Such uncertainty estimates should accompany all reported trends. Furthermore, the issue of imperfect detectability should be properly addressed, as it may cause an underestimation of the relevant state variables (abundance, occupancy, geographical range, species richness). There are many available methods that properly tackle the issue of imperfect detection when monitoring biodiversity, by jointly estimating detectability (see Katsanevakis et al. 2012 for a review).	
Methodology for monitoring, temporal and spatial scope	
Available Methodologies for Monitoring and Monitoring Protocols It is recommended to use standard monitoring methods traditionally being used for marine biological surveys, including, but not limited to plankton, benthic and fouling studies described in relevant guidelines and manuals. However, specific approaches may be required to ensure that alien species are likely to be found, e.g. in rocky shores, port areas and marinas, offshore areas and aquaculture areas. As a complimentary measure and in the absence of an overall Invasive Alien Species (IAS) targeted monitoring programme, rapid assessment studies may be undertaken, usually but not exclusively at marinas, jetties, and fish farms (e.g. Minchin, 2007, Pedersen, 2005, Ashton et al., 2006). The compilation of citizen scientist input (validated by taxonomic experts), can be useful to assess the geographical ranges of established species or to record new species early. For the estimation of Common Indicator 6, it is important that the same sites are surveyed each monitoring period, otherwise the estimation of the trend might be biased by differences among sites. Standard methods for monitoring marine populations include plot sampling, distance sampling, mark-recapture, removal methods, and repetitive surveys for occupancy estimation (see Katsanevakis et al. 2012 for a review specifically for the marine environment). *Katsanevakis S, et al., 2012. Monitoring marine populations and communities: review of methods and tools dealing with imperfect detectability. Aquatic Biology 16: 31–52.*	
Available data sources	

Indicator Title	*Common Indicator 6: Trends in abundance, temporal occurrence, and spatial distribution of non-indigenous species (NIS)*	
Marine Mediterranean Invasive Alien Species database (MAMIAS) - http://www.mamias.org/ European Alien Species Information Network (EASIN) - http://easin.jrc.ec.europa.eu/ CIESM Atlas of Exotic Species in the Mediterranean - http://www.ciesm.org/online/atlas/ World Register of Introduced Marine Species (WRIMS) - http://www.marinespecies.org/introduced/		
Spatial scope guidance and selection of monitoring stations The monitoring of IAS generally should start on a localised scale, such as “hot-spots” and “stepping stone areas” for alien species introductions. Such areas include ports and their surrounding areas, docks, marinas, aquaculture installations, heated power plant effluents sites, offshore structures. Areas of special interest such as marine protected areas, lagoons etc. may be selected on a case by case basis, depending on the proximity to alien species introduction “hot spots”. The selection of the monitoring sites should therefore be based on a previous analysis of the most likely “entry” points of introductions and “hot spots” expected to contain elevated numbers of alien species. The use of Habitat Suitability Models and Ecological Niche Modelling (ENM) may be considered at a later stage of IMAP to identify priority monitoring sites and to predict the spread of IAS.		
Temporal Scope guidance Monitoring at “hot-spots” and “stepping stone areas” for alien species introductions would typically involve more intense monitoring effort, e.g. sampling at least once a year at ports and their wider area and once every two years in smaller harbours, marinas, and aquaculture sites.		
Data analysis and assessment outputs		
Statistical analysis and basis for aggregation Standard statistics for regression analysis should be applied to estimate trends and their related uncertainties.		
Expected assessments outputs - Graphs of the time series of the calculated metrics (abundance, occurrence, etc), including confidence intervals - Distribution maps of the selected species, depicting temporal changes in their spatial distribution - National inventories (and also by the national part of each marine subdivision, if relevant) of non-indigenous species by year		
Known gaps and uncertainties in the Mediterranean NIS identification is of crucial importance, and the lack of taxonomical expertise has already resulted in several NIS having been overlooked for certain time periods. The use of molecular approaches including bar-coding are sometimes needed to confirm traditional species identification. Currently, sampling effort greatly varies among Mediterranean countries and thus on a regional basis current assessments and comparisons may be biased.		
Contacts and version Date		
Key contacts within UNEP for further information		
Version No	**Date**	**Author**
V.1	20/07/2016	SPA/RAC

7. Common Indicator 7: Spawning stock Biomass (EO3);

Indicator Title	*Common Indicator 7: Spawning Stock Biomass*	
Relevant GES definition	**Related Operational Objective**	**Proposed Target(s)**
Achieving or maintaining good environmental status requires that SSB values are equal to or above SSB_{MSY}, the level capable of producing maximum sustainable yield (MSY).	The Spawning Stock Biomass (SSB) is at a level at which reproduction capacity is not impaired	State -B > B_{thr}
Rationale		

Justification for indicator selection

In 2012, following several recommendations made on the management of different fisheries in the Mediterranean and Black Sea (e.g. Recommendations GFCM/27/2002/1, GFCM/30/2006/1 and Resolution GFCM 33/2009/1 on the management of certain fisheries exploiting demersal and small pelagic), and on the basis of Scientific Advisory Committee on Fishery (SAC) advice on the need to develop multiannual management plans based on agreed reference points, the GFCM has formulated the "*Guidelines on a general management framework and presentation of scientific information for multiannual management plans for sustainable fisheries in the GFCM area*". In the GFCM guidelines are included clear indications on suitable objectives and procedures to implement a management plan, and a clear definition is reported of the requirements to provide scientific advice useful for management. The framework is based on the definition of reference points related to key indicators of the status of stocks, such as stock biomass and fishing mortality. Indeed these guidelines, in relation to reference points and stock status, define suitable indicators for biomass either (*Total Biomass or Spawning Stock* Biomass), while suitable indicators for exploitation can be either *Fishing mortality or Exploitation rate* (ratio between fishing mortality and total mortality). In all cases, reference points should be defined in relation to the indicator used. Following the recommendations from the SAC, the advice should be based, if possible, on both indicators of biomass and exploitation, and for each indicator ideally target, threshold and limit (e.g. B_{tgt}, B_{thr}, B_{lim}) reference points should be defined. When only one indicator is available, there should be a clear advice to explore the possibility of having indicators for both biomass and exploitation.

In general terms, a suggested target reference point for biomass and exploitation is that value of the indicator at which maximum sustainable yield (MSY) is obtained from the fishery, in accordance with the 1995 UN Fish Stocks Agreement (UNFSA), while limit and threshold reference points should be established based on precautionary principles.

Spawning Stock Biomass

Biomass reference points are nearly always based on SSB, which is one of the most important stock status indicators and the primary indicator for the reproductive capacity of the stock. Achieving or maintaining good environmental status requires that SSB values are equal to or above SSB_{MSY} (the level capable of producing Maximum Sustainable Yield-MSY).

B_{thr} (Biomass threshold) is defined as a point at which the probability to be below B_{lim} (Biomass limit) is lower than 5%. In absence of precise estimates of the distribution of the biomass estimate, a lognormal distribution of B_{lim} should be assumed, with a coefficient of variation of 40%. This approximately results in $B_{thr} = 2*B_{lim}$.

Fishing mortality (F) is directly related to the way a stock is being fished. Yield will increase as more fishing capacity is applied (more vessels or fishing effort) until it reaches a maximum level (MSY). If fishing mortality is increased further than this MSY, yield will decrease because smaller size fish (which are too young to reproduce) are being caught, leading to a continuous decline of the SSB (total weight of mature fish). Even if a stock is fished at a constant level of fishing mortality, the SSB can fluctuate due to natural factors. Thus, a stock fished constantly at F_{MSY} (the value of F expected to produce the long-term maximum sustainable yield) should result in the SSB fluctuating around SSB_{MSY} (the spawning-stock biomass expected to produce the long-term maximum sustainable yield).

Scientific References

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

-FAO. 1996. Precautionary approach to fisheries. Part 2: scientific papers. Prepared for the Technical Consultation on the Precautionary Approach to Capture Fisheries (Including Species Introductions). Lysekil, Sweden, 6–13 June 1995. FAO Fisheries Technical Paper. No. 350, Part 2. Rome. 210 pp.

Indicator Title	*Common Indicator 7: Spawning Stock Biomass*

-GFCM, 2002. Recommendation GFCM/27/2002/1: Management of selected demersal and small pelagic species.
-GFCM, 2006. Recommendation. GFCM/30/2006/1: Management of certain fisheries exploiting demersal and small pelagic.
-GFCM, 2009. Resolution GFCM/33/2009/1 on the Management of demersal Fisheries in the GFCM area.
-ICES, 2008. Report of the Workshop on Methods to Evaluate and Estimate the Accuracy of Fisheries Data used for Assessment (WKACCU). Bergen, Norway, 27–30 October 2008. ICES CM 2008\ACOM: 32. 41 pp.
-ICES, 2010e. Report of the Workshop on methods to evaluate and estimate the precision of fisheries data used for assessment (WKPRECISE). Copenhagen, Denmark, 8-11 September 2009. ICES CM 2009/ACOM: 40. 43 pp.
-Sparre, P.; Venema, S.C. Introduction to tropical fish stock assessment. Part 1. Manual. *FAO Fisheries Technical Paper*.No. 306.1, Rev. 2. Rome, FAO. 1998. 407p.
-Sparre P.J., 2000. Manual on sample-based data collection for fisheries assessment. Examples from Vietnam. FAO Fisheries Technical Paper. No. 398. Rome, FAO. 2000. 171 pp.
-United Nations, 1995. Conference on straddling fish stocks and highly migratory fish stocks. Sixth session New York, 24 July-4August 1995

Policy Context and targets (other than IMAP)

Policy context description

The overall operational objectives of GFCM are to ensure the conservation and sustainable use, at the biological, social, economic and environmental level, of living marine resources in the area of application.
This means maintain the sustainability of fisheries, in order to prevent overfishing of demersal and small pelagic fish stocks, maintain their stocks at levels that can produce the maximum sustainable yield (MSY) and to facilitate the restoration of stocks to historical levels. GFCM also aims to guarantee a low risk of stocks falling outside safe biological limits and to ensure protection of biodiversity to avoid undermining ecosystems structure and functioning (GFCM, 2013). Fishing mortality must be kept below safe levels to ensure long-term high yields, while limiting the risk of stock collapse and guaranteeing stable and viable fisheries (GFCM, 2012).
To follow these issues and to advance towards its goal of sustainability of fisheries, the GFCM has established a temporal framework and intermediate global objectives through the implementation of both the mid-term strategy (GFCM, 2016b) and the different recommendations as in the Compendium of GFCM decisions.

Indicator/Targets

- SAC 2014: "Provides definitions for stock status and management advice on stocks for which reference points related to indicators of biomass and/or exploitation are available."
- Common Fisheries Policy: "The current policy stipulates that between 2015 and 2020 catch limits should be set that are sustainable and maintain fish stocks in the long term"
- EU-MSFD Descriptor 3: "Populations of all commercially exploited fish and shellfish are within safe biological limits, exhibiting a population age and size distribution that is indicative of a healthy stock"

Policy documents

- EC Directive of the European parliament and of the Council 2008/56/of 17 June 2008 establishing a framework for community action in the field of marine environmental policy (Marine Strategy Framework Directive). http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2008:164:0019:0040:EN:PDF
- GFCM, 2012a. Report of the Transversal Workshop on Spatial Based Approach to Fisheries Management, Rome, Italy, 6–8 February 2012. 2 March 2016]. https://gfcmsitestorage.blob.core.windows.net/ documents/Reports/2012/GFCM-Report-2012-SAC-SCs-Spatial-Approach.pdf
-GFCM, 2012b. Resolution OTH-GFCM/36/2012/ Guidelines on a general management framework and presentation of scientific information for multiannual management plans for sustainable fisheries in the GFCM area
- GFCM 2013. Report on the Sub-Regional Technical Workshop on Fisheries Multiannual Management Plans for the Western, Central and Eastern Mediterranean. 7-10 October 2013, Tunis. http://www.fao.org/3/a-ax847e.pdf
- GFCM, 2014a. Report of the sixteenth session of the Scientific Advisory Committee. St. Julian's, Malta, 17–20 March 2014. 261pp. http://www.fao.org/3/a-i4381b.pdf
- GFCM 2014b. Proposal on the definition of Good Environmental Status and associated indicators and targets for commercially exploited fish and shellfish populations. Scientific Advisory Committee (SAC). St Julian's, Malta, 17-20 March 2014. 18 pp.
-GFCM, 2016b. Resolution GFCM/40/2016/2 for a mid-term strategy (2017–2020) towards the sustainability of Mediterranean and Black Sea fisheries.

Indicator Title	*Common Indicator 7: Spawning Stock Biomass*

- Recommendation GFCM/33/2009/3, 2009. On the implementation of the GFCM task 1 statistical matrix and repealing resolution GFCM/31/2007/1. www.fao.org/gfcm/decisions
- Regulation (EU) No 1380/2013 of the European parliament and of the Council of 11 December 2013 on the Common Fisheries Policy, amending Council Regulations (EC) No 1954/2003 and (EC) No 1224/2009 and repealing Council Regulations (EC) No 2371/2002 and (EC) No 639/2004 and Council Decision 2004/585/EC
- UNEP-MAP 2012. EcAp-MED Project Document. Implementation of the Ecosystem Approach (EcAp) in the Mediterranean by the Contracting parties in the context of the Barcelona Convention for the Protection of the Marine Environment and the Coastal region of the Mediterranean and its Protocols. 34pp.

Indicator analysis methods

Indicator Definition

Description: The Spawning Stock Biomass, usually referred to as SSB, is the total weight of the spawning stock. The SSB is available through stock assessment so not all species will have this information. Note that B_{MSY} is currently not considered as a threshold for stock management in European waters and values are not available. When both biomass indices and exploitation indicators are available (only for few species) the most precautionary will be adopted. Only available if the stock has been assessed. This indicator is linked with sustainable fishing.

The spawning stock biomass (SSB) is the combined weight of all individuals in a fish stock that are capable of reproducing. To calculate the spawning stock biomass, it is necessary to have estimates of the number of fish by length/age group, estimates of the average weight of the fish in each length/age group and an estimate of the amount of fish in each length/age group that are mature. SSB and SSB_{MSY} need to be estimated from appropriate quantitative assessments based on the analysis of catch at-age or/and at length (to be taken as all removals from the stock including discards). Where possible, reference points relative to SSB should be established for each stock.

Priority species (Group 1, 2 and 3), as reported in Appendix A of the GFCM-Data Collection Reference Framework (GFCM-DCRF, 2016), will be the species considered for the evaluation for this indicator.

Methodology for indicator calculation

The status of stocks is ideally based on a validated stock assessment model, from which indicators of stock status (e.g. biomass, fishing mortality, recruitment) are obtained, and reference points are agreed for the chosen indicators. When possible, analytical stock assessment models that incorporate both fishery-dependent (e.g. catches) and independent information (e.g. surveys) are used, although direct surveys are used for some stocks. Different stock assessment models are used in the GFCM area of application, including variations of virtual population models (from pseudo-cohort based models, such as VIT, to tuned versions, such as extended survivor analysis – XSA), statistical catch at age analysis (e.g. state-space assessment model – SAM or stock synthesis – SS3) and biomass models (BioDyn, two-stage biomass models, etc.). Some stock assessment methods are only based on information from scientific surveys at sea (e.g. survey-based assessment – SURBA, or acoustic estimates of biomass).

When no analytical assessment model or reference points are validated by the Scientific Advisory Committee on Fishery (SAC), advice can still be provided on a precautionary basis, in cases where there is evidence that the stock may be threatened (high fishing pressure, low biomass, habitat loss, etc.). When possible, advice on stock status should be based both on biomass and on fishing pressure, using indicators and reference points for both quantities.

Indicator units (*under development*)

- Number of stocks for which status with respect to SSB_{MSY} is known
- The number (and proportion) of stocks above or below SSB_{MSY}
- Trends in SSB

List of Guidance documents and protocols available

- GFCM, 2014a. Report of the sixteenth session of the Scientific Advisory Committee. St. Julian's, Malta, 17–20 March 2014. 261pp.
- GFCM 2014b. Proposal on the definition of Good Environmental Status and associated indicators and targets for commercially exploited fish and shellfish populations. Scientific Advisory Committee (SAC). St Julian's, Malta, 17-20 March 2014. 18 pp.
-Stock Assessment Form version 1.0 (January 2014 - http://www.fao.org/gfcm/data-reporting/data-reporting-stock-assessment/en/)

Data Confidence and uncertainties

Methodology for monitoring, temporal and spatial scope

Available Methodologies for Monitoring and Monitoring Protocols

Indicator Title	*Common Indicator 7: Spawning Stock Biomass*
Several analytical methods, based on population dynamics of different stocks of demersal and small pelagic species, have been applied within the GFCM-WGSAs (Working Groups on Stock Assessment) and are also available in literature. In the GFCM area, data for the assessment of stocks are collected through stock assessment forms (SAF), which also contain information on reference points and outcomes of the assessment (e.g. fishing mortality, exploitation rate, spawning stock biomass, recruitment etc.). Within the GFCM mandate a series of stocks are assessed on an annual basis. On a yearly basis, Scientific and Advisory Committee (SAC) and the Working Group for the Black Sea (WGBS) will identify those species/stocks that should be assessed and for which stock assessment form should be provided.	
Available data sources -Report of the eighteenth session of the Scientific Advisory Committee (SAC) on fisheries Nicosia, Cyprus, 21–23 March 2016 http://www.fao.org/gfcm/reports/statutory-meetings/en/ -Report of the seventeenth session of the Scientific Advisory Committee FAO headquarters, 24-27 March 2015, 310 pp. http://www.fao.org/documents/card/en/c/adea41df-6092-460d-982b-32a977b90be6/ -Report of the fifth meeting of the Working Group on the Black Sea (WGBS) 2016 (05 April-07 April) Kiev, Ukraine. 95pp. http://www.fao.org/gfcm/reports/technical-meetings/en/ -Report of the Working Group on Stock Assessment of Demersal Species (WGSAD), 2015 (23 November-28 November) GFCM HQ. 60pp. http://www.fao.org/gfcm/reports/technical-meetings/en/ -Report of the Working Group on Stock Assessment of Small Pelagic species (WGSASP), 2015 (23 November-28 November) GFCM HQ. 82pp. http://www.fao.org/gfcm/reports/technical-meetings/en/ -Scientific, Technical and Economic Committee for Fisheries (STECF) – Mediterranean assessments part 1 (STECF-15-18). 2015. Publications Office of the European Union, Luxembourg, EUR 27638 EN, JRC 98676, 410 pp. EWG 15-16: Mediterranean assessments - Part 1 https://stecf.jrc.ec.europa.eu/meetings/2015 -Reports of the Scientific, Technical and Economic Committee for Fisheries (STECF) – Mediterranean assessments part 2 (STECF-16-08). 2016. Publications Office of the European Union, Luxembourg, EUR 27758 EN, 483 pp. EWG 15-16: Mediterranean assessments - Part 2 https://stecf.jrc.ec.europa.eu/meetings/2015	
Spatial scope guidance and selection of monitoring stations Stock assessment in the GFCM area of application is often conducted by management units, based on Groups on Stock Assessments (GSAs) (Resolution GFCM/33/2009/2). This method does not ensure that the whole stock is assessed, since stocks may cover several different management units. In some cases, when there is scientific evidence of a stock spreading through different GSAs existing information is combined across GSAs. Although the concept of their delimitation still needs further consideration, the GSAs, appear as the most appropriate subdivisions for stock assessments for management purposes in the Mediterranean Sea.	
Temporal Scope guidance (*under development*)	
Data analysis and assessment outputs	
Statistical analysis and basis for aggregation (*under development*)	
Expected assessments outputs • Monitoring trend of SSB • Monitoring the stock(s) performance • Project the stock(s) trend over time • Provide scientific advice on the status of the resources, as well as to allow countries to prepare recommendations to manage those resources. The information gathered should be sufficient and reliable enough to review the status of the different resources, to assess the economic and social dimensions of the fleets and to provide scientific advice on the status of the resources, as well as to allow countries to prepare recommendations to manage those resources.	
Known gaps and uncertainties in the Mediterranean Even if stock assessments and advice are now available for several stocks in the Mediterranean and Black Sea, and the number of stocks for which estimates of MSY-based indicators are available has also increased, still different stocks lack information on spawning stock biomass (SSB) and/or proxies are not available. Therefore, it is not possible to establish reproductive potential levels relative to MSY.	

Indicator Title	*Common Indicator 7: Spawning Stock Biomass*	
Furthermore, the exploitation of several stocks may be shared, and the available scientific inputs have not been sufficient or have not been organised cohesively at the appropriate scale in view of supporting a regional based decision making process. Some countries have not kept an acceptable level of accuracy due to different causes including the fragmented nature of smaller size stocks exploited by artisanal multiple-gear fisheries, small fishing fleets dispersed over quite long coastlines and islands, and/or no data collection in place.		
Contacts and version Date		
GFCM Secretariat (gfcm-secretariat@fao.org)		
Version No	**Date**	**Author**
V.1	15-12-2016	**GFCM Secretariat**

8. Common Indicator 9: Fishing Mortality (EO3);

Indicator Title	Common Indicator 9: Fishing mortality	
Relevant GES definition	**Related Operational Objective**	**Proposed Target(s)**
Populations of selected commercially exploited fish and shellfish are within biologically safe limits, exhibiting a population age and size distribution that is indicative of a healthy stock	Fishing mortality in the stock does not exceed the level that allows MSY ($F \leq F_{MSY}$).	Pressure -F_{MSY} -F0.1 a proxy of F_{MSY} (more precautionary)
Rationale		

Justification for indicator selection

In 2012, following several recommendations made on the management of different fisheries in the Mediterranean and Black Sea (e.g. Recommendations GFCM/27/2002/1, GFCM/30/2006/1 and Resolution GFCM 33/2009/1 on the management of certain fisheries exploiting demersal and small pelagic), and on the basis of Scientific Advisory Committee on Fishery (SAC) advice on the need to develop multiannual management plans based on agreed reference points, the GFCM has formulated the "*Guidelines on a general management framework and presentation of scientific information for multiannual management plans for sustainable fisheries in the GFCM area*". In the GFCM guidelines clear indications are provided on suitable objectives and procedures to implement a management plan, and is reported a clear definition of the requirements to provide scientific advice useful for management. The framework is based on the definition of reference points related to key indicators of the status of stocks, such as stock biomass and fishing mortality. Indeed these guidelines, in relation to reference points and stock status, define suitable indicators for biomass (either *Total Biomass or Spawning Stock Biomass)*, while suitable indicators for exploitation can be either *Fishing mortality or Exploitation rate* (ratio between fishing mortality and total mortality). In all cases, reference points should be defined in relation to the indicator used. Following the recommendations from the SAC, the advice should be based, if possible, on both indicators of biomass and exploitation, and for each indicator ideally target, threshold and limit (e.g. F_{tgt}, F_{thr}, F_{lim}) reference points should be defined. When only one indicator is available, there should be a clear advice to explore the possibility of having indicators for both biomass and exploitation.

In general terms, a suggested target reference point for biomass and exploitation is that value of the indicator at which maximum sustainable yield (MSY) is obtained from the fishery, in accordance with the 1995 UN Fish Stocks Agreement (UNFSA), while limit and threshold reference points should be established based on precautionary principles.

Fishing mortality

Fishing mortality is considered an essential component of fishery stock status and a fundamental variable in stock assessment. Generally, fishing mortality is defined as the instantaneous rate of the mortality of the number of individuals that die due to fishing, and can be defined in terms either of numbers of fish or in terms of biomass of fish. When fishing mortality is used as an indicator, $F_{0.1}$ (defined as the fishing mortality rate at which the slope of the yield-per-recruit curve is only one-tenth the slope of the curve at its origin) can be used as a proxy for F_{MSY} (i.e. the fishing mortality rate that produces the maximum sustainable yield). The aim of this indicator is to determine the optimum catch that can be harvested from a stock.

Current status

In the Mediterranean and Black Sea, the majority (around 85 percent) of stocks for which a validated assessment exists are fished outside biologically sustainable limits. Biomass reference points are not commonly available for assessed stocks; therefore this percentage is mainly estimated from the level of fishing mortality in relation to the fishing mortality reference point. Current fishing mortality rates can be up to 12 times higher than the target for some stocks (e.g. hake). Most stocks fished within biologically sustainable limits are of small pelagic species (sardine, anchovy or sprat), while only a few stocks of demersal species, such as whiting, some shrimp species, picarel and red mullet, are estimated to be fished at or below the reference point for fishing mortality.

To ensure the highest quality stock assessments, the data used must be accurate and timely evaluated. The Mediterranean fisheries are characterised by fragmented fleets, usually composed by relatively small vessels, use of a large number of landing sites, with multi-species catches. These factors make it difficult and expensive to get extensive and reliable data time series and to get biological samples. In the GFCM areas, data for the assessment of stocks are collected through stock assessment forms (SAF), which also contain information on reference points and outcomes of the assessment (e.g. fishing mortality, exploitation rate,

Indicator Title	Common Indicator 9: Fishing mortality
spawning stock biomass, recruitment etc.). Further, the GFCM has recently developed a new specific data requirement in force for data collection and submission: the Data Collection Reference Framework (GFCM-DCRF, 2016). This new framework has been adopted during the GFCM annual Session 2015. The DCRF is the first GFCM comprehensive framework for the collection and submission of the fisheries-related data that are requested as per existing GFCM Recommendations and are necessary for relevant GFCM subsidiary bodies to formulate advice in accordance with their mandate. It encompasses all the necessary indications for the collection of fisheries data (i.e. global figure of national fisheries, catch; incidental catch of vulnerable species; fleet; effort; socio-economics; biological information) by GFCM members in a standardized way, in order to provide the GFCM with the minimum set of data needed to support fisheries management decision-making processes.	
Scientific References -EC. Directive of the European parliament and of the Council 2008/56/of 17 June 2008 establishing a framework for community action in the field of marine environmental policy (Marine Strategy Framework Directive). -FAO. 1996. Precautionary approach to fisheries. Part 2: scientific papers. Prepared for the Technical Consultation on the Precautionary Approach to Capture Fisheries (Including Species Introductions). Lysekil, Sweden, 6–13 June 1995. FAO Fisheries Technical Paper. No. 350, Part 2. Rome. 210 pp. -GFCM, 2002. Recommendation GFCM/27/2002/1: Management of selected demersal and small pelagic species. -GFCM, 2006. Recommendation. GFCM/30/2006/1: Management of certain fisheries exploiting demersal and small pelagic. -GFCM, 2009. Resolution GFCM/33/2009/1 on the Management of demersal Fisheries in the GFCM area. -ICES, 2008. Report of the Workshop on Methods to Evaluate and Estimate the Accuracy of Fisheries Data used for Assessment (WKACCU). Bergen, Norway, 27–30 October 2008. ICES CM 2008\ACOM: 32. 41 pp. -ICES, 2010e. Report of the Workshop on methods to evaluate and estimate the precision of fisheries data used for assessment (WKPRECISE). Copenhagen, Denmark, 8-11 September 2009. ICES CM 2009/ACOM: 40. 43 pp. -Sparre, P.; Venema, S.C. Introduction to tropical fish stock assessment. Part 1. Manual. *FAO Fisheries Technical Paper.*No. 306.1, Rev. 2. Rome, FAO. 1998. 407p. -Sparre P.J., 2000. Manual on sample-based data collection for fisheries assessment. Examples from Vietnam. FAO Fisheries Technical Paper. No. 398. Rome, FAO. 2000. 171 pp. -United Nations, 1995. Conference on straddling fish stocks and highly migratory fish stocks. Sixth session New York, 24 July-4August 1995	
Policy Context and targets (other than IMAP)	
Policy context description The overall operational objectives of GFCM are to ensure the conservation and sustainable use (at the biological, social, economic and environmental level), of living marine resources in the area of application. This means maintain the sustainability of fisheries, in order to prevent overfishing of demersal and small pelagic fish stocks, maintain their stocks at levels that can produce the maximum sustainable yield (MSY) and to facilitate the restoration of stocks to historical levels. GFCM also aims to guarantee a low risk of stocks falling outside safe biological limits and to ensure protection of biodiversity to avoid undermining ecosystems structure and functioning (GFCM, 2013). Fishing mortality must be kept below safe levels to ensure long-term high yields, while limiting the risk of stock collapse and guaranteeing stable and viable fisheries (GFCM, 2012). To follow these issues and to advance towards its goal of sustainability of fisheries, the GFCM has established a temporal framework and intermediate global objectives through the implementation of both the mid-term strategy (GFCM, 2016b) and the various recommendations (as per the Compendium of GFCM decisions).	
Indicator/Targets • SAC 2014: "Provides definitions for stock status and management advice on stocks for which reference points related to indicators of biomass and/or exploitation are available." • Common Fisheries Policy: "The current policy stipulates that between 2015 and 2020 catch limits should be set that are sustainable and maintain fish stocks in the long term" • EU-MSFD Descriptor 3: "Populations of all commercially exploited fish and shellfish are within safe biological limits, exhibiting a population age and size distribution that is indicative of a healthy	

Indicator Title	Common Indicator 9: Fishing mortality
stock"	

Policy documents

- EC Directive of the European parliament and of the Council 2008/56/of 17 June 2008 establishing a framework for community action in the field of marine environmental policy (Marine Strategy Framework Directive). http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2008:164:0019:0040:EN:PDF
- GFCM, 2012a. Report of the Transversal Workshop on Spatial Based Approach to Fisheries Management, Rome, Italy, 6–8 February 2012. 2 March 2016]. https://gfcmsitestorage.blob.core.windows.net/ documents/Reports/2012/GFCM-Report-2012-SAC-SCs-Spatial-Approach.pdf
-GFCM, 2012b. Resolution OTH-GFCM/36/2012/ Guidelines on a general management framework and presentation of scientific information for multiannual management plans for sustainable fisheries in the GFCM area
- GFCM 2013. Report on the Sub-Regional Technical Workshop on Fisheries Multiannual Management Plans for the Western, Central and Eastern Mediterranean. 7-10 October 2013, Tunis. http://www.fao.org/3/a-ax847e.pdf
- GFCM, 2014a. Report of the sixteenth session of the Scientific Advisory Committee. St. Julian's, Malta, 17–20 March 2014. 261pp. http://www.fao.org/3/a-i4381b.pdf
- GFCM 2014b. Proposal on the definition of Good Environmental Status and associated indicators and targets for commercially exploited fish and shellfish populations. Scientific Advisory Committee (SAC). St Julian's, Malta, 17-20 March 2014. 18 pp.
-GFCM, 2016b. Resolution GFCM/40/2016/2 for a mid-term strategy (2017–2020) towards the sustainability of Mediterranean and Black Sea fisheries.
- Recommendation GFCM/33/2009/3, 2009. On the implementation of the GFCM task 1 statistical matrix and repealing resolution GFCM/31/2007/1. www.fao.org/gfcm/decisions
- Regulation (EU) No 1380/2013 of the European parliament and of the Council of 11 December 2013 on the Common Fisheries Policy, amending Council Regulations (EC) No 1954/2003 and (EC) No 1224/2009 and repealing Council Regulations (EC) No 2371/2002 and (EC) No 639/2004 and Council Decision 2004/585/EC
- UNEP-MAP 2012. EcAp-MED Project Document. Implementation of the Ecosystem Approach (EcAp) in the Mediterranean by the Contracting parties in the context of the Barcelona Convention for the Protection of the Marine Environment and the Coastal region of the Mediterranean and its Protocols. 34pp.

Indicator analysis methods

Indicator Definition

Description: The Maximum Sustainable Yield is, theoretically, the maximum yield that can be obtained from a species, and it is associated with a maximum fishing mortality (F_{MSY}). When F is higher than F_{MSY} the yield decreases. F_{MSY} is considering as a limit due to the consequences of overestimating F. Only available if the stock has been assessed. Fishing mortality (F) reflects all deaths in the stock that are due to fishing per year (not only what is actually landed). It is usually expressed as a rate ranging from 0 (for no fishing) to high values (1.0 or more). It is common practice to refer F as a scalar value but it would be more appropriate to refer to it as a vector. This indicator is linked with sustainable fishing.

The catch should correspond to a fishing mortality (F) that maximises the yield from the stock. This is defined as the MSY, and the fishing mortality rate that generates this is F_{MSY}. F_{MSY} is the F value that will maximise the long-term yield, taking into account natural mortality, growth and the dependence of the abundance of incoming year-classes on the abundance of the spawning stock size. Given the variability and uncertainty inherent in the estimation of fishing mortality reference levels and the difficulty of simultaneously maintaining all stocks in a mixed fishery at their optimum exploitation rate, a range within which the exploitation rate is maintained may be considered appropriate rather than using the exact reference levels as limit or target values.

Priority species (Group 1, 2 and 3) as reported in Appendix A of the GFCM-Data Collection Reference Framework (GFCM-DCRF, 2016), will be the species considered for the evaluation of this indicator.

Methodology for indicator calculation

The status of stocks is ideally based on a validated stock assessment model, from which indicators of stock status (e.g. biomass, fishing mortality, recruitment) are obtained, and reference points are agreed for the chosen indicators. When possible, analytical stock assessment models that incorporate both fishery-dependent (e.g. catches) and independent information (e.g. surveys) are used, although direct surveys are used for some stocks. Different stock assessment models are used in the GFCM area of application, including variations of virtual population models (from pseudo-cohort based models, such as VIT, to tuned versions, such as

Indicator Title	Common Indicator 9: Fishing mortality

extended survivor analysis – XSA), statistical catch at age analysis (e.g. state-space assessment model – SAM or stock synthesis – SS3) and biomass models (BioDyn, two-stage biomass models, etc.). Some stock assessment methods are only based on information from scientific surveys at sea (e.g. survey-based assessment – SURBA, or acoustic estimates of biomass). When no analytical assessment model or reference points are validated by the Scientific Advisory Committee on Fishery (SAC), advice can still be provided on a precautionary basis, in cases where there is evidence that the stock may be threatened (high fishing pressure, low biomass, habitat loss, etc.). When possible, advice on stock status should be based both on biomass and on fishing pressure, using indicators and reference points for both quantities.

Indicator units

- Number of stocks for which status with respect to F_{MSY} is known
- The number (and proportion) of stocks above or below F_{MSY}
- Trends in F/F_{MSY}

List of Guidance documents and protocols available

- GFCM, 2014a. Report of the sixteenth session of the Scientific Advisory Committee. St. Julian's, Malta, 17–20 March 2014. 261pp.
- GFCM 2014b. Proposal on the definition of Good Environmental Status and associated indicators and targets for commercially exploited fish and shellfish populations. Scientific Advisory Committee (SAC). St Julian's, Malta, 17-20 March 2014. 18 pp.
- GFCM-Data Collection Reference Framework (GFCM-DCRF, 2016)
-Stock Assessment Form version 1.0 (January 2014 - http://www.fao.org/gfcm/data-reporting/data-reporting-stock-assessment/en/)

Data Confidence and uncertainties

Methodology for monitoring, temporal and spatial scope

Available Methodologies for Monitoring and Monitoring Protocols

Several analytical methods, based on population dynamics of different stocks of demersal and small pelagic species, have been applied within the GFCM-WGSAs (Working Groups on Stock Assessment) and are also available in literature. In the GFCM area, data for the assessment of stocks are collected through stock assessment forms (SAF), which also contain information on reference points and outcomes of the assessment (e.g. fishing mortality, exploitation rate, spawning stock biomass, recruitment etc.). Within the GFCM mandate a series of stocks are assessed on an annual basis. On a yearly basis, Scientific and Advisory Committee (SAC) and the Working Group for the Black Sea (WGBS) will identify those species/stocks that should be assessed and for which stock assessment form should be provided.

Available data sources

-Report of the eighteenth session of the Scientific Advisory Committee (SAC) on Fisheries Nicosia, Cyprus, 21–23 March 2016
http://www.fao.org/gfcm/reports/statutory-meetings/en/
-Report of the seventeenth session of the Scientific Advisory Committee FAO headquarters, 24-27 March 2015, 310 pp.
http://www.fao.org/documents/card/en/c/adea41df-6092-460d-982b-32a977b90be6/
-Report of the fifth meeting of the Working Group on the Black Sea (WGBS) 2016 (05 April-07 April) Kiev, Ukraine. 95pp.
http://www.fao.org/gfcm/reports/technical-meetings/en/
-Report of the Working Group on Stock Assessment of Demersal Species (WGSAD), 2015 (23 November-28 November) GFCM HQ. 60pp.
http://www.fao.org/gfcm/reports/technical-meetings/en/
-Report of the Working Group on Stock Assessment of Small Pelagic species (WGSASP), 2015 (23 November-28 November) GFCM HQ. 82pp.
http://www.fao.org/gfcm/reports/technical-meetings/en/
-Scientific, Technical and Economic Committee for Fisheries (STECF) – Mediterranean assessments part 1 (STECF-15-18). 2015. Publications Office of the European Union, Luxembourg, EUR 27638 EN, JRC 98676, 410 pp. EWG 15-16: Mediterranean assessments - Part 1
https://stecf.jrc.ec.europa.eu/meetings/2015
-Reports of the Scientific, Technical and Economic Committee for Fisheries (STECF) – Mediterranean assessments part 2 (STECF-16-08). 2016. Publications Office of the European Union, Luxembourg, EUR 27758 EN, 483 pp. EWG 15-16: Mediterranean assessments - Part 2
https://stecf.jrc.ec.europa.eu/meetings/2015

<table>
<tr><td>Indicator Title</td><td colspan="2">Common Indicator 9: Fishing mortality</td></tr>
<tr><td colspan="3">Spatial scope guidance and selection of monitoring stations
Stock assessment in the GFCM area of application is often conducted by management units, based on Groups on Stock Assessments (GSAs) (Resolution GFCM/33/2009/2 and Appendix L and M of the GFCM-DCRF, 2016)). This method does not ensure that the whole stock is assessed, since stocks may cover several different management units. In some cases, when there is scientific evidence of a stock spreading through different GSAs existing information is combined across GSAs. Although the concept of their delimitation still needs further consideration, the GSAs, appear as the most appropriate subdivisions for stock assessments for management purposes in the Mediterranean Sea.</td></tr>
<tr><td colspan="3">Temporal Scope guidance (under development)</td></tr>
<tr><td colspan="3">Data analysis and assessment outputs</td></tr>
<tr><td colspan="3">Statistical analysis and basis for aggregation (under development)</td></tr>
<tr><td colspan="3">Expected assessment outputs
• Monitoring trend of fishing mortality
• Monitoring the stock(s) performance
• Project the stock(s) trend over time
• Provide scientific advice on the status of the resources, as well as to allow countries to prepare recommendations to manage those resources.
• The information gathered should be sufficient and reliable enough to review the status of the different resources, to assess the economic and social dimensions of the fleets and to provide scientific advice on the status of the resources, as well as to allow countries to prepare recommendations to manage those resources.</td></tr>
<tr><td colspan="3">Known gaps and uncertainties in the Mediterranean
Even if stock assessments and advice are now available for several stocks in the Mediterranean and Black Sea, and the number of stocks for which estimates of MSY-based indicators are available has also increased, different stocks still lack information on F reference points and/or proxies are not available. Therefore, it is not possible to establish current fishing mortality levels relative to MSY.
Furthermore, the exploitation of several stocks may be shared, and the available scientific inputs have not been sufficient or have not been organised cohesively at the appropriate scale in view of supporting a regional based decision making process. Some countries have not been kept an acceptable level of accuracy due to different causes including the fragmented nature of smaller size stocks exploited by artisanal multiple-gear fisheries, small fishing fleets dispersed over quite long coastlines and islands and/or no data collection in place.</td></tr>
<tr><td colspan="3">Contacts and version Date</td></tr>
<tr><td colspan="3">GFCM Secretariat (gfcm-secretariat@fao.org)</td></tr>
<tr><td>Version No</td><td>Date</td><td>Author</td></tr>
<tr><td>V.1</td><td>15-12-2016</td><td>GFCM Secretariat</td></tr>
</table>

9. Common Indicator 12: Bycatch of vulnerable and non-target species (EO1 and EO3);

<table>
<tr><td>Indicator Title</td><td colspan="2">Common Indicator 12 : Bycatch of vulnerable and non-target species (EO1 and EO3)</td></tr>
<tr><td>Relevant GES definition</td><td>Related Operational Objective</td><td>Proposed Target(s)</td></tr>
<tr><td>The abundance/trends of populations of seabirds, marine mammals, sea turtles and sharks key species (selected according to their actual and total dependence on the marine environment, and to their ecological representativeness)
is stable or not reducing in a statistically significant way taking into account the natural variability compared to the current situation.</td><td>Incidental catch of vulnerable species (i.e. sharks, marine mammals, seabirds and turtles) are minimized</td><td>Work in progress within GFCM</td></tr>
<tr><td colspan="3">Rationale</td></tr>
<tr><td colspan="3">Justification for indicator selection
Bycatch is the part of the catch that is unintentionally captured during a fishing operation in addition to target species. It may refer to the catch of other commercial species that are landed, commercial species that cannot be landed (e.g. undersized, damaged individuals), non-commercial species that are discarded, as well as to incidental catch of endangered or rare species. Incidental catch of vulnerable species is defined here as a subset of bycatch, which includes species that for some reason are considered vulnerable (i.e. long-lived vertebrates with low reproductive rates such as marine mammals, but also sea turtles, seabirds and elasmobranchs).
Bycatch is considered one of the most important threats to the profitability and sustainability of fisheries, and as such has been recently attracting the attention of most regional fisheries management organizations (RFMOs) and other fisheries management bodies. Bycatch costs fishermen time and money, causes problems to endangered and threatened species, affects marine and coastal ecosystems, and makes it more difficult to measure the effect of fishing on the stock's population, and to set sustainable levels for fishing. Preventing and reducing bycatch is an important part of ensuring sustainable living marine resources and coastal communities. However, estimates of bycatch (both discards and incidental catch if vulnerable species) are still lacking and not with a homogeneous coverage in all Mediterranean and Black Sea regions.
Following this issue, this indicator will focus on the incidental catch of vulnerable species, with a special emphasis on the interaction/impact with fishing activities, monitoring also the spatial and temporal distribution of the catches.</td></tr>
<tr><td colspan="3">Scientific References
-Casale, P. and Margaritoulis, D. (Eds.) .2010. Sea turtle in the Mediterranean: Distribution, threats and conservation priorities. Gland, Switzerland: UICN. 294 pp.
-Coll, M. et al. 2010. The Biodiversity of the Mediterranean Sea: Estimates, Patterns, and Threats. - PLoS ONE 5: e11842.
-FAO, 2003. The ecosystem approach to fisheries. FAO Technical guidelines for responsible fisheries. Rome.
112 pp.
-FAO, 2009. Guidelines to reduce sea turtle mortality in fishing operations. Fisheries Department, Food and Agriculture Organization of the United Nations. Rome. 128 pp.
-FAO, 2011. Fisheries management. Marine protected areas and fisheries. FAO Technical Guidelines for Responsible Fisheries. No. 4, Suppl. 4. Rome. 198 pp.
-FAO, 2016. The State of Mediterranean and Black Sea Fisheries. General Fisheries Commission for the Mediterranean. Rome, Italy.
-Franzosini C., Genov, T., Tempesta, M., 2013. Cetacean Manual for MPA managers. ACCOBAMS, MedPAN and UNEP/MAP-RAC/SPA. Ed. RAC/SPA, Tunis. 77 pp.
Reeves R., Notarbartolo di Sciara G. (compilers and editors). 2006. The status and distribution of cetaceans in the Black Sea and Mediterranean Sea. IUCN Centre for Mediterranean Cooperation, Malaga, Spain. 137 pp.
-IUCN, 2012. Marine mammals and sea turtles of the Mediterranean and Black Seas.</td></tr>
</table>

Indicator Title	Common Indicator 12 : Bycatch of vulnerable and non-target species (EO1 and EO3)
-UNEP/MAP-RAC/SPA, 2003. – Action Plan for the conservation of bird species listed in annex II of the Protocol concerning specially protected areas and biological diversity in the Mediterranean. http://rac-spa.org/ -UNEP/MAP- Blue Plan, 2009. State of the environment and development in the Mediterranean. UNEP/MAP-Blue Plan, Athens. -UNEP, 2013. SAP BIO implementation: The first decade and way forward. UNEP(DEPI)/MED WG.382/5. UNEP RAC/SPA, Tunis. -UNEP/MAP RAC/SPA, 2007. Action Plan for the conservation of Mediterranean marine turtles. Ed. RAC/SPA, Tunis, 40pp. http://rac-spa.org/ -UNEP/MAP-RAC/SPA, 2013. Action Plan for the Conservation of Cetaceans in the Mediterranean Sea http://rac-spa.org/	
Policy Context and targets (other than IMAP)	
Policy context description The overall operational objectives of GFCM are to ensure the conservation and sustainable use (at the biological, social, economic and environmental level), of living marine resources in the area of application. This means maintain the sustainability of fisheries, in order to prevent overfishing of demersal and small pelagic fish stocks, maintain their stocks at levels that can produce the maximum sustainable yield (MSY) and to facilitate the restoration of stocks to historical levels. GFCM also aims to guarantee a low risk of stocks falling outside safe biological limits and to ensure protection of biodiversity to avoid undermining ecosystems structure and functioning (GFCM, 2013). Fishing mortality must be kept below safe levels to ensure long-term high yields, while limiting the risk of stock collapse and guaranteeing stable and viable fisheries (GFCM, 2012). To follow these issues and to advance towards its goal of sustainability of fisheries, the GFCM has established a temporal framework and intermediate global objectives through the implementation of both the mid-term strategy (GFCM, 2016b) and of the various recommendations in the Compendium of GFCM decisions.	
Indicator/Targets -EU Regulation 812/2004 "Concerning incidental catches of cetaceans in fisheries" -EU MSFD Descriptors 1 "The quality and occurrence of habitats and the distribution and abundance of species are in line with prevailing physiographic, geographic and climatic conditions" and 4 "All elements of the marine food webs, to the extent that they are known, occur at normal abundance and diversity and levels capable of ensuring the long-term abundance of the species and the retention of their full reproductive capacity" -EU Habitats Directive -GFCM Recommandations: GFCM/35/2011/3, GFCM/35/2011/4, GFCM/35/2011/5, GFCM/36/2012/2, GFCM/36/2012/3	
Policy documents -Barcelona Convention (Convention for the Protection of the Marine Environment and the Coastal Region of the Mediterranean). -EC Directive of the European parliament and of the Council 2008/56/of 17 June 2008 establishing a framework for community action in the field of marine environmental policy (Marine Strategy Framework Directive). http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2008:164:0019:0040:EN:PDF -EU Biodiversity Strategy http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52011DC0244&from=EN -EU Régulation 1143/2014 http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32014R1143&from=EN - GFCM 2013. Report on the Sub-Regional Technical Workshop on Fisheries Multiannual Management Plans for the Western, Central and Eastern Mediterranean. 7-10 October 2013, Tunis. http://www.fao.org/3/a-ax847e.pdf - GFCM, 2014a. Report of the sixteenth session of the Scientific Advisory Committee. St. Julian's, Malta, 17–20 March 2014. 261pp. http://www.fao.org/3/a-i4381b.pdf - GFCM-Data Collection Reference Framework (GFCM-DCRF, 2016) -GFCM, 2016b. Resolution GFCM/40/2016/2 for a mid-term strategy (2017–2020) towards the sustainability of Mediterranean and Black Sea fisheries. -Marine Strategy Framework Directive http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32008L0056&from=EN	

Indicator Title	Common Indicator 12 : Bycatch of vulnerable and non-target species (EO1 and EO3)
-Strategic Action Programme for the conservation of Biological Diversity (SAP BIO) in the Mediterranean Region http://sapbio.rac-spa.org/ -Draft Updated Action Plan for the conservation of Cetaceans in the Mediterranean Sea http://rac-spa.org/nfp12/documents/working/wg.408_08_eng.pdf -Recommendation GFCM/35/2011/3, 2011. On reducing incidental bycatch of seabirds in fisheries in the GFCM Competence Area. www.fao.org/gfcm/decisions -Recommendation GFCM/35/2011/4, 2011. On the incidental bycatch of sea turtles in fisheries in the GFCM Competence Area. www.fao.org/gfcm/decisions -Recommendation GFCM/35/2011/5, 2011. On fisheries measures for the conservation of the Mediterranean monk seal (*Monachus monachus*) in the GFCM Competence Area. www.fao.org/gfcm/decisions -Recommendation GFCM/36/2012/2, 2012. On mitigation of incidental catches of cetaceans in the GFCM area. www.fao.org/gfcm/decisions -Recommendation GFCM/36/2012/3, 2013. On fisheries management measures for conservation of sharks and rays in the GFCM area. www.fao.org/gfcm/decisions -Strategic Action Programme for the conservation of Biological Diversity (SAP BIO) in the Mediterranean Region - http://sapbio.rac-spa.org/	
Indicator analysis methods	
Indicator Definition The abundance/trends of populations of seabirds, marine mammals, sea turtles and sharks key species (selected according to their actual and total dependence on the marine environment, and to their ecological representativeness) is stable or not reducing in a statistically significant way taking into account the natural variability compared to the current situation. This indicator reports on the catch rate of turtles, marine mammals, sharks and seabirds in the Mediterranean and Black Sea. The trends analysis (i.e. occurrence, spatial distribution, abundance etc.) of the incidental catch rates of those vulnerable species, will demonstrate the impact that different fisheries activities have on this component of the marine ecosystem. Vulnerable species, as reported in Appendix E of the GFCM-DCRF (Data Collection Reference Framework), will be the ones considered for the evaluation of this indicator. Further, other biodiversity components such as abundance of exploited populations, fish communities and other components of the ecosystem will be investigated.	
Methodology for indicator calculation Bycatch data (discards and incidental catch of vulnerable species) can be obtained from different sources and are usually derived from a combination of catch reports, logbooks, observers on board, observers at landing and/or market, dedicated surveys, questionnaires, self-sampling by fishers, market and/or landing survey Incidental catch of vulnerable species can be sampled through: 1) Direct observation - a) at-sea monitoring of commercial catches (*by observers on board*); - b) dedicated survey - c) fishermen (*by self-sampling*) can sample their own bycatch in order that surveys could be made more representative of the whole fleet segment without having to have too many observers. 2) Conducting direct dialogues with fishermen (*by questionnaires*), collecting also perspectives on the bycatch issue, which is meant to complement the on-board observation data analyses, and to provide an integrated approach toward management. 3) Stranded animal monitoring Sampling (through observers on board) should be allocated proportionally to the fishing effort (e.g. fishing days) and following a stratification based on the fleet segmentations (e.g. grouping fleet segments which are similar with regard to their fishing activities; based on the GFCM-DCRF, 2016 schema).	
Indicator units • Incidental catch (weight and number) of vulnerable species by main fleet segments and areas • Trends in abundance • Trends in spatial distribution • Trends in temporal occurrence • Identification of risky areas • Record strandings of vulnerable species due to incidental catch	

Indicator Title	Common Indicator 12 : Bycatch of vulnerable and non-target species (EO1 and EO3)	
List of Guidance documents and protocols available - Several protocols, guidelines and technical documents are available, and can be used, to monitor the different abundance/trends in the incidental catches of populations of seabirds, marine mammals, sea turtles and shark key species. - GFCM-Data Collection Reference Framework (GFCM-DCRF, 2016)		
Data Confidence and uncertainties		
Methodology for monitoring, temporal and spatial scope		
Available Methodologies for Monitoring and Monitoring Protocols Several protocols are available using different monitoring platforms and approaches such as: - Direct observation - Stranded animal monitoring - Landing/market survey - Dedicated surveys - Photo-identification		
Available data sources • Data Collection Reference Framework (GFCM-DCRF, 2016) online platform • ICCAT database https://www.iccat.int/en/ • OBIS-SEAMAP, Ocean Biogeographic Information System Spatial Ecological Analysis of Megavertebrate Populations, is a spatially referenced online database, aggregating marine mammal, seabird, sea turtle and ray & shark observation data from across the globe. http://seamap.env.duke.edu/ • The Mediterranean Database of Cetacean Strandings (MEDACES), has been set-up to co-ordinate all national and regional efforts for riparian countries. Cetacean stranding data are organized into a spatially referenced database of public access.		
Spatial scope guidance and selection of monitoring stations This indicator will take into account the spatial (GSA) and temporal (quarterly) variability in order to monitor both the impact of different fishing activities on vulnerable species by area, and to detect seasonal differences in incidental catch.		
Temporal Scope guidance (*under development*)		
Data analysis and assessment outputs		
Statistical analysis and basis for aggregation (*under development*)		
Expected assessments outputs -Identification of the incidental catch (e.g. vulnerable species composition, quantities, period of the year, etc.) of the main fleet segments (per GFCM sub-region, countries and GSA); -Describe the typology of the current fishing practices pertaining to these fisheries that lead to bycatch (e.g. fishing area, seasonality, fishing gears); -Find out the most important factors that could determine the incidental catch amounts (including ecological and technical factors). -Trend analysis (by quarter and year)		
Known gaps and uncertainties in the Mediterranean As highlighted in the report on the "The state of Mediterranean and Black Sea fisheries" (FAO, 2016), studies on bycatch cover only a small portion of the total fishing activity in the Mediterranean and Black Seas. There are several important gaps of knowledge: bycatch studies are non-existent for many fishing gears, countries or/and sub-regions and most of the existing studies cover relatively short temporal and small spatial scales. This gap of knowledge highlights the need to expand bycatch surveys and standardize practices in order to compare among fisheries, and test potential methods and tools aiming at their mitigation.		
Contacts and version Date		
GFCM Secretariat (gfcm-secretariat@fao.org)		
Version No	**Date**	**Author**
V.1	15-12-2016	**GFCM Secretariat**

10. Common Indicator 13: Concentration of key nutrients in water column (EO5);

Indicator Title	13. Concentration of key nutrients in water column (EO5)	
Relevant GES definition	**Related Operational Objective**	**Proposed Target(s)**
Concentrations of nutrients in the euphotic layer are in line with prevailing physiographic, geographic and climate conditions	Human introduction of nutrients in the marine environment is not conducive to eutrophication	1.Reference nutrients concentrations according to the local hydrological, chemical and morphological characteristics of the un-impacted marine region. 2.Decreasing trend of nutrients concentrations in water column of human impacted areas, statistically defined. 3.Reduction of BOD emissions from land based sources. 4.Reduction of nutrients emissions from land based sources

Rational

Justification for indicator selector

Eutrophication is a process driven by enrichment of water by nutrients, especially compounds of nitrogen and/or phosphorus, leading to: increased growth, primary production and biomass of algae; changes in the balance of nutrients causing changes to the balance of organisms; and water quality degradation. The direct and indirect consequences of eutrophication are undesirable when they degrade ecosystem health and/or the sustainable provision of goods and services, such as algal blooms, dissolved oxygen deficiency, declines in sea-grasses, mortality of benthic organisms and/or fish.Altough, these changes may also occur due to natural processes, the management concern begins when they are attributed to anthropogenic sources.

Scientific References

i. Brzezinski M.A., 1985. The Si:C:N ratio of marine diatoms: interspecific variability and the effect of some environmental variables. Journal of Phycology, Vo. 21, pp. 347–357.
ii. Conley D.J., Schelske C.L., Stoermer E. F., 1993. Modification of the biogeochemical cycle of silica with eutrophication. Mar. Ecol. Prog. Ser. 101, 179-192.
iii. Devlin, M., Painting, S., Best, M., 2007. Setting nutrient thresholds to support an ecological assessment based on nutrient enrichment, potential primary production and undesirable disturbance. Mar. Poll., 55., 65-73.
iv. Carstensen, J., 2007. Statistical principles for ecological status classification of Water Framework Directive monitoring data. Mar. Poll., 55, 3-15.

Policy Context and targets

Policy context description

In the Mediterranean, the UNEP/MAP MED POL Monitoring programme included from its inception the study of eutrophication as part of its seven pilot projects approved by the Contracting Parties at the Barcelona meeting in 1975 (UNEP MAP, 1990a,b). The issue of a consistent monitoring strategy and assessment of eutrophication was first raised at the UNEP/MAP MED POL National Coordinators Meeting in 2001 (Venice, Italy) which recommended to the Secretariat to elaborate a draft programme for monitoring of eutrophication in the Mediterranean coastal waters (UNEP/MAP MED POL, 2003). In spite of a series of assessments reviewing the concept and state of eutrophication, there are important gaps in the capacity to assess the intensity of this phenomenon. Efforts have been devoted to define the concepts to assess the intensity and to extend experience beyond the initial sites in the Adriatic Sea, admittedly, the most eutrophic area in the entire Mediterranean Sea. In the context of the Mediterranean Sea, thethe Integrated Monitoring and

Indicator Title	13. Concentration of key nutrients in water column (EO5)

Assessment Programe (UNEP/MAP, 2016) and the European Marine Strategy Framework Directive (2000/56/EC) are the two main policy tools for the eutrophication phenomenon.

Targets

For each considered marine spatial scale (region, sub-region, local water mass, etc.) the nutrient levels should be compared based on base reference levels and trends monitoring until commonly agreed thresholds have been scientifically assessed and agreed upon in the Mediterranean Sea.

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
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).

Nutrient/Eutrophication related Policy documents

v. UNEP/MAP MED POL (2003). Eutrophication Monitoring Strategy of UNEP/MAP MED POL. UNEP(DEPI)MED WG.231/14. UNEP, Athens.
vi. 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.
vii. UNEP/FAO/WHO (1996). 'Assessment of the state of eutrophication in the Mediterranean Sea'. MAP Technical Reports Series No 106. UNEP, Athens, 211 pp.
viii. UNEP/MAP MED POL (1990a). Activity IV: Research on the effects of pollutants on Marine Organisms and their Populations (UNEP/MAP MED POL Phase I, 1975-1981).
ix. UNEP/MAP MED POL(1990b). Activity V: Research on the effects of pollutants on Marine Communities and Ecosystems (UNEP/MAP MED POL Phase I, 1975-1981).

Indicator analysis methods

Indicator Definition

Concentration of key (inorganic) nutrients in the water column:

Total Nitrogen (TN)
Nitrate (NO_3-N)
Nitrite (NO_2-N)
Ammonium (NH_4-N)
Orthophosphate (P-PO_4)
Total Phosphorus (TP)
Silicate (Si)

Sub-Indicators: Nutrient ratios (molar) of silica, nitrogen and phosphorus where appropriate:

Indicator Title	13. Concentration of key nutrients in water column (EO5)
Si:N, N:P, Si:P	
Methodology for indicator calculation All: Spectrophotometry (manually or automated methods and instrumentation)	
Indicator units All: micromol per liter,that is micromolar concentration (µmol/L =µM) Ratios: adimensional (simple mathematical derivation of ratios from nutrient concentrations)	
List of Guidance documents and protocols available i. OSPAR, 2012. OSPAR MSFD Advice Document on Eutrophication. Approaches to determining good environmental status, setting of environmental targets and selecting indicators for Marine Strategy Framework Directive descriptor 5. ii. Piha, H., Zampoucas, N., 2011. Review of Methodological Standards Related to the Marine Strategy Framework Directive Criteria on Good Environmental Status. JRC Scientific and Technical Reports, EUR 24743 EN iii. UNEP/MAP MED POL (2005). Sampling and Analysis Techniques for the Eutrophication Monitoring Strategy of UNEP/MAP MED POL. MAP Technical Reports Series No. 163. UNEP, Athens. 61pp. iv. Durairaj, P., Sarangi, R.K., Ramalingam, S. et al. Seasonal nitrate algorithms for nitrate retrieval using OCEANSAT-2 and MODIS-AQUA satellite data. Environ Monit Assess (2015) 187: 176. v. See also UNEP/MAP website (http://web.unep.org/unepmap)	
Data Confidence and uncertainties Despite the great variability born by the water layers subject to active hydrodynamic processes, monitoring the characteristics of the seawater is still the most direct way of assessing eutrophication. Inorganic nutrients may be determined either at the surface or at various depths.	
Methodology for monitoring, temporal and spatial scope	
Available Methodologies for Monitoring and Monitoring Protocols Traditional methods for eutrophication monitoring in coastal waters involve in situ sampling/measurements of commonly measured parameters such as nutrients concentration, Concerning available methods for in situ measurements, ships provide flexible platforms for eutrophication monitoring, while remote sensing provides opportunities for a synoptic view over regions or sub-regions. Besides traditional ship measurements, ferry-boxes and other autonomous measuring devices have been developed that allow high frequency and continuous measurements. Sampling for the determination of “in vitro” fluorescence and nutrient analysis may be carried out with relatively little effort if a proper pump and hose are mounted on the ship. The measurements may be done at the surface or just below it with a water intake on the hull of the vessel, or at fixed or varying depths with a towed “fish” and pumping system.	
Available data sources EMODNET Chemistry	
Spatial scope guidance and selection of monitoring stations The first factor promoting eutrophication is nutrient enrichment. This explains why the main eutrophic areas are to be found primarily not far from the coast, mainly in areas receiving high nutrient loads,	

Indicator Title	13. Concentration of key nutrients in water column (EO5)

despite some natural symptoms of eutrophication can also be found, such as in upwelling areas. Additionally, the risk of eutrophication is linked to the capacity of the marine environment to confine growing algae in the well-lighted surface layer. The geographical extent of potentially eutrophic waters may vary widely, depending on:
(i) the extent of shallow areas, i.e. with depth ≤ 20 m;
(ii) the extent of stratified river plumes, which can create a shallow surface layer separated by a halocline from the bottom layer, whatever its depth;
(iii) extended water residence times in enclosed seas leading to blooms triggered to a large degree by internal and external nutrient pools; and
(iv) upwelling phenomena leading to autochthonous nutrient supply and high nutrient concentrations from deep water nutrient pools, which can be of natural or human origin.
Therefore, the geographical scale of monitoring for the assessment of GES for eutrophication will depend on the hydrological and morphological conditions of an area, particularly the freshwater inputs from rivers, the salinity, the general circulation, upwelling and stratification. The spatial distribution of the monitoring stations should, prior to the establishment of the eutrophication status of the marine sub-region/area, be risk-based and proportionate to the anticipated extent of eutrophication in the sub-region under consideration as well as its hydrographic characteristics aiming for the determination of spatially homogeneous areas. The eutrophication monitoring programes should pursue to assess the eutrophication phenomena, based on the differentiation of the scale and time dependent signals from human induced versus natural eutrophication.

Temporal Scope guidance

Flexibility should be incorporated into the design of the monitoring programme to take account of differences in each marine sub-region/area. At the Mediterranean Sea latitudes, in general terms, the pre-summer and winterprimary production bloom intensity peaks of natural eutrophication will define the strategy for the sampling frequency, altough year round measurements of nutrients may be more appropriate. The optimum frequency (seasonal 2 to 4 times per year or monthly 12 times per year) for the monitoring of nutrients at the selected stations should be choseen taking into account the necessity of both to control the deviations of the known natural cycles of eutrophication in coastal areas and the control of (decreasing) trends monitoring impacted areas, therefore, from low frequency (mínimum)to high frequency measurements.
Therefore, either for impacted or non-impacted coastal waters the optimal frequency per year and sampling locations needs to be selected at a local scale, whilst for open waters the sampling frequency to be determined on a sub-regional level following a risk-based approach.

Data analysis and assessment outputs

Although the individual nutrient concentrations and nutrient ratios will be evaluated based on statistical analysis against known reference levels and known marine eutrophication processes, following the evaluation of information provided by a number of countries and other available information, it has to be noted that the Mediterranean countries are using different eutrophication non-mandatory assessment methods such as TRIX, UNITRIX, Eutrophication scale, EI, HEAT, OSPAR, etc. These tools are very important to continue to be used at sub-regional or national levels because there is a long term experience within countries which can reveal / be used for assessing eutrophication trends.
However, in order to increase coherence and comparability regarding eutrophication assessment methodologies, is recommended that further efforts should be made to harmonize existing tools through workshops, dialogue and comparative exercises at regional/subregional/subdivision levels in Mediterranean with a view to further develop common assessment methods.
EXAMPLE: The TRIX index (Vollenweider et al., 1998) may be used for a preliminary assessment of the trophic status of coastal waters in relation to eutrophication providing that its advantages and shortcomings are taken into account (Primpas and Karydis, 2011). The adopted UNEP/MAP MED POL short term eutrophication monitoring strategy monitored parameters to support the TRIX index. This Index is widely used to synthesize key eutrophication variables into a simple numeric expression

Indicator Title	13. Concentration of key nutrients in water column (EO5)	
to make information comparable over a wide range of trophic situations: TRIX Index = (Log10 [ChA·aD%O·DIN·TP]+ k)·m , where: ChA = Chlorophyll a concentration as mg/L; aD%O = Oxygen as absolute % deviation from saturation; DIN = Dissolved Inorganic Nitrogen, N-($NO_3+NO_2+NH_4$) as µg/L; TP = Total Phosphorus as µg/L; k=1.5; m = 10/12 = 0.833		
Expected assessments outputs As sugested by the online expert group on eutrophication established by the Contracting parties it is recommended that with regard to nutrient concentrations, until commonly agreed thresholds have been determined and agreed upon, GES may be determined on a levels and trend monitoring basis.		
Known gaps and uncertainties in the Mediterranean For a complete assessment of eutrophication and GES achievement, GES thresholds and reference conditions (natural background concentrations) are needed not only for chlorophyll-a, but such values must be set in the near future, through dedicated workshops and exercises also for nutrients, transparency and oxygen as minimum requirements (see also related Common Indicator 14). This shoudl include quality assurance schemes, as well as data quality control protocols. Nutrient, transparency and oxygen thresholds and reference values may not be identical for all areas, since is recognized that area-specific environmental conditions must define threshold values. GES could be defined on a sub-regional level, or on a sub-division of the sub-region (such as the Northern Adriatic), due to local specificities in relation to the trophic level and the morphology of the area.		
Contacts and version Date		
http://www.unepmap.org		
Version No	**Date**	**Author**
V.1	8/12/16	MEDPOL

11. Common Indicator 14: Chlorophyll-a concentration in water column (EO5);

Indicator Title	14. Chlorophyll-a concentration in water column (EO5)	
Relevant GES definition	**Related Operational Objective**	**Proposed Target(s)**
Natural levels of algal biomass, water transparency and oxygen concentrations in line with prevailing physiographic, geographic and weather conditions	Direct and indirect effects of nutrient over-enrichment are prevented	1.Chl-a concentrations in high-risk areas below thresholds 2.Decreasing trend in chl-a concentrations in high risk areas affected by human activities 3. Index of turbidity behind threshold in high risk areas 4. Increasing trend of transparency in areas impacted by human activities 5. Dissolved oxygen concentrations in high-risk areas above local threshold 6. Increasing trend in dissolved oxygen concentrations in areas impacted by human activities

Rational

Justification for indicator selector

Eutrophication is a process driven by enrichment of water by nutrients, especially compounds of nitrogen and/or phosphorus, leading to: increased growth, primary production and biomass of algae; changes in the balance of nutrients causing changes to the balance of organisms; and water quality degradation. The consequences of eutrophication are undesirable if they appreciably degrade ecosystem health and/or the sustainable provision of goods and services, such as excessive algal blooms, dissolved oxygen deficiency, declines in sea-grasses, mortality of benthic organisms and/or fish. Although these changes may also occur due to natural processes, the management concern begins when they are attributed to anthropogenic sources.

Scientific References

i. Boyer J.N. Kelble C.R., Ortner P.B., Rudnick D.T., 2009. Phytoplankton bloom status: Chlorophyll a biomass as an indicator of water quality condition in the southern estuaries of Florida, USA. Ecological Indicators 9s:s56- s67.
ii. Primpas I., Karydis M., 2011. Scaling the trophic index (TRIX) in oligotrophic marine environments. Environmental Monitoring and Assessment July 2011, Volume 178, Issue 1-4, pp 257-269.
iii. Vollenweider, R.A., Giovanardi F., Montanari, G., Rinaldi A., 1998. Characterization of the trophic conditions of marine coastal waters, with special reference to the NW Adriatic Sea: proposal for a trophic scale, turbidity and generalized water quality index. Environmetrics, 9, 329-357.

Policy Context and targets

Policy context description

In the Mediterranean, the UNEP/MAP MED POL Monitoring programme included from its inception the study of eutrophication as part of its seven pilot projects approved by the Contracting Parties at the Barcelona meeting

Indicator Title	14. Chlorophyll-a concentration in water column (EO5)

in 1975 (UNEP MAP, 1990a,b). The issue of a consistent monitoring strategy and assessment of eutrophication was first raised at the UNEP/MAP MED POL National Coordinators Meeting in 2001 (Venice, Italy) which recommended to the Secretariat to elaborate a draft programme for monitoring of eutrophication in the Mediterranean coastal waters (UNEP/MAP MED POL, 2003). In spite of a series of assessments reviewing the concept and state of eutrophication, there are important gaps in the capacity to assess the intensity of this phenomenon. Efforts have been devoted to define the concepts to assess the intensity and to extend experience beyond the initial sites in the Adriatic Sea, admittedly, the most eutrophic area in the entire Mediterranean Sea. In the context of the Mediterranean Sea, the European Marien Strategy Framework Directive (200/56/EC) and the Integrated Monitoring and Assessment Programe (UNEP/MAP, 2016), are the two main policy tools for the eutrophication phenomenon.

Targets

For each defined marine spatial scale (region, sub-region ,etc.) the levels should be compared against agreed threshold levels defining High/Good and Good/Medium environmental status based on the indicative thresholds and reference values of Chl-a in Mediterranean coastal water types, according to the Commission Decision of 20 September 2013 (2013/480/EU) establishing, pursuant to Directive 2000/60/EC (WFD), the values of the Member State monitoring system classifications as a result of the intercalibration exercise and repealing Decision 2008/915/EC, recalling on reference conditions (High/Good) and boundaries of good/moderate status (G/M).

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
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).

Nutrient/Eutrophication related Policy documents

v. UNEP/MAP MED POL (2003). Eutrophication Monitoring Strategy of UNEP/MAP MED POL. UNEP(DEPI)MED WG.231/14. UNEP, Athens.
vi. 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.
vii. UNEP/FAO/WHO (1996). 'Assessment of the state of eutrophication in the Mediterranean Sea'. MAP Technical Reports Series No 106. UNEP, Athens, 211 pp.
viii. UNEP/MAP MED POL (1990a). Activity IV: Research on the effects of pollutants on Marine Organisms and their Populations (UNEP/MAP MED POL Phase I, 1975-1981).
ix. UNEP/MAP MED POL(1990b). Activity V: Research on the effects of pollutants on Marine Communities and Ecosystems (UNEP/MAP MED POL Phase I, 1975-1981).

Indicator analysis methods

Indicator Definition
Chlorophyll-a concentration in the water column (State, Impact Indicator);

Sub-Indicators: Water Transparency (State, Impact Indicator) and Dissolved oxygen (State, Impact

Indicator Title	14. Chlorophyll-a concentration in water column (EO5)
Indicator)	

Methodology for indicator calculation

Chlorophyll: Spectrophotometry.
ISO 10260 (1992) on spectrometric determination of the chlorophyll-a concentration provides a standard method for quantification of chlorophyll-a.
Water transparency: measured as Secchi disk depth or according to ISO 7027:1999 Water Quality-Determination of Turbidity
Dissolved Oxygen: Chemical methods, Oxygen sensors, etc. measured near the bottom (under the euphotic layer/oxycline)

Indicator units

microgram per liter (μg/L) - Chlorophyll a
meters – Secchi disk depth; NTU Turbidity Scale (Nephelometric Turbidity Units) – Water transparency
milligram per liter (mg/L) and % Saturation (if temperature and salinity is known) – Dissolved Oxygen

List of Guidance documents and protocols available

i. OSPAR, 2012. OSPAR MSFD Advice Document on Eutrophication. Approaches to determining good environmental status, setting of environmental targets and selecting indicators for Marine Strategy Framework Directive descriptor 5
ii. Piha, H., Zampoucas, N., 2011. Review of Methodological Standards Related to the Marine Strategy Framework Directive Criteria on Good Environmental Status. JRC Scientific and Technical Reports, EUR 24743 EN
iii. UNEP/MAP MED POL, 2005. Sampling and Analysis Techniques for the Eutrophication Monitoring Strategy of UNEP/MAP MED POL. MAP Technical Reports Series No. 163. UNEP, Athens. 61pp.

Data Confidence and uncertainties

Despite the great variability born by the water layers subject to active hydrodynamic processes, monitoring the characteristics of the seawater is still the most direct way of assessing eutrophication. A number of parameters have been identified as providing most information relative to eutrophication e.g. chlorophyll, dissolved oxygen, inorganic nutrients, organic matter, suspended solids, light penetration, aquatic macrophytes, zoobenthos, etc. They all may be determined either at the surface or at various depths.
If only limited means are available, determination of those parameters that synthesize the most information should be retained. Chlorophyll determinations for example, although not very precise representations of the system, are data which provide a great deal of information. Turbidity may also be a good measure of eutrophication, except near the mouths of rivers where inert suspended solids may be extremely abundant. Dissolved oxygen is one parameter that integrates much information on the processes involved in eutrophication, provided it is measured near the bottom or, at least, below the euphotic zone where an oxycline usually appears.

Methodology for monitoring, temporal and spatial scope

Available Methodologies for Monitoring and Monitoring Protocols

Traditional methods for eutrophication monitoring in coastal waters involve in situ sampling/measurements of commonly measured parameters such as nutrients concentration, chlorophyll 'a' concentration, phytoplankton abundance and composition, transparency and dissolved oxygen concentration. Concerning available methods for in situ measurements, ships provide flexible platforms for eutrophication monitoring, while remote sensing provides opportunities for a synoptic view over regions or sub-regions. Besides traditional ship measurements, ferry-boxes and other autonomous measuring devices have been developed that allow high frequency and continuous measurements.
Modelling and remote sensing should also be considered as alternatives or in addition to in situ

Indicator Title	14. Chlorophyll-a concentration in water column (EO5)

measurements, depending on the requirements with respect to data. In general, in situ measurements always remain necessary to validate and calibrate the models and data calculated from satellite measurements.

However, satellite data need to be supported by ground-truth data. A good strategy appears to be a combination of remote sensing and scanning of the area known or suspected to be affected with automatic measuring instruments such as thermo-salinometer, dissolved oxygen sensors and in vivo fluorometer and/or nephelometer. Sampling for the determination of “in vitro” fluorescence and nutrient analysis may be carried out with relatively little effort if a proper pump and hose are mounted on the ship. The measurements may be done at the surface or just below it with a water intake on the hull of the vessel or at fixed or varying depths with a towed “fish” and pumping system.

Available data sources

http://www.unepmap.org

Satellite databases such as in EMIS http://mcc.jrc.ec.europa.eu/emis/

Spatial scope guidance and selection of monitoring stations

The extent of eutrophication shows spatial variation, for instance coastal regions versus the open sea. The frequency and spatial resolution of the monitoring programme should reflect this spatial variation in eutrophication status and pressures following a risk based approach and the precautionary principle. The geographical extent of potentially eutrophic waters may vary widely, depending on:

(i) the extent of shallow areas, i.e. with depth ≤ 20 m;

(ii) the extent of stratified river plumes, which can create a shallow surface layer separated by a halocline from the bottom layer, whatever its depth

(iii) extended water residence times in enclosed seas leading to blooms triggered to a large degree by internal and external nutrient pools; and

(iv) upwelling phenomena leading to autochthonous nutrient supply and high nutrient concentrations from deep water nutrient pools, which can be of natural or human origin.

Therefore, the geographical scale of monitoring for the assessment of GES for eutrophication will depend on the hydrological and morphological conditions of an area, particularly the freshwater inputs from rivers, the salinity, the general circulation, upwelling and stratification. The spatial distribution of the monitoring stations should, prior to the establishment of the eutrophication status of the marine sub-region/area, be risk-based and proportionate to the anticipated extent of eutrophication in the sub-region under consideration as well as its hydrographic characteristics aiming for the determination of spatially homogeneous areas. The eutrophication monitoring programes should pursue the assessment of the eutrophication phenomena, based on the differentiation of the scale and time-dependent signals from human induced versus natural eutrophication.

Temporal Scope guidance

The current national eutrophication monitoring programmes implemented so far by the Contracting Parties in the framework of the UNEP/MAP MED POL programme should be used as a sound basis for monitoring under the EcAp. It could be recommended:

Chl-a: For coastal stations minimum sampling 4/year, 6-12 /year recommended; For open waters sampling frequency to be determined on a sub-regional level following a risk based approach

Water transparency: idem Chl-a

Dissolved Oxygen: idem Chl-a

Data analysis and assessment outputs

Statistical analysis and basis for aggregation

The classification scheme on chl-a concentration developed by MEDGIG as an assessment method easily applicable by all Mediterranean countries based on the indicative thresholds and reference values adopted. Further, developments within the European MSFD and OSPAR Commission with regard eutrophication should also be taken into account.

Indicator Title	14. Chlorophyll-a concentration in water column (EO5)

Further, it has to be noted that the Mediterranean countries are using different eutrophication non-mandatory assessment methods such as TRIX, UNITRIX, Eutrophication scale, EI, HEAT, OSPAR, etc. These tools are very important to continue to be used at sub-regional or national levels because there is a long term experience within countries which can reveal / be used for assessing eutrophication trends.
However, in order to increase coherency and comparability regarding eutrophication assessment methodologies is recommended that further efforts should be made to harmonize existing tools through workshops, dialogue and comparative exercises at regional/subregional/subdivision levels in Mediterranean with a view to further develop common assessment methods.

EXAMPLE: The TRIX index (Vollenweider et al., 1998) may be used for a preliminary assessment of the trophic status of coastal waters in relation to eutrophication providing that its advantages and shortcomings are taken into account (Primpas and Karydis, 2011). The adopted UNEP/MAP MED POL short term eutrophication monitoring strategy monitored parameters to support the TRIX index. This Index is widely used to synthesize key eutrophication variables into a simple numeric expression to make information comparable over a wide range of trophic situations:
TRIX Index = (Log10 [ChA·aD%O·DIN·TP]+ k)·m , where:
ChA = Chlorophyll a concentration as mg/L; aD%O = Oxygen as absolute % deviation from saturation;
DIN = Dissolved Inorganic Nitrogen, N-(NO3+NO2+NH4) as μg/L; TP = Total Phosphorus as μg/L; k=1.5; m = 10/12 = 0.833

Expected assessments outputs

GES thresholds and trends are recommended to be used in a combined way, according to data availability and agreement on GES threshold levels. In the framework of UNEP/MAP MED POL there is experience with regard to using quantitative thresholds. It is proposed that for the Mediterranean region, quantitative thresholds between “good” (GES) and “moderate” (non GES) conditions for coastal waters could be based as appropriate on the work carried out in the framework of the MEDGIG intercalibration process of the EU Water Framework Directive (WFD).The Contracting Parties are recommended to rely on the classification scheme on chl-a concentration (μg/l) in coastal waters as a parameter easily applicable by all Mediterranean countries based on the indicative thresholds and reference values of Chl-a in Mediterranean coastal water types (according to 2013/480/EU, see reference below), recalling on reference conditions and boundaries of good/moderate status (G/M).
In this context regarding the definition of subregional thresholds for chlorophyll-a water typology is very important for further development of classification schemes of a certain area. Within the MEDGIG exercise the recommended water types for applying eutrophication assessment is based on hydrological parameters characterizing a certain area dynamics and circulation.
2013/480/EU: Commission Decision of 20 September 2013 establishing, pursuant to Directive 2000/60/EC of the European Parliament and of the Council, the values of the Member State monitoring system classifications as a result of the intercalibration exercise and repealing Decision 2008/915/EC

Known gaps and uncertainties in the Mediterranean

For a complete assessment of eutrophication and GES achievement, GES thresholds and reference conditions (natural background concentrations) are needed not only for chlorophyll-a, but such values must be set (in the near future), through dedicated workshops and exercises also, water transparency and oxygen as minimum requirements. This shoudl include quality assurance schemes, as well as data quality control protocols.
Further, in order to increase coherence and comparability regarding eutrophication assessment methodologies, it is recommended that further efforts should be made to harmonize existing tools

Indicator Title	14. Chlorophyll-a concentration in water column (EO5)	
through workshops, dialogue and comparative exercises at regional/subregional/subdivision levels in Mediterranean with a view to further improve and develop common assessment methods.		
Contacts and version Date		
http://www.unepmap.org		
Version No	**Date**	**Author**
V.1	8/12/16	MEDPOL

12. Common Indicator 15: Location and extent of the habitats impacted directly by hydrographic alterations (EO7);

Indicator Title	*Common Indicator 15: Location and extent of the habitats impacted directly by hydrographic alterations*	
Relevant GES definition	**Related Operational Objective**	**Proposed Target(s)**
Negative impacts due to new structures 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 *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. For example, the definition of functional habitats under EO1 could help identify the priority benthic habitats for consideration in EO7 (see Annex 1, for a first general identification of these habitats). 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.* *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*		
Policy Context and targets		
Policy context description **Protocol Concerning Specially Protected Areas and Biological Diversity in the Mediterranean** calls 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 Parties to		

Indicator Title	*Common Indicator 15: Location and extent of the habitats impacted directly by hydrographic alterations*

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".

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 is basically transposed MSFD's Descriptor 7. However, it should be kept in mind that this Directive is eligible only at the EU level.

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 impacted directly by the alterations and/or the circulation changes induced by them: footprints of impacting structures. It concerns area/habitat and the proportion of the total area/habitat where alterations of hydrographical conditions are expected to occur (estimations by modeling 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) Modeling potential changes in the spatial extent of habitats affected by permanent alterations, using field data and validated model data.

Models should be calibrated and continuously supported and validated with "in situ" monitoring datasets.

A methodological approach of how to reflect the objectives of the Hydrography Common Indicator, in the main steps undertaken in an EIA (and SEA) procedure can be seen in Figure 1.

Indicator Title	*Common Indicator 15: Location and extent of the habitats impacted directly by hydrographic alterations*

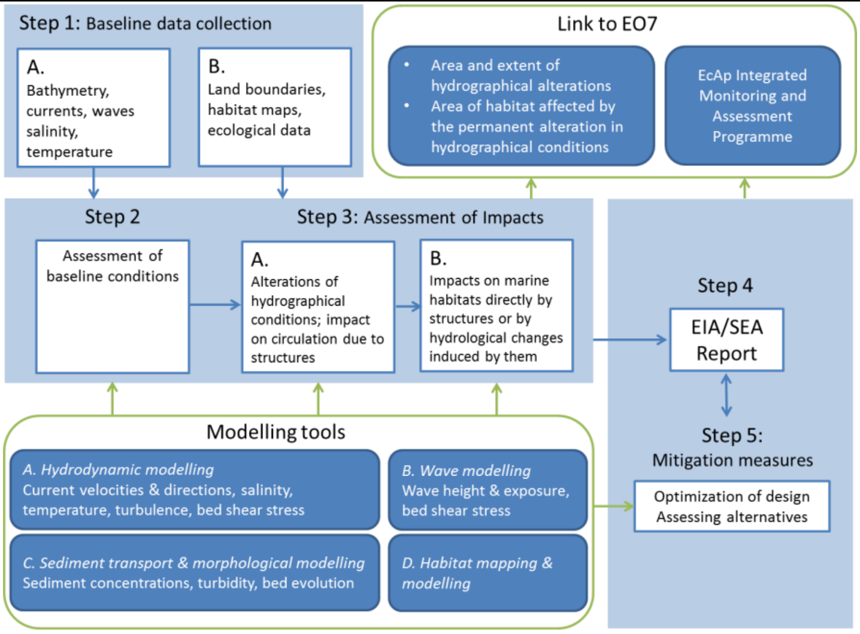

Figure 1. Methodological approach of how to integrate the EIA/SEA process with the implementation of EO7

More details on methodological approach can be found in Chater 4.1.1. of the „Guidance Document on how to reflect changes in hydrographical conditions in relevant assessments".

Depending on the existence and availability of data and on the physical or biological processes to be taken into account, different physical characteristics sould be monitored.

For coastal site, in which the distribution of habitats of interest and the off-shore hydrodynamic conditions are „well known", having topo-bathymetric data of the study zone (including the structure to be built) and data (measured or modelled) should be sufficient to calibrate the model and numerically assess hydrographic alterations caused by structures.For more particular or complex cases, other physical characteristics can be needed (seafloor topography, turbidity, fresh water input, salinity, temperature...).

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

Indicator units

- *km2of impacted habitat*
- *proportion (%) of the total area/habitat impacted*

List of Guidance documents and protocols available

- *"Guidance document on how to reflect changes in hydrographical conditions in relevant assessments" by Spiteri, C. (2015);*
- *"Draft Integrated Monitoring and Assessment Guidance";*
- *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

Indicator Title	*Common Indicator 15: Location and extent of the habitats impacted directly by hydrographic alterations*

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.
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.*

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 Scopeguidance
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 distribution (area, location, eventually density…) of the habitats of interest located in and around the future impacted area and 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)*
  During this period, strong changes should happen on hydrographical, morphological and habitat 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 distribution of the habitats of interest around the construction and the changes in hydrodynamic conditions (assessed by comparing present and initial conditions).*
- *After construction (5 to 10 years after)*
  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 habitats considered (link*

Indicator Title	*Common Indicator 15: Location and extent of the habitats impacted directly by hydrographic alterations*
to EO1 → adequate frequency/habitat)and on the intensity of changes in hydrographical, morphological or habitats 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).* *NOTE: "The exact format of habitats/GIS data will be defined in link with EO1 indicator."* *The data on hydrographical conditions concern the wave and current conditions of the study zone, without and with the construction and the resulting hydrographical alterations. To ensure uniformity and comparability of all these data, their expected characteristics should be defined.*	
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, 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. To identify these lacks, a global and clear inventory of existing and available data in Mediterranean Sea should be done.* *Other difficulties come from the use of numerical models to assess hydrographic alterations. These tools need several data (bathymetry, offshore hydrodynamics data, field data) and can be costly and time-consuming. Moreover, the use of these tools needs some experience and some knowledge about the processes and theories involved.* *To conclude, such an integrated assessment of impacts calls for additional research efforts on habitat modeling, pressure mapping and cumulative impacts, along with monitoring of potentially affected areas.*	
Contacts and version Date	
Key contacts within UNEP for further information	

Indicator Title	*Common Indicator 15: Location and extent of the habitats impacted directly by hydrographic alterations*	
Version No	**Date**	**Author**
V.1	27/6/16	PAP/RAC
V2	11/07/16	Olivier Brivois
V3	13/07/16	Olivier Brivois

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

Indicator Title	17. Concentration of key harmful contaminants measured in the relevant matrix (EO9)	
Relevant GES definition	**Related Operational Objective**	**Proposed Target(s)**
Level of pollution is below 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 either Background Assessment Criteria or Environmental Assessment Criteria (BACs/EACs) or below reference concentrations (from other sources) 2. No deterioration trends 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 selector

Environmental chemical pollution is directly linked with humankind activities and advancements. 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, marine and atmospheric) are the first steps to understand and discover a growing environmental problem. The monitoring of the spatial and temporal scales of the harmful and noxious substances' occurrence determines either a chronic or acute contamination/pollution episode. Currently, new man-made chemicals and emerging pollutants continue to enter the marine environment and interact with the different marine 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.

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.
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., Šcancar, J., Milacic, R., Kniewald, G., Mikac, N., 2012. Organotin compounds in seawater and Mytilus galloprovincialis mussels along the Croatian Adriatic Coast. *Mar.Poll.Bull.*, 64, 189–199
vi. Nakata, H., Shinohara, R.I., Nakazawa, Y., Isobe, T., Sudaryanto, A., Subramanian, A., Tanabe, S., Zakaria, M.P., Zheng, G.J., Lam, P.K.S., Young Kim, E., Yoon Min, B., Wef, S.U., Hung Viet, P., Tana, T.S., Prudente, M., Donnell, F., Lauenstein, G., Kannan, K., 2012. Asia–Pacific mussel watch for emerging pollutants: Distribution of synthetic musks and benzotriazole UV stabilizers in Asian and US coastal waters. Mar. Pollut. Bull., 64, 2211–2218

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

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 ecosystem compartments are undertaken in response to the UNEP/MAP Barcelona Convention (1975) and its Land-Based Protocol, the UNEP/MAP MED POL Monitoring Program, as well as international, european (e.g. EU WFD or EU MSFD) or other national policy drivers. A considerable amount of founding actions are available through the pollution monitoring and assessment component of the UNEP/MAP MED POL Programme from the past decades, including monitoring pilot programmes (ecotoxicological effects of contaminats). 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 its policy framework built in the Mediterranean Sea.

Targets

Initial targets of GES under Common Indicator 17 will be focused on the control of environmental levels, trend improvements and the reduction of emissions at sources. The target monitoring will be based upon data of a relatively small number of both legacy and 'traditional' chemicals reflecting the scope of current programmes and the availability of suitable agreed assessment criteria for them. The inclusion of emerging chemical compounds of environmental concern and their targets for GES within IMAP will be implemented as the scientific knowledge develops.

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
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/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.
vii. 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.
viii. UNEP/MAP MED POL – Phase III, Programme for the Assessment and Control of Pollution

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

in the Mediterranean Region. MAP Technical Report Series No. 120, UNEP, Athens, 1999.
ix. OSPAR Commission, 2013. Levels and trends in marine contaminants and their biological effects - CEMP Assessment Report 2012. Monitoring and Assessment Series, 2013.
x. EEA, 2003. Hazarous 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
xi. EEA, 1999 State and pressures of the marine and coastal Mediterranean environment. Enivronmental issues series nº5. European Environmental Agency, Copenhagen, 1999. http://www.eea.eu.int

Indicator analysis methods

Indicator Definition

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

BIOTA: In marine organisms, whole soft tissues or dissected parts according sampling and sample preparation protocols, and primarily in bivalve species and/or fish:
Trace/Heavy Metals (TM): Total mercury (HgT), Cadmium (Cd) and Lead (Pb)
Organochlorinated compounds (PCBs, Hexachlorobenzene, Lindane and ΣDDTs)
Polycyclic aromatic hydrocarbons (US EPA 16 Reference PAHs Compounds),

Lipid content, flesh fresh/dry weight ratio for normalisation purposes

SEDIMENTS: In coastal, platform and offshore sediments (< 2 mm particle size fraction):
Trace/Heavy Metals: Total mercury (HgT), Cadmium (Cd) and Lead (Pb)
Organochlorinated compounds (PCBs, Hexachlorobenzene, Lindane and ΣDDTs)
Polycyclic aromatic hydrocarbons (US EPA 16 Reference PAHs Compounds)

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

SEAWATER: the monitoring for environmental assessment purposes and the determination of contaminants in seawater presents specific challenges and higher costs. For the mid/long-term monitoring programes, such as IMAP, these are recommended to be carried out on a country decision basis.

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

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.

Indicator units

Trace/Heavy Metals (TM) and Aluminium: mass/dry or wet weight mass of sample according MEDPOL

Indicator Title	17. Concentration of key harmful contaminants measured in the relevant matrix (EO9)
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 are subject to Quality Assurance Protocols and interlaboratory exercises: QA/QC through UNEP/MAP MED POL/IAEA MESL, National QA/QC Procedures	
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 of contaminants and effects in the sea, 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 in pollutant concentrations.	
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. 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.	
Spatial scope guidance and selection of monitoring stations The spatial scope for monitoring should include long-term master stations, distributed spatially as relevant and should include local spatial refinements, such as transect sampling (for sediment and/or active biomonitoring). Therefore, it is a direct function of the assessment of risks and the monitoring purpose (long-term). The selection of the sampling sites for the monitoring of contaminants and biological effects in the marine environment should consider: • Areas of concern identified on the basis of the review of the existing information. • 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). • Sites representative in monitoring of other sea-based (shipping) and atmospheric sources. • Reference sites: For reference values and background concentrations.	

Indicator Title	17. Concentration of key harmful contaminants measured in the relevant matrix (EO9)	
• Representative sensitive pollution sites/areas at sub regional scale. • Deep-sea sites/areas of potential particular concern The selected sites should allow the collection of a realistic number of samples over the years (e.g. be suitable for sediment sampling, 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. Coordination with monitoring for other Ecological Objectives is crucial for cost-effective and future integrated assessment.		
Temporal Scope guidance Sampling frequencies will be determined by the purpose and the status of the national marine monitoring. INITIAL PHASE MONITORING: BIOTA (mussel yearly) and SEDIMENTS (coastal every two years) ADVANCED PHASE MONITORING (fully completed and reported MED POL Phase III datasets): BIOTA (from 1 to 3 years according trends and chemicals) and SEDIMENTS (from 3 to 6 years depending on the characteristics of sedimentation areas and the chemical concerned). The temporal scope may range from seasonally variable parameters up to large time scales, e.g. sediment core monitoring (years to decades). 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 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.		
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 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. Therefore, the 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 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	13/1/17	MEDPOL

14. <u>Common Indicator 18: Level of pollution effects of key contaminants where a cause and effect relationship has been established (EO9);</u>

Indicator Title	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	1. Contaminants effects below thresholds. Levels of biomarkers identified comply with agreed Mediterranean Background Assessment Criteria or Environmental Assessment Criteria (BACs/EACs). .
Rational		

Justification for indicator selector

Upon exposure to certain doses 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 subcellular level. These ’sublethal’ effects, when integrated, often converge to visible harm for the organisms and posible 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 doses) 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 subcellular 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, suchs as ‘omics’ developments, will futher define the indicators and the methodologies for these common indicator for toxicological effects.

Scientific References

i. European Comission, 2014. Technical report on aquatic effect-based monitoring tools. Technical Report - 2014 – 077.
ii. Davies, I. M. And Vethaak, A.D., 2012. Integrated marine environmetal monitoring of chemicals and their effects. ICESCoopérative 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
v. Scarpato, R., L. Migliore, G. Alfinito-Cognetti and R. Barale (1990), Induction of micronuclei in gill tissue of *Mytilus galloprovincialis* 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 *Limanda limanda. 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

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

In most Mediterranean countries, the monitoring of a range of hazardous chemical substances in different marine ecosystem compartments are undertaken in response to the UNEP/MAP Barcelona Convention (1975) and its Land-Based Protocol, the UNEP/MAP MED POL Monitoring Program, as well as international, european (e.g. EU WFD or EU MSFD) or other national policy drivers. A considerable amount of founding actions are available through the pollution monitoring and assessment component of the UNEP/MAP MED POL Programme from the past decades, including monitoring pilot programmes (ecotoxicological effects of contaminats). The environmental assessments have been used for the identification and confirmation of significant marine contaminant occurrence, distribution, 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 its policy 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
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 *Mytilus galloprovincialis*) and/or fish (such as *Mullus barbatus*)

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

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, comet assay, hepatic pathologies assessment, reduction of survival in air by Stress on Stress (SoS), larval embryotoxicity assay).

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

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 disolved.

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

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

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 of contaminants and effects in the sea, 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. 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 biomonitoring activities, in line with the new monitoring requirements.

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.

Spatial scope guidance and selection of monitoring stations

The spatial scope for monitoring should include long-term master stations, distributed spatially as relevant and include local spatial refinements, such as transect sampling (for sediment and/or active biomonitoring), and therefore, is a direct function of the assessment of risks and the monitoring purpose (long-term). The selection of the sampling sites for the monitoring of contaminants and biological effects in the marine environment should consider:

• Areas of concern identified on the basis of the review of the existing information.
• 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).
• Sites representative in monitoring of other sea-based (shipping) and atmospheric sources.
• Reference sites: For reference values and background concentrations.
• Representative sensitive pollution sites/areas at sub regional scale.
• Deep-sea sites/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 by the purpose and the status of the national marine monitoring.

INITIAL PHASE MONITORING: BIOTA (mussel yearly) and SEDIMENTS (coastal every two years),

<table>
<tr><td>Indicator Title</td><td colspan="2">18. Level of pollution effects of key contaminants where a cause and effect relationship has been established (EO9)</td></tr>
<tr><td colspan="3">as for chemical monitoring focusing on few locations (hotspots and reference stations) if biological effects will be determined for both.

ADVANCED PHASE MONITORING (fully completed and reported MED POL Phase III datasets, including biological effects): At these stage the objective should be the integration of the chemical and biological monitoring on a efficient manner. Therefore, a refinement of the biological effects long-term monitoring should be implemented and maintained based on previous pilot monitoring activities (Initial Phase).

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.</td></tr>
<tr><td colspan="3">Data analysis and assessment outputs</td></tr>
<tr><td colspan="3">Statistical analysis and basis for aggregation

Monitoring should allow the necessary statistical data treatments and long-term time-trend analysis.</td></tr>
<tr><td colspan="3">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 BACs can be estimated, whereas for biomarkers of effects both BACs and EACs can be established.</td></tr>
<tr><td colspan="3">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.</td></tr>
<tr><td colspan="3">Contacts and version Date</td></tr>
<tr><td colspan="3">http://www.unepmap,org</td></tr>
<tr><td>Version No</td><td>Date</td><td>Author</td></tr>
<tr><td>V.2</td><td>13/1/16</td><td>MEDPOL</td></tr>
</table>

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

Indicator Title	19. Occurrence, origin (where possible), and extent of acute pollution events (e.g. slicks from oil, oil products and hazardous substances) and their impact on biota affected by this pollution (EO9)	
Relevant GES definition	**Related Operational Objective**	**Proposed Target(s)**
Occurrence of acute pollution events is reduced to the minimum.	Acute pollution events are prevented and their impacts are minimized	1. Decreasing trend in the occurrences of acute pollution events. Minimum tolerance (near to 0 events) is considered under MARPOL Annex I for the Mediterranean Sea (special area)
Rational		
Justification for indicator selector Oil spills and acute/chromic events of oil introduction in the marine environment cause proven impairment of the health of ecosystems at all levels (coastal habitats, seabirds, marine mammal populations, offshore, etc.), as well as socio-economic impacts (mainly on tourism, fisheries and aquaculture). The prevention and control of major acute pollution events needs to be monitored.		
Scientific References ITOPF.“Effect of oil pollution on the marine environment”. ITOPF, Technical Information Paper 13. GESAMP.Report n° 75: “Estimates of Oil Entering the Marine Environment from Sea-Based Activities”, IMO/FAO/UNESCO-IOC/WMO/WHO/IAEA/UN/UNEP Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection (2007). Zeina G. Kassaify, Rana H. El Hajj, Shady K. Hamadeh, Rami Zurayk and Elie K. Barbour. “Impact of Oil Spill in the Mediterranean Sea on Biodiversified Bacteria in Oysters”,Journal of Coastal Research, Vol. 25, No. 2 (2009), pp. 469-473. Published by: Coastal Education & Research Foundation, Inc. Peterson CH, Rice SD, Short JW, Esler D, Bodkin JL, Ballachey BE, Irons DB. “Longterm ecosystem response to the Exxon Valdez oil spill”. Science 302:2082–2086(2003).		
Policy Context and targets		
Policy context description Acute pollution from oil and other hazardous substances, resulting either from maritime casualties or from ships’ routine operations, are addressed in a number of international conventions leaded by IMO (IMO is the UN agency regulating pollution incidents from ships worldwide), some of which provide for stricter regimes in the Mediterranean Sea, including discharges of oil and oily mixtures. At regional level, the UNEP/MAP-Barcelona Convention and its Prevention and Emergency Protocol are crucial instruments enabling cooperation and joint-action to support all Mediterranean Coastal States implementing and enforcing IMO Conventions on pollution prevention and preparedness and response to oil and Hazardous and Noxious Substances (HNS) spills. The Regional Marine Pollution Emergency Response Centre for the Mediterranean Sea (REMPEC),administered by IMO and operating within the framework of UNEP/MAP, is responsible for the implementation of the Prevention and Emergency Protocol, and maintains a database on alerts and accidents causing or likely to cause pollution of the sea by oil (since 1977) and by other harmful substances (since 1989) in the Mediterranean Sea. Further, the adoption in COP 19 of the UNEP/MAP		

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

Barcelona Convention Offshore Protocol Action Plan (The Protocol for the Protection of the Mediterranean Sea against Pollution from the Exploration and Exploitation of the Continental Shelf and the Seabed and its Subsoil (Offshore Protocol), the Contracting Parties should endeavor to ratify the Protocol and develop and adopt monitoring procedures and programmes for offshore activities, is envisaged to take place building on the IMAP of the EcAp.

Targets

Initial targets of GES under Common Indicator 18 will be reduction of oil spills and acute/chronic events, and therefore decreasing the occurrence trends (minimum tolerance, near to 0 events is considered under MARPOL Annex I for the Mediterranean Sea)

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

Related Policy documents

iv. Establishment of a Mediterranean Network of Law Enforcement Officials relating to MARPOL within the framework of the Barcelona Convention.UNEP(DEPI)/MED IG.21/9 Annex II – Thematic Decisions (p. 181).
v. Protocol concerning cooperation in preventing pollution from ships and, in case of emergency, combating pollution of the Mediterranean Sea (2002) ("Prevention and Emergency" Protocol of the Barcelona Convention)
vi. Protocol for the Protection of the Mediterranean Sea against Pollution from the Exploration and Exploitation of the Continental Shelf and the Seabed and its Subsoil (Offshore Protocol of the Barcelona Convention)
vii. International Convention for the Prevention of Pollution from Ships (MARPOL Convention), specifically its Annex I (Regulations for the Prevention of Pollution by Oil), Annex II (Regulations for the Control of Pollution by Noxious Liquid Substances in Bulk) and Annex III (Harmful Substances carried at Sea in Packaged Form).
viii. International Convention on Oil Pollution Preparedness, Response and Cooperation (OPRC, 1990) and Protocol on Preparedness, Response and Cooperation for pollution incidents by hazardous and noxious substances (OPRC-HNS Protocol).

Indicator analysis methods

Indicator Definition

In the case of oil and HNS acute pollution events, the indicator will be obtained from the information of oil and HNS pollution events recorded and submitted in the Mediterranean Sea each year.

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

Methodology for indicator calculation

Under the 2002 Prevention and Emergency Protocol, Contracting Parties have an obligation (Article 9), to inform on the following (see the format below):
(1) all accidents causing or likely to cause pollution of the sea by oil and other harmful substances;
(2) the presence, characteristics and extent of spillages of oil or other harmful substances observed at sea which are likely to present a serious and imminent threat to the marine environment or to the coast or related interests of one or more of the Contracting Parties;
(3) their assessments and any pollution combating actions taken or envisaged to be taken; and
(4) the evolution of the situation.

BCRS (Barcelona Convention Reporting System) format:

(a) accident location (latitude and longitude or closest shore location);
(b) accident type* (*cargo transfer failure, contact, collision, engine breakdown, fire/explosion, grounding, foundering/weather, hull structural failure, machinery breakdown, other);
(c) vessel IMO number or vessel name;
(d) vessel flag;
(e) whether any product has been released or not. If yes, the type of product released (Oil/Hazardous and Noxious Substances) should be specified; and
(f) whether any actions have been taken or not. If yes, the actions taken should be specified.

In addition to monitoring pollution events occurrences against the target (Incidents involving oil or hazardous substances are < or = 1 event per year), it is recommended to carry out a trend analysis in order to measure performance against the target. Data on actual pollution events from ships would be collected every year and compared to the data for the previous year, to calculate a % increase or a % decrease in occurrences yearly frequency.

Indicator units

The Guidelines for Co-operation in Combating Marine Oil Pollution in the Mediterranean (UNEP/IG.74/5, UNEP/MAP, 1987) recommended Parties to report to REMPEC all spillages or discharges of oil in excess of 100 cubic metres. To align with the *Revised reporting formats for a mandatory reporting system under MARPOL 73/78* ("one-line" entry format) adopted by IMO in 1996 (see MEPC/Circ.318), a Joint Session of MEDPOL and REMPEC Focal Points Meeting agreed to report spillages over 50 cubic meters.

List of Guidance documents and protocols available

i. ITOPF.“*Aerial Observation of Marine Oil Spills”*, Technical Information Paper 1;
ii. ITOPF.“*Recognition of Oil on Shorelines”*, Technical Information Paper 6;
iii. ITOPF.“*Fate of Marine Oil Spills”*, Technical Information Paper 2.
iv. ITOPF.“*Response to Marine Chemical Incidents”*, Technical Information Paper 17.
v. Bonn Agreement. “*Bonn Agreement Oil Appearance Code*”.
vi. IPIECA/IMO/GPO/CEDRE: “*Aerial Observation of Oil Spills at Sea”*, February 2015.
vii. CEDRE: “*Surveying Sites Polluted by Oil*”(April 2006).
viii. REMPEC: “*Mediterranean Guidelines on Oiled Shorelines Assessment*”(September 2009).
ix. GESAMP: “*Revised GESAMP Hazard Evaluation Procedure for Chemical Substances Carried by Ships”*(2014).
x. IMO Codes:
- For packaged goods: International Maritime Dangerous Goods Code (IMDG Code).
- For Bulk liquids: International Code for the Construction and Equipment of Ships Carrying Dangerous Chemicals in Bulk (IBC Code).

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

- For Gases: International Code for the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk (IGC Code).
- For solids in bulk: Appendix 9 of Code of Safe Practice for Solid Bulk Cargoes (BC Code) if also covered by IMDG Code in packaged form.

Data Confidence and uncertainties

Although characterization of impact of oil and oily products at sea and on shore is well documented and response strategies well defined, there has been much less investment in research for HNS spills. Chemical spills occur at a much lower frequency than spills of oil and involve a very large variety of products with different physical and toxicity properties. Therefore, the characterization of impacts from HNS pollution due to maritime casualties is more complex and response strategies and indicators will vary according to the specific chemical product involved.

Methodology for monitoring, temporal and spatial scope

Available Methodologies for Monitoring and Monitoring Protocols

As oil and HNS accidental spills and discharges from ships take the form of acute pollution events, there are no specific pollution methodologies for systematic oil and HNS pollution surveillance in IMO Conventions and guidance documents, where monitoring is addressed from the perspective of ships' compliance monitoring (flag state surveys; coastal state and port state controls) or in the context of pollution response operations. In this latter case, a monitoring protocol has been developed to detect and survey pollution events.

Pollution events are monitored using the following methods/protocols:

Oil:

- Expert human eye observation;
- Aerial observation (human eye observation and/or remote sensing equipment);
- Satellite imagery analysis.
- Sampling and analysis.

Monitoring at sea will provide the following information:

- Volume of oil: use ITOPF guidance based on oil type and appearance to assess thickness (mm) and volume of oil (m3/km2) at sea, or the guidance of the Bonn Agreement Oil Appearance Code (BAOAC) identifying the following relations between oil appearances and oil volume:
    1. sheen, 0.15-0.3 m^3/km^2
    2. rainbow, 0.3 - 5 m^3/km^2
    3. metallic, 5 - 50 m^3/km^2
    4. discontinuous true color, 50-200 m^3/km^2
    5. continuous true color, >200 m^3/km^2.
- Location and coverage of slick at sea (latitude and longitude - GPS),
- Oil characteristics (persistent vs. non persistent / viscosity),
- Origin of slick (if visible ship name and IMO number, offshore installations ID number)

On-shore monitoringon shore will be used to assess the extent of impacted shorelines, type and degree of contamination as well as impact on habitats and wildlife casualties.

HNS:

Detection of HNS pollution events and assessment of impacts is primarily achieved on site by expert human eye observation, complemented with real time monitoring, sampling and analysis, as well as the use of modelling tools. Conclusions of any risk assessment for HNS will be based on a number of information

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

including identification of incident circumstances and location; identification of the chemical involved, its properties / toxicity, and its form (packaged / bulk) as well as identification of sensitive neighbouring areas and environment conditions. Further, Article 18 of the UNEP/MAP Barcelona Convention Protocol for the Protection of the Mediterranean Sea against Pollution Resulting from Exploration and Exploitation of the Continental Shelf and the Seabed and its Subsoil (Offshore Protocol), states that in cases of emergency the Contracting Parties shall implement mutatis mutandis the provisions of the Emergency Protocol.

Available data sources

Because pollution events originating from ships must lead to response operations and investigations, there are a number of reporting obligations and reporting protocols that are useful for the purpose of determining the frequency of occurrences and assess trends:

(1) Contents and forms of reports that ships must send following maritime casualties involving oil and other hazardous substances are detailed in MARPOL Protocol I. In addition, IMO has developed the General Principles for Ship Reporting Systems and Ship Reporting Requirements, including Guidelines for Reporting Incidents Involving Dangerous Goods, Harmful Substances and/or Marine Pollutants, containing recommendations on reporting requirements (when to report, information required, whom to report to).

(2) At regional level, REMPEC has developed a oil pollution reporting format (POLREP) for use between Contracting Parties to the Prevention and Emergency Protocol of the Barcelona Convention and between these Contracting Parties and REMPEC when a pollution event at sea has occurred or when there is a threat of pollution.

(3) With respect to illegal discharges of oil from ships, REMPEC has organised pilot projects on surveillance and monitoring of oil discharges et sea in the past. These initiatives have led to the creation of the Mediterranean Network of Law Enforcement Officials (MENELAS). This network works as a forum where information is exchanged and it is expected that data on pollution incidents (as well as on investigation and prosecution as the case may be) will be collected. REMPEC presently acts as Secretariat for the MENELAS initiative, which has developed a reporting format.

(4) The Reporting System for the Barcelona Convention and its Protocols (BCRS) also requests information on spill incidents that have occurred during a biennium.

Databases available:

REMPEC Alert and Accidents Database available in the following versions:

- On-line database (accidents can be sorted by: date; accident location (country); vessel type; and release quantity and type.)
- Report containing the data and statistical analysis; and
- A Geographical Information System (GIS).

MEDGIS-MAR 2012-2015, http://medgismar.rempec.org/ provides data (private access) on offshore, marine incidents, oil handling facilities, and response equipment.

IMO Database: IMO maintains a Global Integrated Shipping Information System (GISIS) http://gisis.imo.org with a module on marine casualties and incidents.

Spatial scope guidance and selection of monitoring stations

REMPEC will continue to be the central organisation coordinating and maintaining data on oil and HNS acute events and pollution surveillance in the Mediterranean Sea. REMPEC has implemented

Indicator Title	19. Occurrence, origin (where possible), and extent of acute pollution events (e.g. slicks from oil, oil products and hazardous substances) and their impact on biota affected by this pollution (EO9)
pilot projects involving aerial surveillance exercises and satellite imagery analysis jointly with Mediterranean Coastal States and this effort should be strengthened.	
Temporal Scope guidance As oil and HNS pollution incidents from ships occurs unexpectedly (as a consequence of maritime casualties) or are not systematic (MARPOL illicit discharges), it is expected that pollution monitoring will continue to essentially take place "in real time" when pollution incidents actually happen or are detected.	
Data analysis and assessment outputs	
Statistical analysis and basis for aggregation Frequencies and quantitative statistical analysis. The basis for aggregation would be a "nested approach" over a geographical scale. Trend analysis to calculate the percentage of occurrences for oil and HNS incidents over a period of time (yearly) in the Mediterranean Sea.	
Expected assessments outputs Temporal trends analysis and distribution maps. If possible, relate this trend to the maritime traffic crossing the Mediterranean Sea.	
Known gaps and uncertainties in the Mediterranean While Contracting Parties to the Barcelona Convention and the Prevention and Emergency Protocol have a pollution monitoring and reporting obligation, data submitted to REMPEC are still scarce. Thus the main aim during the Initial Phase of the IMAP will be to strengthen monitoring efforts towards this already existing obligation. Further, there is a lack of obligation for Reporting on Coastal and marine habitats and biota impacted or physically affected. It could be used as a new pressure/impact indicator to assess the overall impact in the marine ecosystems.	
Contacts and version Date	
http://www.rempec.org	

Version No	**Date**	**Author**
V.2	13/1/17	MEDPOL/REMPEC

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

Indicator Title	20. Actual levels of contaminants that have been detected and number of contaminants which have exceeded maximum regulatory levels in commonly consumed seafood (EO9)	
Relevant GES definition	**Related Operational Objective**	**Proposed Target(s)**
Concentrations of contaminants are within the regulatory limits for consumption by humans. No regulatory levels of contaminants in seafood are exceded.	Levels of known harmful contaminants in major types of seafood do not exceed established standards	1. Concentrations of contaminants are within the regulatory limits set by legislation. 2. Decreasing trend in the frequency of cases of seafood samples above regulatory limits for contaminants
Rational		
Justification for indicator selector One of the potential risks associated with the occurrence of harmful substances (chemicals, nanoparticles, microplastics, toxins) in the marine environment is the human exposure through commercial fish and shellfish species (primarily, from wild fisheries and aquaculture). These organisms are exposed to environmental contaminants which enter their organism through different mechanisms and pathways according to their thropic level, which include from filter feeding to predatory strategies (crustaceans, bivalves, fish). Consequently, there exist both bioaccumulation and biomagnification processes of these chemicals released in the marine environment. Common examples are the well-known bioaccumulation of metals and organic compounds in commercial bivalve species (such as the *Mytillus galloprovincialis* in the Mediterranean Sea) or alkyl mercury compounds (methylmercury) in tuna fish, which should be increased by new and emerging contaminants in the near future.		
Scientific References i. Vandermeersch, G. et al. 2015. Environmental contaminants of emerging concern in seafood – European database on contaminant levels. Environmental Research, 143B, 29-45. ii. Maulvault, A.M. et al. 2015. Toxic elements and speciation in seafood samples from different contaminated sites in Europe. Environmental Research, 143B, 72-81. iii. Molin, M. et al., 2015. Arsenic in the human food chain, biotransformation and toxicology – Review focusing on seafood arsenic. Journal of Trace Elements in Medicine and Biology, 31, 249-259. iv. Bacchiocchi, S. et al. 2015. Two-year study of lipophilic marine toxin profile in mussels of the North-central Adriatic Sea: First report of azaspiracids in Mediterranean seafood. Toxicon, 108, 115-125. v. Perello, G. et al., 2015. Human exposure to PCDD/Fs and PCBs through consumption of fish and seafood in Catalonia (Spain): Temporal trend. Food and Chemical Toxicology, 81, 28-33. vi. Zaza, S. et al. 2015. Human exposure in Italy to lead, cadmium and mercury through fish and seafood product consumption from Eastern Central Atlantic Fishing Area. Journal of Food Composition and Analysis, 40, 148-153. vii. Cruz, R. Brominated flame retardants and seafood safety: A review. Environment International, 77, 116-131. viii. Dellate, E. et al. 2014. Individual methylmercury intake estimates from local seafood of the Mediterranean Sea, in Italy. Regulatory Toxicology and Pharmacology, 69, 105-112. ix. Spada, L. et al. 2014. Mercury and methylmercury concentrations in Mediterranean seafood and surface sediments, intake evaluation and risk for consumers. International Journal of Hygiene and Environmental Health, 215, 418-42.		
Policy Context and targets		
Policy context description		

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

The understanding of the health risks to humans (maximum levels, intake, toxic equivalent factors, etc.) and the food safety prevention, including emerging contaminants, through the consumption of potentially poisoned seafood is a challenge and a priority policy issue for governments, as well as a major societal concern. There are different initiatives and regulations at national and international levels mainly for the fishery economic sector, which have established public health recommendations and maximum regulatory levels for different contaminants in numerous marine commercial target species. Methylmercury poisoning continues as a global priority policy issue and in 2013 the Global Legally Binding Treaty (Minamata Convention on Mercury) was launched by UNEP. Further, the US Food and Drug Administration, the European Food Safety Authority and FAO are also national and international authorities with regard to seafood safety.

Targets

Initial targets of GES under Common Indicator 20 will be to maintain the chemical contaminants of human health concern under regulatory levels in seafood set/recommended/agreed by national and/or international authorities and their trends with regard their occurrence should decrease pointing towards zero events.

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
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. **EU 1881/2006. Commission Regulation (EC) No 1881/2006 of 19 December 2006 setting maximum levels for certain contaminants in foodstuffs. European Commission.**
vii. US FDA http://www.fda.gov/Food/FoodborneIllnessContaminants/Metals/ucm115644.htm
viii. Joint FAO/WHO Expert consultation on the risk and benefits of fish consumption. FAO Fisheries and Aquaculture Report No. 978. ISSN 2070-6987. Rome, January, 2010.
ix. List of maximum levels for contaminants in foods set by the FAO/WHO Codex Alimentarius Commission can be found at ftp://ftp.fao.org/codex/Meetings/cccf/cccf7/cf07_INFe.pdf
x. Global Legally Binding Treaty (Minamata Convention on Mercury) http://www.mercuryconvention.org/

Indicator analysis methods

Indicator Definition

Number of detected regulated contaminants* in commercial species.

Number of detected regulated contaminants* exceeding regulatory limits.

(*list of contaminants can be found in the links from the previous section)

Indicator Title	20. Actual levels of contaminants that have been detected and number of contaminants which have exceeded maximum regulatory levels in commonly consumed seafood (EO9)
Additional parameters required: sample identification, location, date and biometrics <u>Sub-indicators:</u> other relevant chemicals and emerging pollutants are recommended to be carried out on a country decision basis.	
Methodology for indicator calculation Number of detected contaminants: monitoring by national regulatory and inspection bodies through statistics and databases Number of detected contaminants exceeding regulatory limits: monitoring by national regulatory and inspection bodies through statistics and databases	
Indicator units (frequencies, %) - Number of detected contaminants in individual commercial species (frequencies, %) - Number of detected contaminants exceeding regulatory limits in appropriate units, for example, mg/kg fresh weight (parts per million, ppm, fresh weight) or µg/g fresh weight (part per billion, ppb, fresh weight).	
List of Guidance documents and protocols available Refer to UNEP Methods and Protocols for Marine Pollution, as well as from other regional conventions for the determination of contaminants in marine organisms (Note, pre-treatment of samples from marine organisms might differ between sample preparation and analytical methods and care should be taken when comparing the different reference values.	
Data Confidence and uncertainties The data confidence is directly related to the number of available tests performed to commercial species and their regularity, beyond the analytical quality assurance/qualiry control (QA/QC) related to the determination of contamiants in fish	
Methodology for monitoring, temporal and spatial scope	
Available Methodologies for Monitoring and Monitoring Protocols There are no directly-applicable monitoring protocols in order to fulfil the requirement of this Common Indicator. Risk-based public health methodologies to define the monitoring are recommended.	
Available data sources At present national databases (if available), research papers and environmental databases (the MED POL Database)	
Spatial scope guidance and selection of monitoring stations Risk-based methodologies to define monitoring are recommended. Guidance for monitoring stations: environmental monitoring, fish markets, aboard fishing fleets, sampling at regular inspections by national authorities	
Temporal Scope guidance Risk-based methodologies to define monitoring are recommended.The temporal scope is highly linked to the data confidence and uncertainty of the indicator. Yearly statistics would be the basic time period.	
Data analysis and assessment outputs	
Statistical analysis and basis for aggregation	

Indicator Title	20. Actual levels of contaminants that have been detected and number of contaminants which have exceeded maximum regulatory levels in commonly consumed seafood (EO9)	
Monitoring should allow the necessary statistical data treatments and long-term time-trend evaluations. Geographic reporting scales (within IMAP implementation) should be also considered in terms of indictor aggregation: (1) Whole region (i.e. Mediterranean Sea); (2) Mediterranean sub-regions, as presented in the Initial Assessment of the Mediterranean Sea, UNEP(DEPI)/MED IG.20/Inf.8; (3) Coastal waters and other marine waters; (4) Subdivisions of coastal waters provided by Contracting Parties		
Expected assessments outputs Assessment outputs would be based on trend analysis and annual statistics		
Known gaps and uncertainties in the Mediterranean As this is a new Common Indicator within the context of marine environmental protection policy (*ca*. Ecosystem Approach and IMAP implementation) its applicability beyond food consumer protection and public health would need to be determined, (although intuitively it reflects the health status of the marine environment in terms of their delivery of benefits e.g. fisheries industry). Thus, monitoring protocols, risk-based approaches, analytical testing and assessment methodologies would need to be further examined among Contracting Parties national food safety authorities, research organisations and/or environmental agencies.		
Contacts and version Date		
http://www.unepmap.org		
Version No	**Date**	**Author**
V.2	13/1/17	MEDPOL

17. Common Indicator 23: Trends in the amount of litter in the water column including microplastics and on the seafloor (EO10);

Seafloor Marine Litter:

Indicator Title	*Common indicator 23: Trends in the amount of litter in the water column including microplastics and on the seafloor*	
Relevant GES definition	**Related Operational Objective**	**Proposed Target(s)**
Number/amount of marine litter items in the water surface and the seafloor do not have negative impacts on human health, marine life, ecosystem services and do not create risk to navigation	10.1. The impacts related to properties and quantities of marine litter in the marine and coastal environment are minimized	Decreasing trend in the number/amount of marine litter items in the water surface and the seafloor
Rationale		

Justification for indicator selection

The seafloor has been identified as an important sink for marine litter. From the existing information marine litter can be found in varying depths and places, showing considerable spatial variability. Most litter comprises of high-density materials and hence sinks. Even low-density synthetic polymers such as polyethylene and polypropylene, may sink under the weight of fouling or additives. The Mediterranean Sea is a special case, as its shelves are not extensive and its deep sea environments can be influenced by the presence of coastal canyons. However there are several studies investigating the abundance of marine litter on the seafloor of the Mediterranean Sea (Galil et al., 1995; Galgani et al., 1996, 2000; Ioakeimidis et al., 2014; Pham et al., 2014; Ramirez-Llodra et al., 2013).

The geographical distribution of litter on the seafloor is strongly influenced by hydrodynamics, geomorphology and human factors. Litter that reaches the seafloor may already have been transported considerable distance, only sinking when weighted down by entanglement and fouling by a wide variety of bacteria, algae, animals and fine-grained accumulated sediments, and litter can then sink to the seafloor. The consequence is an accumulation of litter on specific seafloor locations in response to local sources and oceanographic conditions (Galgani et al., 2000; Keller et al., 2010; Watters et al., 2010). Moreover, seafloor litter tends to become trapped in areas of low circulation. Once litter reaches the seafloor, it lies on the seafloor and it may even partly buried in areas of very high sedimentation rate (Ye and Andrady, 1991). Taking also into account the persistence of most of litter materials (i.e. plastics) and thus the fact that many of the recorded marine litter may be present on the seafloor for year or even decades, then the monitoring of seafloor marine litter becomes extremely important.Information regarding the abundance of small plastic particles accumulating in the deep-sea sediments is still very limited as only few studies exist on this field (Van Cauwenberghe et al., 2013; Woodall et al., 2014) and further work should be encouraged.

Scientific References

- Galgani F., Souplet A., Cadiou Y. (1996). Accumulation of debris on the deep floor off the French Mediterranean coast. Marine Ecology Progress Series 142(1-3):225-234.
- Galgani, F., Leaute, J.P., Moguedet, P., Souplet, A., Verin, Y., Carpentier, A., Goraguer, H., Latrouite, D., Andral, B., Cadiou, Y., Mahe, C., Poulard, J.C., Nerisson, P. (2000). Litter on the Sea Floor Along European Coasts. Marine Pollution Bulletin, Vol. 40, No. 6, pp. 516-527.
- Galil, B.S., Golik, A., Turkay, M. (1995). Litter at the Bottom of the Sea: A Sea Bed Survey in

Indicator Title	*Common indicator 23: Trends in the amount of litter in the water column including microplastics and on the seafloor*

the Eastern Mediterranean. Marine Pollution Bulletin, Vol. 30, No. 1, pp. 22-24.
- Ioakeimidis C, Zeri C, Kaberi H, Galatchi M, Antoniadis K, Streftaris N, Galgani F, Papathanassiou E, Papatheodorou G. A comparative study of marine litter on the seafloor of coastal areas in the Eastern Mediterranean and Black Seas. Mar Pollut Bull. 2014;89:296–304.
- Keller, A.A., Fruh, E.L., Johnson, M.M., Simon, V., McGourty, C., 2010. Distribution and abundance of anthropogenic marine debris along the shelf and slope of the US West Coast. Mar. Pollut. Bull. 60, 692–700.
- Lundqvist, J. (2013) – Monitoring marine debris, Report of university of Gothenburg, Faculty of sciences, 22 pages.
- Pham CK, Ramirez-Llodra E, Alt CHS, Amaro T, Bergmann M, Canals M, Company JB, Davies J, Duineveld G, Galgani F, Howell KL, Huvenne VAI, Isidro E, Jones DOB, Lastras G, Morato T, Gomes-Pereira JN, Purser A, Stewart H, Tojeira I, Tubau X, Van Rooij D, Tyler PA, (2014). Marine litter distribution and density in European Seas, from the shelves to deep basins. PLoS One. 2014;9:e95839..
- Ramirez-Llodra, E., De Mol, B., Company, J. B., Coll, M., Sardà, F. (2013). Effects of natural and anthropogenic processes in the distribution of marine litter in the deep Mediterranean Sea. Progress in Oceanography, Vol. 118, pp. 273–287.
- Van Cauwenberghe, L., Claessens, M., Vandegehuchte, M.B., Mees, J., Janssen, C.R., 2013. Assessment of marine debris on the Belgian Continental Shelf. Mar. Pollut. Bull. 73, 161e169.
- Watters, D.L., Yoklavich, M.M., Love, M.S., Schroeder, D.M., 2010. Assessing marine debris in deep seafloor habitats off California. Mar. Pollut. Bull. 60, 131–138.
- Woodall, L., Sanchez-Vidal, A., Canals, M., Paterson, G., Coppock, R., Sleight, V.,et al. (2014). The deep sea is a major sink for microplastic debris. R. Soc. Open Sci. 1:140317.
- Ye S. and Andrady A.L., 1991. Fouling of floating plastic debris under Biscayne Bay exposure conditions. Mar. Pollut. Bull. 22(12), 608-613.

Policy Context and targets (other than IMAP)

Policy context description

The UN Environment / Mediterranean Action Plan Barcelona Convention Regional Plan on Marine Litter Management in the Mediterranean Region is the first ever legally binding regional plan adopted by a Regional Sea Convention (Decision IG. 21/7) that addresses marine litter management in regional level in a coherent manner and sets out legally binding measures at regional and national level, and implementation timetables. The main objectives of the ML Management Regional Plan are to prevent and reduce marine litter generation and its impact on marine and coastal environment in order to achieve good environmental status (GES) as per the relevant Mediterranean ecological objectives and ecosystem approach based Marine Litter related targets adopted by UN Environment / Mediterranean Action Plan in 2012 and 2013 during the 17th and 18th Meeting of the Contracting Parties of the Barcelona Convention consecutively. Moreover, through its Articles 11 “Assessment of marine litter in the Mediterranean” and 12 “Mediterranean Marine Litter Monitoring Programme”, the Regional Plan on Marine Litter includes a series of specific provisions for the countries for monitoring and assessment of marine litter i.e. assess the state of marine litter, the impact to marine and coastal environment and human health, the socio-economic aspects of marine litter management, the development of marine litter data banks, the development of national monitoring programmes on marine litter etc.

The EU Marine Strategy Framework Directive (MSFD) (2008/56/EC) requires European Member States to develop strategies that should lead to programmes of measures to achieve or maintain Good Environmental Status (GES) in European Seas. MSFD sets the framework for Member States to

Indicator Title	*Common indicator 23: Trends in the amount of litter in the water column including microplastics and on the seafloor*

achieve by 2020 GES for their marine waters, considering 11 descriptors. Descriptor 10 focuses on marine litter, stating that GES is achieved only when "Properties and quantities of marine litter do not cause harm to the coastal and marine environment".

Indicator/Targets

UN Environment / Mediterranean Action Plan Decision IG.21/3 adopted by the 18th Meeting of the Contracting Parties of the Barcelona Convention on the Ecosystem Approach including adopting definition of GES and targets proposes as target for Indicator 10.1.2: Decreasing trend in the number of/amounts of marine litter items in the water surface and the seafloor.

Moreover, in the framework of the UN Environment / Mediterranean Action Plan Barcelona Convention Regional Plan on Marine Litter Management in the Mediterranean (Decision IG.21/7 - 18th Meeting of the Contracting Parties), a series of Marine Litter Baseline Values and Environmental Targets have been adopted by the 19th Meeting of the Contracting Meeting (Decision IG.22/10):

Baseline Values for Seafloor Marine Litter:
- Minimum value: 0 items/km^2
- Maximum value: 4,860,000 items/ km^2
- Mean value: 340,000 items/ km^2
- Proposed Baseline: 200,000 – 500,000 items/ km^2

Environmental Targets for Seafloor Marine Litter:
- Types of Target: % of decrease
- Minimum: Stable
- Maximum: 10% in 5 years
- Reduction Targets: Statistically Significant (15% in 15 years is possible)

Policy documents

- UN Environment / Mediterranean Action Plan, Regional Plan on Marine Litter Management in the Mediterranean, Decision IG.21/7 (2013)[4].
- UN Environment / Mediterranean Action Plan, Integrated Monitoring and Assessment Programme of the Mediterranean Sea and Coast and Related Assessment Criteria, Decision IG 22/7 (2016)[5].
- UN Environment, Marine Litter Legislation Toolkit for Policymakers (2016)[6].
- European Commission, Marine Strategy Framework Directive, Directive 2008/56/EC (2008)[7].
- European Commission, Decision on criteria and methodological standards on good environmental status of marine waters (2010)[8].

Indicator analysis methods

Indicator Definition

[4] https://wedocs.unep.org/rest/bitstreams/8222/retrieve (ENG)/ https://wedocs.unep.org/rest/bitstreams/8223/retrieve (FR)
[5] https://wedocs.unep.org/rest/bitstreams/8385/retrieve
[6] http://www.unep.org/stories/Ecosystems/Marine-Litter-Legislation-A-toolkit-for-Policymakers.asp
[7] http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32008L0056&from=EN
[8] http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32010D0477(01)&from=EN

Indicator Title	*Common indicator 23: Trends in the amount of litter in the water column including microplastics and on the seafloor*

GES Definition: Number/amount of marine litter items in the water surface and the seafloor do not have negative impacts on human health, marine life, ecosystem services and do not create risk to navigation.

Methodology for indicator calculation

General strategies for the investigation of seabed marine litter are similar to those used to assess the abundance and type of benthic species. The most common approaches to evaluate sea-floor litter distributions use opportunistic sampling. This type of sampling is usually coupled with regular fisheries surveys (marine reserve, offshore platforms, etc.) and programmes on biodiversity, since methods for determining seafloor litter distributions (e.g. trawling, diving, video) are similar to those used for benthic and biodiversity assessments. The use of submersibles or Remotely Operated Vehicles (ROVs) is a possible approach for deep sea areas although this requires expensive equipment. Monitoring programmes for demersal fish stocks, undertaken as part of the Mediterranean International Bottom Trawl Surveys (MEDITS), operate at large regional scale and provide data using a harmonized protocol, which may provide a consistent support for monitoring litter at Regional scale on a regular basis and within the ECAP requirements.

<u>Shallow sea-floor (<20m):</u>
The most commonly used method to estimate marine litter density in shallow coastal areas is to conduct underwater visual surveys with SCUBA/snorkelling. These surveys are best based on line transect surveys of litter on the sea-floor, which is derived from UN Environment (Cheshire, 2009). The protocol is actually in use for evaluation of benthic fauna. It requires SCUBA equipment and trained observers. Only litter items above 2.5 cm are considered, between 0 and 20 m (to 40 meters with skilled divers).

Individual litter within 4 m of the line (half of the width –Wt - of the line transects) are recorded. For each observed litter item, when possible, the corresponding line segment of occurrence and its perpendicular distance from the line (yi - for the estimation of detection probability, measured with the use of a 2 m plastic rod), and litter size category (wi) are recorded. The nature of the bottom/habitat is also recorded. The length of the line transects vary between 20 and 200 m, depending on the depth, the depth gradient, the turbidity, the habitat complexity and the litter density (Katsavenakis, 2009). Results are expressed in litter density (items/m2 or items/ 100 m2).
In distance sampling surveys, detectability is used to correct abundance estimations (Katsavenakis, 2009). The standard software for modelling detectability and estimating density/abundance, based on distance sampling surveys, is DISTANCE (Thomas et al., 2006).

<u>Monitoring the Sea-floor (20-800m):</u>
From all the methods assessed, trawling (otter trawl) has been shown to be the most suitable for large scale evaluation and monitoring (Goldberg, 1995, Galgani et al., 1995, 1996, 2000). Nevertheless there are some restrictions in rocky areas and in soft sediments, as the method may be restricted and/or underestimate the quantities present. This approach is however reliable, reproducible, allowing statistical processing and comparison of sites. As recommended by UN Environment (Cheshire, 2009), sites should be selected to ensure that they:

i. Comprise areas with uniform substrate (ideally sand/silt bottom);
ii. Consider areas generating/accumulating litter;
iii. Avoid areas of risk (presence of munitions), sensitive or protected areas;
iv. Do not impact on any endangered or protected species.

Indicator Title	*Common indicator 23: Trends in the amount of litter in the water column including microplastics and on the seafloor*
Sampling units should be stratified relative to sources (urban, rural, close to riverine inputs) and impacted offshore areas (major currents, shipping lanes, fisheries areas, etc.). General strategies to investigate seabed litter are similar to methodology for benthic ecology and place more emphasis on the abundance and nature of items (e.g. bags, bottles, pieces of plastics) rather than their mass. The occurrence of international bottom trawls surveys such as MEDITS (Mediterranean/Black Sea) provide useful and valuable means for monitoring marine litter. These are using common gears depending on region (MEDITS net in the Mediterranean) and provide some harmonized and common conditions of sampling (20 mm mesh, 30-60 min tows, large sampling surface covered) and hydrographical and environmental information (surface & bottom temperature, surface & bottom salinity, surface & bottom current direction & speed, wind direction & speed, swell direction and height).	
Indicator units • Litter on the seafloor shallow coastal waters(0-20m): visually surveyed litter items size above 2.5cm • Litter on the seafloor 20-800m: items/ha or items/km^2 of litter collected in bottom trawl surveys	
List of Guidance documents and protocols available - UN Environment / Intergovernmental Oceanographic Commission, Guidelines on Survey and Monitoring of Marine Litter" (2009). - UN Environment / Mediterranean Action Plan, Integrated Monitoring and Assessment Programme Guidance document (2016) (UNEP(DEPI)/MED_IG/22/Inf7). - EU MSFD TGML, Guidance on Monitoring of Marine Litter in European Seas (2013). - International bottom trawl survey in the Mediterranean, Instructional Manual, MEDITS Working Group (2013). - DeFishGear, Methodology for Monitoring Marine Litter on the Seafloor (continental shelf) Bottom Trawl Surveys (2016).	
Data Confidence and uncertainties Several Contracting Parties from UN Environment / Mediterranean Action Plan and its Mediterranean Pollution Assessment and Control Programme (MED POL) have indicated they will use their fish stock surveys for benthic litter monitoring. This is considered to be an adequate approach although quantities of litter might be underestimated, given restrictions in some areas. The adoption of a common protocol will lead to a significant level of standardization among the Contracting Parties countries that apply this type of sampling strategy. Data on litter in shallow sea-floor are collected through protocols already validated for benthic species. Until now, no quality assurance programme has been considered for litter monitoring on the sea-floor. For MEDITS, sampling data are collected in the DATRAS database and participate in data quality checking for hydrographical and environmental conditions. This process may also support quality insurance for data on litter. Currently, there are on-going discussions on how to organize and harmonize a specific system to collect, validate and organize data through a common platform, enabling the review and validation of data. MEDITS has included litter data to be analysed within a specific sub-group.	

Indicator Title	*Common indicator 23: Trends in the amount of litter in the water column including microplastics and on the seafloor*
Methodology for monitoring, temporal and spatial scope	

Available Methodologies for Monitoring and Monitoring Protocols

Monitoring the shallow seafloor (<20m):
Recreational and professional scuba divers can provide valuable information on litter they see underwater and they are uniquely positioned to support benthic litter monitoring efforts. They can access, have the skills and the equipment needed to collect, record, and share information about litter they encounter underwater. Many dive clubs and dive shops organize underwater clean-ups, often in partnerships with NGOs or local governments. Many of these events, when managed, can be a valuable source of information and possibly be a part of a regular survey, monitoring or even assessment efforts while using volunteers.

For some Contracting Parties use of volunteer divers might be a good opportunity for shallow-water litter monitoring but standardization and conformity with common methodologies and tools such as those proposed by the EU MSFD Technical Group on Marine Litter (TGML) should be achieved. Fixed sites, common frequency and sampling methodology can be easily established by each Contracting Party and training, material distribution etc. can be achieved relatively easily when partner NGOs or research institutions are involved.

Monitoring the Seafloor (20-800m):
Templates for data recording have been integrated in MEDITS Manuals. Data on litter should be collected on these templates using items categories such as those listed for Sea-floor prepared by TGML. Other elements from the haul operations should be also recorded – See MEDITS for the Mediterranean/Black Sea. Data on litter should be reported as items/ha or items/km^2 before further processing and reporting.

A standardized litter classification system has been defined for monitoring the sea floor by the EU MSFD TGML. The categories were defined in accordance with types of litter found at regional level, enabling common main categories for all regions. The main categories have a hierarchical system including sub categories. It considers 4 main categories of material for the Mediterranean (wood, paper/cardboard, other, unspecific). There are various subcategories for a more detailed description of litter items. Other specific categories may be added by Contracting Parties and additional description of the item may provide added-value, as long as the main categories and sub-categories are maintained. Furthermore, the weight, picture and note of potential attached organisms may further complement the classification of items.

Site information and trawling sampling characteristics such as date, position, type of trawl, speed, distance, sampled area, depth, hydrographical and meteorological conditions should be recorded. Data-sheets should be filled out for each trawl and compiled by survey. If multiple counts (transects/observers) are run at any given site then a new sheet should be used for each trawl shot. After each survey data must be aggregated for analysis and reporting.

Towed video camera for shallow waters (Lundqvist, 2013) or ROVs for deeper areas are simpler and generally cheaper and must be recommended for litter surveys. There are some available protocols where litter is counted on routes and expressed as item/km, especially when using submersibles/ROVs at variable depths above the deep sea floor (Galgani et al., 1996) however technology enables the evaluation of densities trough video-imagery using a standardized approach especially for shallow waters.

Indicator Title	*Common indicator 23: Trends in the amount of litter in the water column including microplastics and on the seafloor*

Available data sources

- DeFishGear Project: http://www.defishgear.net/
- Hellenic Centre for Marine Research (HCMR): www.hcmr.gr
- Institut français de recherche pour l'exploitation de la mer (IFREMER): http://wwz.ifremer.fr/
- International Bottom Trawl Surveys in the Mediterranean (MEDITS): http://www.sibm.it/SITO%20MEDITS/principaleprogramme.htm
- Laboratory of Marine Geology and Physical Oceanography, Department of Geology, University of Patras: http://www.oceanus.upatras.gr/?q=node/15

Spatial scope guidance and selection of monitoring stations

Monitoring the shallow seafloor (<20m):
Surveys are conducted through 2 line transects for each site. Unbiased design-based inference requires allocating the transects randomly in the study area or on a grid of systematically spaced lines randomly superimposed. However, with a model-based approach like density surface modelling (DSM), it is not required that the line transects are located according to a formal and restrictive survey sampling scheme, although good spatial coverage of the study area is desirable. Line transect are defined with a nylon line, marked every 5 meters with resistant paints, that is deployed using a diving reel while SCUBA diving.

Monitoring the seafloor (20-800m):
UN Environment (Cheshire, 2009) recommends that at least 20 sampling units will be selected at regional level although a higher level of redundancy (i.e. replication) in sampling units within each region is highly recommended.

Moreover, the protocol of the EU MSFD TGML for sampling and trawling margins (20-800m) has been standardized for each region. For the Mediterranean Region, the protocol is derived from the MEDITS protocol (see the protocol manual, Bertran et al., 2007). The hauls are positioned following a depth stratified sampling scheme with random drawing of the positions within each stratum. The number of positions in each stratum is proportional to the surface of these strata and the hauls are made in the same position from year to year. The following depths (10 – 50; 50 – 100; 100 – 200; 200 – 500; 500 - 800 m) are fixed in all areas as strata limits. The total number of hauls for the Mediterranean Sea is 1385; covering the shelves and slopes from 11 countries in the Mediterranean.

Temporal Scope guidance

Monitoring the shallow seafloor (<20m):
The minimum sampling frequency for any site should be annually. Ideally it is recommended that locations are surveyed every three months (allowing an interpretation in terms of seasonal changes).

Monitoring the seafloor (20-800m):
The haul duration is fixed at 30 minutes on depths less than 200m and at 60 minutes at depths over 200m (defined as the moment when the vertical net opening and door spread are stable), using the same GOC 73 trawl with 20 mm mesh nets (Bertran et al, 2007) and sampling between May and July, at 3 knots between 20 and 800 m depth.

Data analysis and assessment outputs

Indicator Title	*Common indicator 23: Trends in the amount of litter in the water column including microplastics and on the seafloor*

Statistical analysis and basis for aggregation

Basic statistics may be applied during the analysis and aggregation of the results.

Expected assessments outputs

- Assess marine litter found on the seafloor of the Mediterranean sea at basin scale;
- Assess abundance, density (items/ha or items/km^2), spatial and temporal distribution and types;
- Identify sources to target prevention and reduction measures;
- Map existing information in order to assess marine litter accumulation areas on the seafloor of the Mediterranean Sea

Known gaps and uncertainties in the Mediterranean

More than 50 studies were conducted worldwide between 2000 and 2015, but until recently very few covered extensive geographical areas or considerable depths. While there is sufficient knowledge on seafloor marine litter for the Northern part of the Mediterranean sea, however more information shall be acquired for the Southern part of the Mediterranean. Moreover, accumulation areas shall be assessed with priority on the convergence zones and deep-sea canyons.

Contacts and version Date: *UNEP/MAP 16 January 2017*

Key contacts within UN Environment for further information

- Ms Tatjana Hema, Deputy Coordinator, UN Environment / Mediterranean Action Plan (Tatjana.Hema@unep.org)
- Ms Virginie Hart, Programme Officer, UN Environment / Mediterranean Action Plan, Mediterranean Pollution Assessment and Control Programme (MED POL) (Virginie.Hart@unep.org)

Version No	**Date**	**Author**
V.1		

Floating Marine Litter:

Indicator Title	*Common indicator 23: Trends in the amount of litter in the water column including microplastics and on the seafloor*	
Relevant GES definition	**Related Operational Objective**	**Proposed Target(s)**
Number/amount of marine litter items in the water surface and the seafloor do not have negative impact on human health, marine life, ecosystem services and do not create risk to navigation	The impacts related to properties and quantities of marine litter in the marine and coastal environment are minimized (10.1)	Decreasing trend in the number/amount of marine litter in the water surface and the seafloor.

Indicator Title	*Common indicator 23: Trends in the amount of litter in the water column including microplastics and on the seafloor*	
Rationale		

Justification for indicator selection

The Mediterranean Sea is often referred to as one of the places with the highest concentrations of litter in the world. For floating litter, very high levels of plastic pollution are found, but densities are generally comparable to those being reported from many coastal areas worldwide. Floating marine litter comprises the mobile fraction of debris in the marine environment, as it is less dense than seawater. However, the buoyancy and density of plastics may change during their stay in the sea due to weathering and biofouling (Barnes et al., 2009). Polymers comprise the majority of floating marine debris, with figures reaching up to 100%. Although synthetic polymers are resistant to biological or chemical degradation processes, they can be physically degraded into smaller fragments and hence turn into micro litter, measuring less than 5 mm.

They can also be transported by currents until they sink to the sea floor, are deposited on the shore, or are degraded over time. A 30-year circulation model using various input scenarios showed the accumulation of floating debris in ocean gyres and closed seas, such as the Mediterranean Sea, made up 7-8% of the total debris expected to accumulate (Lebreton et al., 2012).

Visual assessment approaches include the use of research vessels, marine mammal surveys, commercial shipping carriers, and dedicated litter observations. Aerial surveys are now being employed for larger items. Although the basic principle of floating debris monitoring through visual observation is very simple, there are few datasets available for the comparable assessment of debris abundance, and monitoring is only performed occasionally.

Scientific References

- Aliani S., Griffa A., A.Molcard (2003) Floating debris in the Ligurian Sea, north-western Mediterranean, Marine Bulletin, 46, 1142-1149.
- Barnes D.K., Galgani F., Thompson R.C., M.Barlaz (2009) Accumulation and fragmentation of plastic debris in global environments. Philosophical Transactions of the Royal Society B 364, 1985–1998. doi:10.1098/rstb.2008.0205.
- Gerigny O., Henry M., Tomasino C., F.Galgani (2011). Déchets en mer et sur le fond. in rapport de l'évalution initiale, Plan d'action pour le milieu marin - Mediterranée Occidentale, rapport PI Déchets en mer V2 MO, pp. 241-246.
- Lebreton L., Greer S., J.Borrero (2012) Numerical modelling of floating debris in the world's oceans, Marine Pollution Bulletin 64, 653-661.
- Suaria G., Avio C., Lattin G., regoli F., S. Aliani (2015) Neustonic microplastics in the Southern Adriatic Sea. Preliminary results. Micro 2015. Seminar of the Defishgear projct, Abstract book, Piran 4-6 may 2015, p 42.
- Topcu T., G.Ozturk (2013) Origin and abundance of marine litter along sandy beaches of the Turkish Western Black Sea Coast. Mar. Env. Res., 85, 21-28.
- UNEP (2009), Marine Litter A Global Challenge, Nairobi: UNEP. 232 pp.

Policy Context and targets (other than IMAP)

Policy context description

Indicator Title	*Common indicator 23: Trends in the amount of litter in the water column including microplastics and on the seafloor*

The UN Environment / Mediterranean Action Plan Barcelona Convention Regional Plan on Marine Litter Management in the Mediterranean Region is the first ever legally binding regional plan adopted by a Regional Sea Convention (Decision IG. 21/7) that addresses marine litter management in regional level in a coherent manner and sets out legally binding measures at regional and national level, and implementation timetables. The main objective of the Regional Plan on Marine Litter Management in the Mediterranean is to prevent and reduce marine litter generation and its impact on marine and coastal environment in order to achieve good environmental status (GES) as per the relevant Mediterranean ecological objectives and ecosystem approach based Marine Litter related targets adopted by UN Environment / Mediterranean Action Plan in 2012 and 2013 during the 17th and 18th Meeting of the Contracting Parties of the Barcelona Convention consecutively. Moreover, through its Articles 11 “Assessment of marine litter in the Mediterranean” and 12 “Mediterranean Marine Litter Monitoring Programme”, the Regional Plan on Marine Litter includes a series of specific provisions for the countries for monitoring and assessment of marine litter i.e. assess the state of marine litter, the impact to marine and coastal environment and human health, the socio-economic aspects of marine litter management, the development of marine litter data banks, the development of national monitoring programmes on marine litter etc.

The EU Marine Strategy Framework Directive (MSFD) (2008/56/EC) requires European Member States to develop strategies that should lead to programmes of measures to achieve or maintain Good Environmental Status (GES) in European Seas. MSFD sets the framework for Member States to achieve by 2020 GES for their marine waters, considering 11 descriptors; descriptor 10, focuses on marine litter, stating that GES is achieved only when "properties and quantities of marine litter do not cause harm to the coastal and marine environment".

Indicator/Targets

UN Environment / Mediterranean Action Plan Decision IG.21/3 of the 18th Meeting of the Contracting Parties of the Barcelona Convention on the Ecosystem Approach including adopting definition of GES and targets proposes as target for Indicator 10.1.2: Decreasing trend in the number of/amounts of marine litter items in the water surface and the seafloor.

Moreover, in the framework of the UN Environment / Mediterranean Action Plan Barcelona Convention Regional Plan on Marine Litter Management in the Mediterranean, adopted by the 18th Meeting of the Contracting Parties (Decision IG.21/7), a series of Marine Litter Baseline Values and Environmental Targets have been adopted by the 19th Meeting of the Contracting Parties (Decision IG.22/10):

Baseline Values for Floating Marine Litter:
- Minimum value: 0 items/km^2
- Maximum value: 195 items/ km^2
- Mean value: 3.9 items/ km^2
- Proposed Baseline: 3-5 items/ km^2

Environmental Targets for Floating Marine Litter:
- Types of Target: % of decrease
- Minimum: -
- Maximum: -
- Reduction Targets: Statistically Significant

Indicator Title	*Common indicator 23: Trends in the amount of litter in the water column including microplastics and on the seafloor*

Baseline Values for Floating Microplastics:
- Minimum value: - items/km^2
- Maximum value: 4,860,000 items/ km^2
- Mean value: 340,000 items/ km^2
- Proposed Baseline: 200,000 – 500,000 items/ km^2

Environmental Targets for Floating Microplastics:
- Types of Target: % of decrease
- Minimum: -
- Maximum: -
- Reduction Targets: Statistically Significant

Policy documents

- UN Environment / Mediterranean Action Plan, Regional Plan on Marine Litter Management in the Mediterranean, Decision IG.21/7 (2013)[9].
- UN Environment / Mediterranean Action Plan, Integrated Monitoring and Assessment Programme of the Mediterranean Sea and Coast and Related Assessment Criteria, Decision IG.22/7 (2016)[10].
- UN Environment, Marine Litter Legislation Toolkit for Policymakers (2016)[11].
- European Commission, Marine Strategy Framework Directive, Directive 2008/56/EC (2008)[12].
- European Commission, Decision on criteria and methodological standards on good environmental status of marine waters (2010)[13].

Indicator analysis methods

Indicator Definition

GES Definition: Number/amount of marine litter items in the water surface and the seafloor do not have negative impacts on human health, marine life, ecosystem services and do not create risk to navigation.

Methodology for indicator calculation

The reporting of monitoring results requires the grouping into categories of material, type and size of litter object. The approach for categories of floating litter is linked with the development of a "master list" with the categories (Artificial Polymer Materials, Rubber, Cloth/Textile, Paper/Cardboard, Processed/Worked Wood, Metal, Glass/Ceramics) for other environmental compartments such as the "master list" prepared by the EU MSFD TGML. This allows cross comparisons. For the practical use during the monitoring the list has to be arranged by object occurrence frequency so that the data acquisition can be done in the required short time. As floating litter items will be observed but not collected, the size is the only indicative parameter of the amount of plastic material that it contains. The size of an object is defined here as its largest dimension, width or length, as visible during the

[9] https://wedocs.unep.org/rest/bitstreams/8222/retrieve (ENG) / https://wedocs.unep.org/rest/bitstreams/8223/retrieve (FR)
[10] https://wedocs.unep.org/rest/bitstreams/8385/retrieve
[11] http://www.unep.org/stories/Ecosystems/Marine-Litter-Legislation-A-toolkit-for-Policymakers.asp
[12] http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32008L0056&from=EN
[13] http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32010D0477(01)&from=EN

Indicator Title	*Common indicator 23: Trends in the amount of litter in the water column including microplastics and on the seafloor*

observation.

The lower size limit for the observations is determined by the observation conditions. A lower size limit that appears to be reasonable for observation from “ships-of-opportunity” and is in line with the size for beach litter surveys is probably the 2.5 cm. This denotes that observations not achieving this minimum size limit cannot be recommended. For reporting purposes size range classes must be introduced as visual observation will not permit the correct measuring of object sizes. Only the estimation of size classes is feasible. The size determination/reporting scheme should enclose the following classes: 2.5 – 5 cm, 5 - 10 cm, 10 – 20 cm, 20 – 30 cm, 30 – 50 cm. While also wider size range classes (e.g. 2.5–10cm, 10–30cm, 30–50 cm) could be utilized, it will be important that a common approach is used, as the data will be combined in common data bases. The upper size limit will have to be determined by statistical calculations regarding the density of the object occurrence in comparison to transect width, length and frequency. In coherence with the beach litter surveys an upper limit of 50 cm is here provisionally proposed. It has to be evaluated in experiments and from initial data sets if items larger than 50 cm should be reported, as their relevance in the statistical evaluation of data from short and narrow coastal transects might be questionable.

Indicator units

For floating marine litter the unit of reporting will be items of floating litter, 2.5 to 50 cm per km². The data will be available for the different categories and size classes.

List of Guidance documents and protocols available

- UN Environment / Intergovernmental Oceanographic Commission, Guidelines on Survey and Monitoring of Marine Litter (2009).
- UN Environment / Mediterranean Action Plan, Integrated Monitoring and Assessment Programme Guidance document (2016) (UNEP(DEPI)/mED_IG.22/Inf.7).
- EU MSFD TGML, Guidance on Monitoring of Marine Litter in European Seas (2013).
- DeFishGear project “Methodology for Monitoring Marine Litter on the Sea Surface Visual observation” (2015).

Data Confidence and uncertainties

The observation of floating marine litter from ships is subject to numerous variables in the observation conditions. They can be divided into operational parameters, related to the ship properties and observation location. Protocols should be developed where the processing of the collected information, starting from the documentation on board, its compilation, elaboration and further use would be part of the protocol in order to derive comparable final results. The format should allow a compilation across different observing institutes and areas or regions. This would allow a plotting of floating litter distribution over time and thus finally allow the coupling with oceanographic current models.

The widespread acquisition of monitoring data will need some kind of inter-comparison or calibration in order to ensure comparability of data between different areas and over time, for trend assessments. Approaches for this should be developed and implemented. This can be hands (eyes)–on training courses with comparisons of observations. Such events should be organized at Regional level with

Indicator Title	*Common indicator 23: Trends in the amount of litter in the water column including microplastics and on the seafloor*

further implementation at national scale. A methodology for calibrating observation quality by artificial targets may be devised through research efforts.

Methodology for monitoring, temporal and spatial scope

Available Methodologies for Monitoring and Monitoring Protocols

A harmonized approach for the quantification of floating marine litter by ship-based observers has been developed by the EC MSFD Technical Group on Marine Litter (TGML). It has the scope to harmonize the monitoring of floating marine litter:

- In the size range from 2.5 to 50 cm;
- Observation width needs to be determined according to observation set-up;
- It is planned for use from ships of opportunity;
- It is based on transect sampling;
- It should cover short transects; and
- Also record necessary metadata.

The observation from ships-of-opportunity should ensure the detection of litter items at 2.5 cm size. The observation transect width will therefore depend on the elevation above the sea, the ship speed and the observation conditions. Typically a transect width of 10 m can be expected, but a verification should be made and the width of the observation corridor chosen in a way that all items in that transect and within the target size range, can be seen. Table below provides a preliminary indication of the observation corridor width, with varying observation elevation and speed of vessel (kn = knot = nautical mile/h). The parameters need to be verified prior to data acquisition.

Observation elevation above sea	Ship speed 2 knots = 3.7 km/h	6 knots =11.1 km/h	10 knots = 18.5 km/h
1 m	6m	4m	3m
3m	8m	6m	4m
6m	10m	8m	6m
10m	15m	10m	5m

The ideal location for observation will often be in the bow area of the ships. If that area is not accessible, the observation point should be selected so that the target size range can be observed, eventually reducing the observation corridor, as ship induced waves might interfere with the observations. An inclinometer can be used to measure distances at sea (Doyle, 2007).

The protocol will have to go through an experimental implementation phase during which it is applied in different sea regions by different institutions, its practicality is tested and feedback for definition of observation parameters is provided.

The observation, quantification and identification of floating litter items must be made by a dedicated observer who does not have other duties contemporaneously. Observation for small items and surveying intensively the sea surface leads to fatigue and consequently to observation errors. The transect lengths should therefore be selected in a way that observation times are not too long. Times of 1 h for one observer could be reasonable, corresponding to a length of a few kilometres.

Available data sources

Indicator Title	*Common indicator 23: Trends in the amount of litter in the water column including microplastics and on the seafloor*

- DeFishGear Project: http://www.defishgear.net/
- Hellenic Marine Environment Protection Association (HELMEPA): http://www.helmepa.gr/en/home.php\

Spatial scope guidance and selection of monitoring stations

The monitoring of floating marine litter by human observers is a methodology indicated for short transects in selected areas. In a region with little or no information about floating marine litter abundance it might be advisable to start by surveys in different areas in order to understand the variability of litter distribution. The selected areas should include expected low density areas (e.g. open sea) as well as expected high density areas (e.g. close to ports). This will help to obtain maximum/minimum conditions and train the observers. Other selected areas (e.g. in estuaries), in the vicinity of cities, in local areas of touristic or commercial traffic, incoming currents from neighbouring areas or outgoing currents should be considered. Based on the experience obtained in this initial phase, a routing programme including areas of interest should then be established.

Temporal Scope guidance

The observation of floating marine litter is strongly dependent on the observation conditions, in particular on the sea state and wind speed. The organization of monitoring must be flexible enough to take this into account and to re-schedule observations in order to meet appropriate conditions. Ideally the observation should be performed after a minimum duration of calm sea, so that there is no bias by litter objects which have been mixed into the water column by recent storms or heavy sea.
The initial, investigative monitoring should be performed with a higher frequency in order to understand the variability of litter quantities in time. Even burst sampling, i.e. high sampling frequency over short period, might be appropriate in order to understand the variability of floating marine litter occurrence.

For trend monitoring the timing will depend on the assumed sources of the litter, this can be e.g. monitoring an estuary after a rain period in the river basin, monitoring a touristic area after a holiday period. The timing of the surveys will also depend on the schedule of the observation platforms. Regular patrols of coast guard ships, ferry tracks or touristic trips may offer frequent opportunities which thus also allow the use during the needed calm weather conditions.

Data analysis and assessment outputs

Statistical analysis and basis for aggregation

No specific statistical tool is required for the analysis of the observed floating marine litter items. However, it is not uncommon that floating marine litter items appear grouped, either because they have been released together or because they accumulate on oceanographic fronts. The reporting system should acknowledge this and foresee a way to report such groups. The occurrence of such accumulation areas needs to be considered when evaluating the data. Along with the litter occurrence data, a series of metadata should be recorded, including geo-referencing (coordinates) and wind speed (m/s). This accompanying data shall allow the evaluation of the data in the correct context.

Indicator Title	*Common indicator 23: Trends in the amount of litter in the water column including microplastics and on the seafloor*

Expected assessments outputs

- Assess accumulation zones for floating marine litter items;
- Assess abundance, density and types of floating marine litter items in a more precise way;
- Information on the degradation process;
- Comparison with marine litter found in other sea compartments.
-

Known gaps and uncertainties in the Mediterranean

Only a few studies have been published on the abundance of floating macro and mega debris in Mediterranean waters (Aliani et al., 2003; UNEP, 2009; Topcu et al., 2010, Gerigny et al., 2011, Suaria and Aliani, 2015), and the reported quantities measuring over 2 cm range widely from 0 to over 600 items per square kilometer. So the abundance of floating marine litter in the Mediterranean Sea cannot be estimated with accuracy. Moreover we still have no information on the accumulation zones for floating marine litter items.

Contacts and version Date: *UNEP/MAP 16 January 2017*

Key contacts within UN Environment for further information

- Ms Tatjana Hema, Deputy Coordinator, UN Environment / Mediterranean Action Plan (Tatjana.Hema@unep.org)
- Ms Virginie Hart, Programme Officer, UN Environment / Mediterranean Action Plan, Mediterranean Pollution Assessment and Control Programme (MED POL) (Virginie.Hart@unep.org)

Version No	**Date**	**Author**
V.1		

18. Candidate Indicator 26: Proportion of days and geographical distribution where loud, low, and mid-frequency impulsive sounds exceed levels that are likely to entail significant impact on marine animals (EO11);

Indicator Title	Common indicator 26: Proportion of days and geographical distribution where loud, low and mid-frequency impulsive sounds exceed levels that are likely to entail significant impact on marine animals	
Relevant GES definition	**Related Operational Objective**	**Proposed Target(s)**
Noise from human activities causes no significant impact on marine and coastal ecosystems.	Energy inputs into the marine environment, especially noise from human activities, are minimized	• Not more than 100 days per year • Not more than 25% of Mediterranean Sea area • Not within feeding/breeding grounds
Rational		

Justification for indicator selector

- Easy to implement (No need to implement complex acoustic methodologies)
- Cost-effective (no field work required, no deployment of sound recorders)
- Takes into consideration the impact of impulsive noise on representative cetacean species of the Mediterranean
- Consistent with the MSFD-D11 (Impulsive noise indicator)

Scientific References

Dekeling, R.P.A., Tasker, M.L., Van der Graaf, A.J., Ainslie, M.A, Andersson, M.H., André, M., Borsani, J.F., Brensing, K., Castellote, M., Cronin, D., Dalen, J., Folegot, T., Leaper, R., Pajala, J., Redman, P., Robinson, S.P., Sigray, P., Sutton, G., Thomsen, F., Werner, S., Wittekind, D., Young, J.V., 2014. Monitoring Guidance for Underwater Noise in European Seas, Part I: Executive Summary, JRC Scientific and Policy Report EUR 26557 EN, Publications Office of the European Union, Luxembourg, 2014, doi: 10.2788/29293

Dekeling, R.P.A., Tasker, M.L., Van der Graaf, A.J., Ainslie, M.A, Andersson, M.H., André, M., Borsani, J.F., Brensing, K., Castellote, M., Cronin, D., Dalen, J., Folegot, T., Leaper, R., Pajala, J., Redman, P., Robinson, S.P., Sigray, P., Sutton, G., Thomsen, F., Werner, S., Wittekind, D., Young, J.V., 2014. Monitoring Guidance for Underwater Noise in European Seas, Part II: Monitoring Guidance Specifications, JRC Scientific and Policy Report EUR 26555 EN, Publications Office of the European Union, Luxembourg, 2014b, doi: 10.2788/27158

Dekeling, R.P.A., Tasker, M.L., Van der Graaf, A.J., Ainslie, M.A, Andersson, M.H., André, M., Borsani, J.F., Brensing, K., Castellote, M., Cronin, D., Dalen, J., Folegot, T., Leaper, R., Pajala, J., Redman, P., Robinson, S.P., Sigray, P., Sutton, G., Thomsen, F., Werner, S., Wittekind, D., Young, J.V., 2014. Monitoring Guidance for Underwater Noise in European Seas, Part III: Background Information and Annexes, JRC Scientific and Policy Report EUR 26556 EN, Publications Office of the European Union, Luxembourg, 2014 c, doi: 10.2788/2808

Policy Context and targets

Policy context description

Underwater noise is concretely being considered by the Contracting Parties to the UNEP/MAP Barcelona Convention for the first time under the Ecosystems Approach process (**Decision 17/6 and 20/4, COP17**).

Decision 21/3 (**COP18**) considered that many aspects of noise monitoring and the impact of noise on the marine environment are not yet sufficiently understood to allow a proper definition of Good Environmental Status (GES) related to Ecological Objective 11 (Energy including Underwater Noise)

Indicator Title	Common indicator 26: Proportion of days and geographical distribution where loud, low and mid-frequency impulsive sounds exceed levels that are likely to entail significant impact on marine animals

In 2014-2015 ACCOBAMS in cooperation with the UNEP/MAP Secretariat developed the "**Basin-wide Strategy for underwater noise monitoring in the Mediterranean**" thanks to its working group on noise (Joint ASCOBANS/ACCOBAMS/CMS Noise Working Group).

This strategy was included in the Integrated Monitoring and Assessment Programme (**IMAP**) during the **CORMON Meeting** in Athens (March 30 – April 01, 2015), which was finally adopted by Parties during the **COP19**.

Finally, during the COP19, ACCOBAMS and the UNEP/MAP signed an **MoU** covering the issue of underwater noise.

Targets
No target proposed yet

Policy documents
List and url's

Report of the following Meetings: COP17-18-19
http://www.unepmap.org/index.php?module=events&action=detail&id=65
http://rac-spa.org/nfp12/documents/reference/13ig21_9_eng.pdf
http://195.97.36.231/dbases/MEETING_DOCUMENTS/12IG20_8_Eng.pdf

Reports of the 4th and 5th EcAp Coordination Unit (this last not available online)
http://195.97.36.231/dbases/MEETING_DOCUMENTS/14WG401_8_ENG.pdf

Report of the Meeting of the CORMONs, Athens 30 March – 01 April 2015 (not available online)

Report of the Meeting of MEDPOL and joint-session MEDPOL/REMPEC, Malta 16-19, June 2015.
http://195.97.36.231/dbases/MEETING_DOCUMENTS/15WG417_17_ENG.pdf

Indicator analysis methods

Indicator Definition
Number of days over a year and number of cells over a grid in which noise exceeding given thresholds occurs

Methodology for indicator calculation
Computing the indicator units through a GIS software over a spatial grid of 20x20 km resolution[14]

Indicator units
pulse-block days: the number of days that a certain threshold (pulse) is exceeded in an area (block)

List of Guidance documents and protocols available

ACCOBAMS, 2015. A basin-wide strategy for underwater noise monitoring in the Mediterranean. Report prepared by Alessio Maglio, Manuel Castellote and Gianni Pavan.

Data Confidence and uncertainties

Data confidence is expected to be high due to the simplicity of the data themselves (location, period and intensity of noise sources used)

[14] The current recommendation for the spatial grid resolution is 20x20 km but this is subject to changes until the development of the Mediterranean register of noise sources is completed.

Indicator Title	Common indicator 26: Proportion of days and geographical distribution where loud, low and mid-frequency impulsive sounds exceed levels that are likely to entail significant impact on marine animals
The main uncertainty is GES definition and therefore the establishment of thresholds : what spatial and temporal coverage from noise sources is considered as acceptable? In other words: below how many *pulse-block days* and in how many blocks (grid cells) do we consider the indicator as being in GES? Further uncertainty is given by the spatial grid: current proposal is 20x20 km resolution but other options are on the table (see footnote 2)	
Methodology for monitoring, temporal and spatial scope	
Available Methodologies for Monitoring and Monitoring Protocols Monitoring Methodology: A register of the use of noise sources is the necessary tool enabling a monitoring programme. The register is a database with data on the use of underwater noise sources: location, period and intensity at least. Monitoring Protocol: Data on the use of impulsive noise sources (location, period, and intensity at least) are entered in the register on a regular basis (once, twice or more times per year). This is done by a selected contact person in each country.	
Available data sources ACCOBAMS Noise Register (currently at early stage development) National data repositories available for some countries for specific activities (e.g. licensing areas for seismic exploration). Some exemples: http://unmig.mise.gov.it/; http://www.minetur.gob.es http://www.ifremer.fr/sismer http://bo.ismar.cnr.it http://unmig.sviluppoeconomico.gov.it http://energy.gov.il http://www.sigetap.tn http://www.ypeka.gr http://www.beph.net	
Spatial scope guidance and selection of monitoring stations No monitoring stations needed Spatial scope: regular spatial grid (see footnote 2)	
Temporal Scope guidance Analysis is to be done once a year, i.e 1 computation of *pulse-block days* per grid cell per year. Data can be entered several times a year in the register. No fixed periodicity proposed.	
Data analysis and assessment outputs	
Statistical analysis and basis for aggregation Basic descriptive statistics are needed to compute the indicator (see **Methodology for indicator calculation** and **Indicator units** above in this table) One data repository (noise register) is established by country. Data from single countries are aggregated through the ACCOBAMS Noise Register	
Expected assessments outputs (I.e. trend analysis, distribution maps, etc. and methods used)	

Indicator Title	Common indicator 26: Proportion of days and geographical distribution where loud, low and mid-frequency impulsive sounds exceed levels that are likely to entail significant impact on marine animals

The assessment outputs are the following:

- a GIS map showing the spatial and temporal distribution of noise sources over a year; the value associated to each grid cell (block) in such map is the total number of *pulse-block days* for that year
- Noise source coverage values: Number of grid cells and % of the total cell number with # of *pulse-block days* > 0
- Trend analysis is possible across years

Known gaps and uncertainties in the Mediterranean

No particular gap or uncertainty concerning data analysis and assessment outputs

Contacts and version Date

Key contacts within UNEP for further information

The joint CMS/ACCOBAMS/ASCOBANS Noise Working Group, through the ACCOBAMS Secretariat
Jardin de l'UNESCO
Terrasses de Fontvieille
98000 Monaco
Tel : +377 98 98 20 78

Version No	**Date**	**Author**
V.1	10/07/2016	ACCOBAMS

19. <u>Candidate Indicator 27: Levels of continuous low frequency sounds with the use of models as appropriate (EO11).</u>

Indicator Title	Common indicator 27: Levels of continuous low frequency sound with the use of models as appropriate	
Relevant GES definition	**Related Operational Objective**	**Proposed Target(s)**
Noise from human activities causes no significant impact on marine and coastal ecosystems.	Energy inputs into the marine environment, especially noise from human activities, are minimized	• Not more than 100 days per year • Not more than 25% of Mediterranean Sea area • Not within feeding/breeding grounds

Rational

Justification for indicator selector

- Addresses the main contributors to continuous low frequency noise levels (ships)
- Addresses the potential masking effect of anthropogenic continuous noise on representative cetacean species of the Mediterranean
- Consistent with the MSFD-D11 (Ambient noise indicator)

Scientific References

Dekeling, R.P.A., Tasker, M.L., Van der Graaf, A.J., Ainslie, M.A, Andersson, M.H., André, M., Borsani, J.F., Brensing, K., Castellote, M., Cronin, D., Dalen, J., Folegot, T., Leaper, R., Pajala, J., Redman, P., Robinson, S.P., Sigray, P., Sutton, G., Thomsen, F., Werner, S., Wittekind, D., Young, J.V., 2014. Monitoring Guidance for Underwater Noise in European Seas, Part I: Executive Summary, JRC Scientific and Policy Report EUR 26557 EN, Publications Office of the European Union, Luxembourg, 2014, doi: 10.2788/29293

Dekeling, R.P.A., Tasker, M.L., Van der Graaf, A.J., Ainslie, M.A, Andersson, M.H., André, M., Borsani, J.F., Brensing, K., Castellote, M., Cronin, D., Dalen, J., Folegot, T., Leaper, R., Pajala, J., Redman, P., Robinson, S.P., Sigray, P., Sutton, G., Thomsen, F., Werner, S., Wittekind, D., Young, J.V., 2014. Monitoring Guidance for Underwater Noise in European Seas, Part II: Monitoring Guidance Specifications, JRC Scientific and Policy Report EUR 26555 EN, Publications Office of the European Union, Luxembourg, 2014b, doi: 10.2788/27158

Dekeling, R.P.A., Tasker, M.L., Van der Graaf, A.J., Ainslie, M.A, Andersson, M.H., André, M., Borsani, J.F., Brensing, K., Castellote, M., Cronin, D., Dalen, J., Folegot, T., Leaper, R., Pajala, J., Redman, P., Robinson, S.P., Sigray, P., Sutton, G., Thomsen, F., Werner, S., Wittekind, D., Young, J.V., 2014. Monitoring Guidance for Underwater Noise in European Seas, Part III: Background Information and Annexes, JRC Scientific and Policy Report EUR 26556 EN, Publications Office of the European Union, Luxembourg, 2014 c, doi: 10.2788/2808

Policy Context and targets

Policy context description

Underwater noise is concretely being considered by the Contracting Parties to the UNEP/MAP Barcelona Convention for the first time under the Ecosystems Approach process (**Decision 17/6 and 20/4, COP17**).

Decision 21/3 (**COP18**) considered that many aspects of noise monitoring and the impact of noise on the marine environment are not yet sufficiently understood to allow a proper definition of Good Environmental Status (GES) related to Ecological Objective 11 (Energy including Underwater Noise)

In 2014-2015 ACCOBAMS in cooperation with the UNEP/MAP Secretariat developed the "**Basin-wide Strategy for underwater noise monitoring in the Mediterranean**" thanks to its working group on noise (Joint ASCOBANS/ACCOBAMS/CMS Noise Working Group).

Indicator Title	Common indicator 27: Levels of continuous low frequency sound with the use of models as appropriate
This strategy was included in the Integrated Monitoring and Assessment Programme (**IMAP**) during the **CORMON Meeting** in Athens (March 30 – April 01, 2015), which was finally adopted by Parties during the **COP19**. Finally, during the COP19, ACCOBAMS and the UNEP/MAP signed an **MoU** covering the issue of underwater noise.	
Targets No target proposed yet	
Policy documents *List and url's* Report of the following Meetings: COP17-18-19 http://www.unepmap.org/index.php?module=events&action=detail&id=65 http://rac-spa.org/nfp12/documents/reference/13ig21_9_eng.pdf http://195.97.36.231/dbases/MEETING_DOCUMENTS/12IG20_8_Eng.pdf Reports of the 4th and 5th EcAp Coordination Unit (this last not available online) http://195.97.36.231/dbases/MEETING_DOCUMENTS/14WG401_8_ENG.pdf Report of the Meeting of the CORMONs, Athens 30 March – 01 April 2015 (not available online) Report of the Meeting of MEDPOL and joint-session MEDPOL/REMPEC, Malta 16-19, June 2015. http://195.97.36.231/dbases/MEETING_DOCUMENTS/15WG417_17_ENG.pdf	
Indicator analysis methods	
Indicator Definition Annual mean sound pressure level and 33% exceedance level in selected frequecy bands (third-octave bands centered at 20, 63, 125, 250, 500, 2000)	
Methodology for indicator calculation Calculating through appropriate software: - the arithmetic mean sound pressure level of a given number of sound recordings of a fixed duration over a year; - the sound pressure level exceeded during 1/3 of a year (33% Exceedance level)	
Indicator units dB re 1µPa RMS	
List of Guidance documents and protocols available ACCOBAMS, 2015. A basin-wide strategy for underwater noise monitoring in the Mediterranean. Report prepared by Alessio Maglio, Manuel Castellote and Gianni Pavan.	
Data Confidence and uncertainties Data confidence depends mainly on the characteristics of the sound recorder used, on its calibration, on the mooring conditions, and on the location. Also, the southern Mediterranean areas are less covered by the AIS system which provide one of the data type necessary for acoustic modelling and mapping. This certainly affects the quality of monitoring through models and mapping	

Indicator Title	Common indicator 27: Levels of continuous low frequency sound with the use of models as appropriate

A great uncertainty arises by the standardisation of methodologies for sound recording and analysis

GES definition is also uncertain: what continuous noise levels are acceptable (GES)?

Methodology for monitoring, temporal and spatial scope

Available Methodologies for Monitoring and Monitoring Protocols

Monitoring Methodology: continuous sound recording at fixed sites through sound recording stations and acoustic modelling and mapping through simulated data validated through field measures.

Monitoring Protocol: recordings are stored in a storage facility (server) during the year. These can be retrieved manually or automatically transmitted through appropriate networks (wi-fi, GPRS, Satellite) from the station to the server. Cabled sound recorders, directly connected to land, can also be used. Fieldwork is limited to deployment and maintenance of sound recorders. Data are analysed once a year over the whole acoustic dataset obtained. Models and mapping are computed through appropriate software once a year.

Available data sources

EMSO-ESONET, LIDO (for recordings)
Input data for acoustic modelling (depth, seafloor, temperature and salinity profiles, etc.) available at many freely available data repositories (e.g. My-Ocean project in the EU; rich data from NOAA also for the European waters)
AIS databases for ship parameters (position, speed, vessel type, etc.)

Spatial scope guidance and selection of monitoring stations

Spatial scope: Contracting Parties (CPs) should consider the whole maritime space under their jurisdiction for placing the acoustic devices, following the guidelines hereafter for selecting the location.

Location of monitoring stations: areas of low shipping density for deep areas; more hydrophones in complex coastal landscapes (islands, archipelagos, jagged coastlines); avoid trawling areas; avoid areas with strong tidal effects; avoid locations close to sound producing activities other than shipping

Temporal Scope guidance

Monitoring stations should be able to **continuously** record underwater sound, all year long

Data analysis and assessment outputs

Statistical analysis and basis for aggregation

Basic descriptive statistics are needed to compute the indicator (see **Methodology for Indicator Calculation** earlier in this table)

Aggregation could be done through transboundary cooperation at the sub-regional level

Expected assessment outputs
(I.e. trend analysis, distribution maps, etc. and methods used)

The assessment outputs are the following:

- Trend analysis across years (any robust statistical technique able to detect a trend can be used)
- Map of mean sound pressure level over a year
- Map of 33% exceedance level over a year

<table>
<tr><td>Indicator Title</td><td colspan="2">Common indicator 27: Levels of continuous low frequency sound with the use of models as appropriate</td></tr>
<tr><td colspan="3"></td></tr>
<tr><td colspan="3">Known gaps and uncertainties in the Mediterranean

Lack of standardisation in data analysis could affect the assessment.</td></tr>
<tr><td colspan="3">Contacts and version Date</td></tr>
<tr><td colspan="3">Key contacts within UNEP for further information
The joint CMS/ACCOBAMS/ASCOBANS Noise Working Group, through the ACCOBAMS Secretariat
Jardin de l'UNESCO
Terrasses de Fontvieille
98000 Monaco
Tel : +377 98 98 20 78</td></tr>
<tr><td>Version No</td><td>Date</td><td>Author</td></tr>
<tr><td>V.1</td><td>10/07/2016</td><td>ACCOBAMS</td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td></tr>
</table>