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Agenda Item 3: State of Play of Integrated Monitoring and Assessment Programme (IMAP) Implementation with regards to EO5 and EO9, MED POL Monitoring Programme and Way Forward

IMAP Guidance Factsheets: Update for Common Indicators 13, 14, 17, 18, 20 and 21; New proposal for Candidate Indicators 26 and 27

UNEP/MAP
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Note by the Secretariat

The 19th Meeting of the Contracting Parties (COP 19), held in February 2016, adopted the Integrated Monitoring and Assessment Programme (IMAP) of the Mediterranean Sea and Coast and Related Assessment Criteria (Decision IG. 22/7), with a list of regionally agreed good environmental status descriptions, common indicators and targets, with principles and clear timeline for its implementation. Furthermore, the UN Environment/MAP Programme of Work (PoW) adopted at COP 19, included under Output 1.4.3: “Implementation of IMAP (the EcAp-based integrated monitoring and assessment programme) coordinated, including GES common indicators factsheets”.

In line with IMAP, Guidance Factsheets were developed, reviewed and agreed by the Meeting of the Ecosystem Approach Correspondence Group on Pollution Monitoring (CorMon on Pollution Monitoring) held in Marseilles, France, 19-21 October 2016 and the Meeting of the MED POL Focal Points, held in Rome, Italy, 29-31 May 2017, for the Common Indicators to ensure coherent monitoring. The Guidance Factsheets provide concrete guidance to the Contracting Parties supporting implementation of their respective national monitoring programmes aligned with IMAP.

The comments received by the Contracting Parties were considered and approved by the 6th Meeting of the Ecosystem Approach Coordination Group, held in Athens, Greece, 11th September. It must be noted that the Guidance Factsheets were used during the elaboration of the Mediterranean Quality Status Report 2017 (Med QSR 2017).

Taking into account evolving needs to fill the gaps, in particular related to assessment component of the Guidance Factsheets, the UN Environment/MAP Programme of Work (PoW) adopted at COP 20, under Output 2.4.1 for national pollution and litter monitoring programmes, provides for undertaking important monitoring activities supported by data quality assurance and control, including further development of the IMAP Guidance Factsheets.

The present document outlines the revision of the Guidance Factsheets for Common Indicators 13, 14, 17, 18, 20 and 21 related to the Ecological Objectives 5 (Eutrophication) and 9 (Contaminants) and proposes for the first time the Guidance Factsheets for the Candidate Indicators 26 and 27 related to Ecological Objective 11 (Energy including underwater noise).

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List of Abbreviations / Acronyms

ACCOBAMS	Agreement on the Conservation of Cetaceans in the Black Sea, Mediterranean Sea and Contiguous Atlantic Area
CI	Common Indicator
COP	Conference of the Parties
CORMON	Correspondence Group on Monitoring
DDs	Data Dictionaries
DSs	Data Standards
EcAp	Ecosystem Approach
EEA	European Environmental Agency
EO	Ecological Objective
EU	European Union
FAO	Food and Agriculture Organization of the United Nations
GES	Good Environmental Status
HELCOM	Baltic Marine Environment Protection Commission - Helsinki Commission
ICES	International Council for the Exploration of the Sea
IMAP	Integrated Monitoring and Assessment Programme of the Mediterranean Sea and Coast and Related Assessment Criteria
INFO/RAC	Regional Activity Centre for Information and Communication
MAP	Mediterranean Action Plan
MED POL	Programme for the Assessment and Control of Marine Pollution in the Mediterranean Sea
MED QSR	Mediterranean Quality Status Report
MSFD	Marine Strategy Framework Directive
OSPAR	Convention for the Protection of the Marine Environment for the North-East Atlantic
PoW	Programme of Work
SoED 2019	2019 State of Environment and Development Report
US EPA	United States Environmental Protection Agency
WFD	Water Framework Directive

1. INTRODUCTION

1. The Guidance Factsheets update proposed in this document strictly follows the structure of the IMAP Common Indicator Guidance Factsheets as approved by the 6th Meeting of the Ecosystem Approach Coordination Group. The amended Guidance Factsheets follow in particular on an update of the assessment maps in 2019 for the purpose of preparation of the SoED 2019. They are consistent with the Data Standards (DSs) and Data Dictionaries (DDs) of the IMAP (Pilot) Info System currently in development by INFO/RAC under the overall coordination of the Secretariat.

2. The main elements of the update are:

i. Ecological Objective 5 (Eutrophication):

Common Indicator 13:

- Scientific References: A new reference on establishing nutrient concentrations to support good ecological status is added.
- Available data sources: MED POL database added.
- Temporal Scope guidance: Small changes introduced, including adding of the example for sampling frequency definition through the discriminant limit of two adjacent mean values for CI14 to be used as base when the thresholds and boundaries for key nutrients will be available.
- Data analysis and assessment outputs: The Example is no more appropriate and is deleted. Namely, in a near future for CI 13 a move to the boundaries/thresholds concept should be followed, and the local indicator or approach will be of minor importance. Near all, the same example was given in the CI14 section and therefore it is deleted both from CI 13 and 14.

Common Indicator 14:

- Available data sources: Rewritten and properly cited.
- Spatial scope guidance and selection of monitoring stations: small corrections.
- Temporal Scope guidance: Mostly rewritten and added to the protocol to define the sampling frequency through the discriminant limit of two adjacent mean values.
- Statistical analysis and basis for aggregation: Totally rewritten to include the typology criteria and settings, as the Coastal Water types reference conditions and G/M boundaries. The Example is no more appropriate and is deleted.
- Expected assessments outputs: A reference to new Commission Decision (EU) 2018/229 of 12 February 2018 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, is added.

ii. Ecological Objective 9 (Contamination)

- **Common Indicator CI17**

- Justification for the indicator selection: some refinements in the paragraph have been included.
- Policy context and targets: some refinements have been included in both Policy context description and Targets subsections.
- Policy documents: reference is made in General Policy Documents to the updated EU MSFD in 2010 and the new amendments in 2017, as well as to the EU WFD revisions, which were not mentioned before. In the Contaminants related policy documents reference is made to the last publication on water matters by the EEA (EEA, 2018. European Waters – Assessment of status and pressures 2018. EEA Report /No 7, 2018).

- Indicator definition: some refinements have been included such as the need for offshore sediment stations, plus highlighting the fact that the agreed compounds need to be measured in seawater, biota and sediments for this multiparametric indicator, which matches and are included in the list of chemicals, Data Standards and Data Dictionaries (DSs and DDs) of the IMAP (Pilot) Info System under Common Indicator 17.
- Methodology for indicator calculation: a final sentence has been included to stress the use of validated methodologies for measurements.
- Data confidence and uncertainties: the paragraph has been rewritten and extended for clarification.
- Methodology for monitoring, temporal and spatial scope: The four subsections have been slightly rewritten for further clarification.
- Data analysis and assessment outputs: a few words have been amended for clarification of the paragraphs.

- **Common Indicator CI18**
- Policy context description: some refinements have been included.
- Indicator definition: a note has been included to inform that the development of the IMAP (Pilot) Info System will take into account the biochemical measurements and toxicological methods as agreed for the CI18 for reporting purposes.
- Available Methodologies for Monitoring and Monitoring Protocols: a reference is made to the availability of other guidance and monitoring protocols in other Regional Seas Conventions, such as OSPAR (and a reference to ICES Cooperative Research Report, No 315, November 2012. Integrated marine environmental monitoring of chemicals and their effects. Ed. Ian M. Davis and Dick Vethaack included:).
- Temporal scope guidance: some refinements have been included to clarify the paragraphs.

- **Common Indicator CI20**
  - Policy context description: FAO acronym description has been cited.
  - Indicator definition: explicit reference is made to European Regulation EU 1881/2006 and some sentences have been rewritten.
- **Common Indicator CI21**
  - Justification for the indicator selection and Scientific References: some parts of the paragraphs have been rewritten for simplicity and the scientific references revised. The reference, matching the criteria followed by IMAP has been included (vii.US EPA RWQC 2012. Recreational Water Quality Criteria. OFFICE OF WATER 820-F-12-058. Scientific document).
  - Policy context indicator and Targets: A clear mention is made to the Decision IG. 20/9 (Criteria and Standards for bathing waters quality in the framework of the implementation of Article 7 of the LBS Protocol. COP17, Paris, 2012).
  - Indicator definition: the sentence “Percentage of intestinal enterococci concentration measurements within established standards” has been deleted as this is not the indicator definition rather than the target. The definition is suggested as follows: “Concentration (Colony-forming unit, CFU) of intestinal enterococci in the water sample (normalized to 100 mL) collected at one beach location”. These measurements are followed by the established statistical methodology for water quality assessment (next subsection).
  - Indicator units: the subsection now read: “the 90th and 95th percentiles of the log10 normal probability density function of the CFU datasets measured at one single location according established monitoring and assessment protocols and standards”.
  - List of Guidance documents and Protocols available: reference to Decision 20/9 has been included.

- Data Confidence and Uncertainties: the paragraph have been rewritten for clarification.
- Available Methodologies for Monitoring and Monitoring Protocols: the sentence has been rewritten and the reference to Decision IG. 20/9 stated.
- Available data sources: the previous text has been deleted and replaced by: For some Mediterranean countries European and non-European, the European Environmental Agency (EEA) has published a number of reports and the datasets are available through their website services. https://www.eea.europa.eu/data-and-maps/indicators/bathing-water-quality
- Spatial scope guidance and selection of monitoring stations: in this subsection it is suggested to observe Directive 2006/7/EC.

3. The above listed amendments introduced in the Common Indicator IMAP Guidance Factsheets are provided in UNEP/MED WG.463/Inf.3.

4. In line with Decision IG.22/7, the Secretariat and ACCOBAMS prepared a proposal of the Guidance Factsheets for Common Indicators 26 and 27 of the Ecological Objective 11 for consideration of this Meeting of CorMon on Pollution Monitoring as presented in the following section.

3. THE GUIDANCE FACTSHEET FOR THE CANDIDATE INDICATOR 26

5. The Guidance Factsheet for **Common Indicator 26 (EO11):** 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 is presented in the following tabular form.

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	Number of days with impulsive sounds sources, their distribution within the year and spatially within the assessment area, are below thresholds
Rational		
Justification for indicator selection Anthropogenic energy introduced by human activities into the marine environment includes sound, light and other electromagnetic fields, heat and radioactive energy. The most widespread and pervasive is underwater sound (Dekeling et al., 2013a). Sound energy input can occur at varying spatial and temporal scales. Anthropogenic sounds may be of short duration (i.e. impulsive) or be long lasting (i.e. continuous). Lower frequency sounds can be transmitted far (tens to thousands of kilometres), whereas higher frequency sounds transmit less well in the marine environment (hundreds of meters to few kilometres (Urick, 1996). Most common sources of marine noise pollution include ship traffic, geophysical exploration and oil and gas exploitation, military sonar use and underwater detonations, telemetry devices and acoustic modems, scientific research involving the use of active acoustic sources, and offshore and inshore industrial construction works. Such activities are growing throughout the Mediterranean Sea (e.g.DeMicco; OWEMES, 2012; US Energy Information administration, 2013). Marine organisms can be adversely affected both on short and long timescales (and include acute or chronic impact and temporary or permanent effects (Richardson et al, 1995). Adverse effects can be		

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

subtle (e.g. temporary reduction in hearing sensitivity, stress effects causing reduced immunity, reproduction success or survival), or more obvious (e.g. injury, death). The former may be difficult to observe and evaluate while the latter may in some circumstances be related to acute short-range noise exposures. Concerning noise source-specific impact, it has been demonstrated that naval exercises involving the use of mid-frequency active sonars caused several mass stranding events of Cuvier's beaked whales along the coasts of the Mediterranean Sea and in other sea areas at least during the last 20 years (e.g. Frantzis, 1998; Fernandez et al., 2004; Martin et al., 2004; Agardy et al., 2007; Filadelfo et al., 2009). Further, this correlation is suspected also for the case of geophysical surveys (e.g. Southall et al., 2013; Castellote and Llorens 2013), although definite results are not available yet. Further, displacement and/or acoustic behavioural disruption may occur for Mediterranean fin whales in response to low frequency impulsive noise at very long ranges, reaching more than 200 km (Borsani et al., 2008; Castellote et al., 2012). Finally, sperm whales and beaked whales have been identified to be highly sensitive to mid-frequency impulsive sounds (e.g. Aguilar de Soto et al., 2006; Weir, 2008).

Management concern is primarily associated to the negative effects of noise on sensitive protected species, such as some species of marine mammals.

Scientific References

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Borsani JF, Clark CW, Nani B, Scarpiniti M. 2008. FIN WHALES AVOID LOUD RHYTHMIC LOW-FREQUENCY SOUNDS IN THE LIGURIAN SEA. *Bioacoustics - The International Journal of Animal Sound and its Recordings* **17**: 151–193.

Castellote M, Clark CW, Lammers MO. 2012. Acoustic and behavioural changes by fin whales (Balaenoptera physalus) in response to shipping and airgun noise. *Biological Conservation* **147**: 115–122.

Castellote M and Llorens C. 2013. Review of the effects of offshore seismic surveys in cetaceans: are mass strandings a possibility? 3rd International Conference: The Effects of Noise on Aquatic Life. Budapest, Hungary, August 2013.

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

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

De Micco P. The prospect of Eastern Mediterranean gas production: An alternative energy supplier for the EU?

Fernandez A, Arbelo M, Deaville R, Patterson IAP, Castro P, Baker JR, Degollada E, Ross HM, Herraez P, Pcknell AM, et al. 2004. Whales, sonar and decompression sickness (reply). *Nature* 576: 575–576.
Filadelfo R, Mintz J, Michlovich E, D'Amico A, Tyack PL, Ketten DR. 2009. Correlating Military Sonar Use with Beaked Whale Mass Strandings: What Do the Historical Data Show? *Aquatic Mammals* 35: 435–444.

Frantzis A. 1998. Does acoustic testing strand whales? *Nature* 392: 29.
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OWEMES. 2012. Offshore wind and other marine renewable energies in the Mediterranean and European seas. In Proceedings of the European Seminar OWEMES 2012, Lazzari A, Molinas P (eds). National Agency for New Technologies, Eneregy and Sustainable Economic Development: Rome;
Richardson, W. J., C. R. Greene, Jr., C. I. Malme, and D. H. Thomson (eds). 1995. Marine Mammals and Noise. Academic Press, San Diego CA, 576 pp.

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Urick, Robert J. (1996). Principles of underwater sound. pp 444 Peninsula Publishing. 3rd Edition.
US Energy Information Administration. 2013. Overview of oil and natural gas in the Eastern Mediterranean region. Geology

Weir CR. 2008. Overt Responses of Humpback Whales (*Megaptera novaeangliae*) Sperm Whales (*Physeter macrocephalus*), and Atlantic Spotted Dolphins (*Stenella frontalis*) to Seismic Exploration off Angola. *Aquatic Mammals* **34**: 71–83.

Policy Context and targets

Policy context description

Generalities:

In the marine environment, the term pollution is defined in several legal frameworks by the following statement: "the introduction by man, directly or indirectly, of substances or energy into the marine environment […]". This definition includes anthropogenic noise as a form energy caused by human activities. As such, underwater noise pollution is addressed by Regional Seas Conventions, where the following initiatives are considered the most relevant for the management of activities generating noise, and the mitigation of their adverse effects on the marine environment:

- For the Barcelona Convention, the Ecosystem Approach process (EcAp), started in 2008;

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- For the OSPAR and HELCOM Conventions, the adoption for their respective monitoring and assessment processes of the indicators related to underwater noise as proposed in the framework of the MSFD (2011 and 2012).

In parallel, the European Union adopted the same definition of pollution given in the paragraph above in the text of the Marine Strategy Framework Directive (MSFD, 2008/56/EC, adopted in 2008). The MSFD gave a considerable impulse to the undertaking of actions, programs, measures, as well as scientific research to cover the knowledge gaps on underwater noise, and hence develop appropriate guidance on the management of man-made noise in the marine environment.
With regards to the MSFD, underwater noise is addressed by Descriptor 11, and two criteria were selected for monitoring and assessment purposes, one addressing loud impulsive signals produced by several coastal and offshore works (pile driving, explosions, seismic pulses, etc.), the other targeting the contribution of anthropogenic sources, especially shipping, to ambient noise levels. Since the adoption of the MSFD (2008), the European Commission issued two Decisions addressing methodological standards for the monitoring and assessment of underwater noise: Commission Decision 2010/477/EU on criteria and methodological standards on good environmental status of marine waters, and Commission Decision 2017/848/EU laying down criteria and methodological standards on good environmental status of marine waters and specifications and standardised methods for monitoring and assessment, and repealing Decision 2010/477/EU.

Concerning the EcAp process, among the eleven Ecological Objectives (EOs), and respective operational objectives and indicators agreed through Decision 20/4 (17th Meeting of Contracting Parties, COP 17), EO11 addresses underwater noise produced by human activities. However, during the COP 18 (Istanbul, 2013), Decision 21/3 provided a specific list of descriptions of good environmental status and targets for the other EOs, contrary to EO11, considered not yet sufficiently understood to allow a proper definition of good environmental status. Therefore, 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 proposed to address two types of noise for the monitoring and assessment purposes, as for the MSFD process: loud impulsive signals produced by several coastal and offshore works (pile driving, explosions, seismic pulses, etc.), and the contribution of anthropogenic sources, especially shipping, to ambient noise levels. The 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.

Several other legal frameworks have addressed anthropogenic underwater noise and its impact on the marine environment and wildlife: The International Whaling Commission (IWC), the Convention on Biological Diversity (CBD), the Convention on Migratory Species (CMS), ACCOBAMS and ASCOBANS, as well as the European Parliament, and more. Almost all the initiatives undertaken by such legal frameworks deal with the impact of noise on some environmental element (usually sensitive marine fauna such as cetaceans and fish, turtles, crustaceans, etc.), while in the MSFD and EcAp processes emphasis is put on the human activities generating noise. This is likely due to the fact that managing human activities in the sea is theoretically easier than managing impact. However, the

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effectiveness of such an approach rely on a good understanding of the relationship between noise and impact, which is very often not the case.

With specific regards to impulsive noise:

In EU Member States, human activities producing loud impulsive signals into the marine environment are managed nationally through licensing systems, and the consideration of the impact of noise in such management processes is especially due to the European Directive on the Environmental Impact Assessment (EIA Directive). However, the EIA Directive is “project-bases”, contrarily to the MSFD and EcAp, which are “ecosystem-based”. The main difference between project-based and ecosytem-based approach is that in the case of an EIA, the project developer (e.g. an industry) is responsible for assessing and mitigating the impact of its own activities, while in the case of the EcAp and MSFD processes, country’s governments are responsible for the achievement and/or maintenance t of the good environmental status, which include addressing and managing the potential adverse impact of all pressures in the marine environment.

The transposition in national legislation of the EIA Directive resulted in different national management systems. For instance, in the UK a standard mitigation framework applies to a list of well-defined activities; in Germany, impulsive sound signals are allowed as far as they do not exceed legal thresholds (a certain received noise level at 750 m from the source); in Italy the project developer need to implement 60 days monitoring before and after the activity to understand whether or not the activity caused any impact.

Again, while the EIA Directive gave considerable results in managing the impact of single activities introducing noise into the sea, a framework addressing the ecosystem scale has been in need of development in the past decade. This Factsheet addressed exactly this point and provides elements for the implementation of the ecosystem approach to the management of activities producing impulsive noise.

Targets

The primary activity under common indicator 26 should be the setting up by countries of a database (“a noise register[1]”) for the registration of “noise events”, where a noise event is the occurrence of loud impulsive signals (in low and mid frequency bands) on a given day and in a given place. Once the register is built, it is possible to obtain an overview of the spatial and temporal distribution of noise-producing activities, as well as set the specific thresholds to achieve defined targets. During the QUIETMED project (DG ENV/MSFD Second Cycle/2016) an interim list was drawn of possible targets addressing especially regulatory and management aspects of underwater noise. Possible target shall deal indeed with (not exhaustive list): increasing the number of mitigation measures applied to activities potentially causing impact, decreasing the number of activities generating loud noise in habitats of sensitive cetacean species, applying time-space closures (set on biological and ecological bases) to the occurrence of activities with the highest potential of causing impact to mention few.

Policy documents

Report of the following Meetings: COP17-18-19

[1] See for example: http://underwaternoise.ices.dk/map.aspx ; http://accobams.noiseregister.org/

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- 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 5thEcAp Coordination Unit meeting:
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

Report of the Meeting of MED POL and joint-session MED POL/REMPEC, Malta 16-19, June 2015.
http://195.97.36.231/dbases/MEETING_DOCUMENTS/15WG417_17_ENG.pdf

DIRECTIVE 2008/56/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCILof 17 June 2008 establishing a framework for community action in the field of marine environmental policy (Marine Strategy Framework Directive)

Commission Decision of 1 September 2010 on criteria and methodological standards on good environmental status of marine waters (2010/477/EU)

Commission Decision 2017/848/EU of 17 May 2017 laying down criteria and methodological standards on good environmental status of marine waters and specifications and standardised methods for monitoring and assessment, and repealing Decision (2010/477/EU)

Council Directive 85/337/EEC of 27 June 1985 on the assessment of the effects of certain public and private projects on the environment; and successive amendments in 1997 (97/11/EC), 2003 (2003/35/EC), and 2009 (2009/31/EC). This Directive was repealed and replaced by the following: Directive 2011/92/EU of the European Parliament and of the Council of 13 December 2011 on the assessment of the effects of certain public and private projects on the environment; also amended in 2014 (2014/52/EU).

Indicator analysis methods

Indicator Definition

The indicator is defined by the number of days with impulsive sound sources in an assessment area and over a defined period. Such areas may be the cells of a spatial grid, or larger scale areas such as the subdivision, sub regional and regional scales. Not all impulsive noise sources are to be accounted for, only those exceeding thresholds considered as having a significant impact on populations of sensitive wildlife. The impact is considered significant when severe displacement of animals from their habitats occurs due to noise. Thresholds for the onset of significant impact are defined in the “Basin-wide Strategy for underwater noise monitoring in the Mediterranean” (ACCOBAMS, 2015).

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Methodology for indicator calculation

The calculation is given by the sum of all days where noise events occurs over a defined period (one year or temporal window such as month or trimester), and for an assessment unit. As described above, a noise event is the occurrence of loud impulsive signals (in low and mid frequency bands) on a given day and in a given place.

A spatial grid with a regular cell size is proposed to compute the number of days with impulsive sound sources. The calculation is done for each grid cell using common GIS software or more sophisticated web applications. Also, the calculation may be done in assessment areas as a whole: sub-regions, the whole region, or subdivisions decided at the country level.

The “Basin-wide Strategy for underwater noise monitoring in the Mediterranean” (ACCOBAMS, 2015) proposed to use a 20x20 km spatial grid. However, recent developments (especially thanks to the QUIETMED project) led to propose different options, including: the spatial grid already used by the General Fisheries Commission for the Mediterranean (GFCM statistical rectangles), which is has a dimension of 30 min in latitude and longitude, or the adoption for all noise sources of spatial grids already used by countries to manage human activities nationally (e.g. Oil&Gas licenced areas).

Indicator units

The indicator unit is called ***pulse-block days*** (PBDs), meaning the number of days of occurrence of impulsive noise events in an area (block), in a given period.

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.

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.

Recommendations to Member States to set up the national registers of impulsive noise according to criterion D11C1 of the Commission Decision 2017/848/EU and ACCOBAMS premises, and generalisation for the EcAp process. Deliverable 3.4, QUIETMED project. DG ENV/MSFD Second Cycle/2016.

Data Confidence and uncertainties

Data confidence is expected to be high due to the simplicity of the data themselves. To meet minimum objectives of monitoring Common Indicator 26, only the location (geographical coordinates or area), the period (dates) and intensity of noise sources used are necessary. All such information, including the intensity of the noise source, should be obtained from declarative data, i.e. it is not necessary to

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measure the real noise level with any equipment, or to carry out fieldwork to locate noise-producing activities.

Declarative data can be sought in the national institutes already centralising data on marine activities (e.g. institutions managing Oli & Gas licensing procedures; or environmental impact assessment procedures; etc.). This system, on the one hand result in very low costs for obtaining data, while in the other hand add some uncertainty.

Uncertainty is mainly due to the fact that declarative data maybe not available (e.g. sensitive data such as data on military activities), not well specified or with important gaps, or not completely suitable for impulsive noise monitoring as described in this Factsheet. There is little chance that no data be available at all, or with important gaps, concerning the position and the period of marine activities, while this may be the case concerning information on the intensity of noise sources. Therefore, this fact may be overcome by setting conservative thresholds for up taking marine activities in the noise register.

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 fed with data on the use of underwater noise sources (noise events).

Tools for monitoring impulsive noise sources (i.e. tool for setting the noise register): the joint use of a spreadsheet (MS Excel or similar) and common GIS software is considered as the recommendation to meet the minimum requirements of Common Indicator 26, where the spreadsheet is used to record noise events, and the GIS software to perform spatial analysis of these areas (e.g. to compute the number of pulse-block days).

What noise sources should be registered:

- **Pile driving**. Pile driving is a conventional technique employed in many coastal and offshore constructions, such as wind farms, offshore platforms, harbour extensions etc. The growth of the wind energy sector caused a great increase in the use of this technique both in coastal and offshore environments.
- **Airgun**. The airgun is presently the most employed technology for carrying out marine seismic exploration. Such surveys are pervasive worldwide, in shallow and deep water as well as in coastal or offshore environments
- **Explosives**. Underwater detonations may occur for the disposal of explosives or may be planned during maritime construction, e.g. to fragment rock prior to dredging. This is the loudest source of underwater noise and need to be treated with particular care.
- **Sonar**. Low-, mid- and high frequency active sonars (LFAS, MFAS, HFAS) are employed during military exercises as well as during academic and industrial surveys, such as fish stock

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estimations and bathymetric surveys. Especially, low- and mid- frequency naval sonars are of great concern given the mass stranding events of cetaceans linked in space and time with military exercises and need to be addressed with particular care.

- **Acoustic Deterrents**. High-powered devices designed to keep marine mammals away from fish farms by causing them pain. Frequencies range from 5-20KHz for repelling pinipeds and 30-160KHz for delphinids (Carretta et al, 2008, Lepper et al, 2004, Lurton, 2010, OSPAR, 2009).

<u>What information to collect to enter into the register:</u>

Data	**Units and/or comments**	**Priority**
Position	geographic position (lat/long) or pre-defined block/area which can be identified through a coding system (single identifier for each block used)	Required
Dates	Start and end day	Required
Source intensity	Source level or proxy, unique levels or in bins (see Annex 5.3 for corresponding tables of values in bins)	Required
Source spectra	Frequency range	Additional
Duty cycle		Additional
Duration of transmission	Actual time/time period	Additional
Directivity		Additional
Source depth		Additional
Platform speed	For moving sources like seismic surveys	Additional

<u>Minimum thresholds (Source intensity) for including a noise event in the register</u>:

- For low frequency sources: no thresholds, i.e. all sources to be registered
- For mid-frequency sources, table hereafter:
-

Noise source type	Thresholds for inclusion of noise events in the register
Explosive	mTNTeq> 8 g
Airgun	SLz-p > 209 dB re 1 µPa m
Low/mid freq sonar	176 dB re 1 µPa m
Low/mid freq acoustic deterrent	176 dB re 1 µPa m
Other pulse	186 dB re 1 $\mu Pa^2\ m^2\ s$

Again, **there is no need to measure on the field** and data are to be sought in institutions centralising data (Ministries, national regulatory bodies, etc.).

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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 developed but not yet operational, expected to be on-line in 2019).

National data repositories available for some countries for specific activities (e.g. licensing areas for seismic exploration). Some examples:
http://www.minetur.gob.es
http://www.ifremer.fr/sismer
http://bo.ismar.cnr.it
http://unmig.mise.gov.it/;
http://unmig.sviluppoeconomico.gov.it
http://energy.gov.il
http://www.sigetap.tn
http://www.ypeka.gr
http://www.beph.net

Further data repositories are open data platform developed by different organisations, where the most relevant appear to be the following: EmodNet (EU funded platform). From EmodNet it is possible to access data gates for marine activities, including marine renewable energy plants, platforms, cables and others.

For military activities, as a first approach, the *notice to mariners*[2] can be monitored to gather information on possible military activities. Notice to mariners are indeed freely available information for navigation.

Spatial scope guidance and selection of monitoring stations

No monitoring stations needed, only declarative data are required to fill up the noise register. Concerning the spatial scope at large: the monitoring methodology is based on the use of a regular spatial grid to compute pulse-block days. In this sense, a block is a unit of area of a spatial management system, for example a cell of the regular spatial grid. If a noise event lasts several days in the same block (ca. area), the pulse-block day is equal to the number of days of duration of that noise event.

Based on the calculation of PBDs, it is possible to derive other quantities such as:

- the extent in km², or the proportion (%) of the assessed area, with impulsive sound sources. Here a country may decide to apply a minimum number of PBDs to account an area (e.g. a grid cell or blocks) in the calculation of the extent or proportion. Example: A conservative choice

[2] Notice to mariners are information issued by country's military authorities. Such notices inform on sailing in a given area about the occurrence of some military exercise or other activity that may be dangerous for boats sailing in the area. For example, notice to mariners may be used for collecting data about military activities to be included in the noise register

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(ca. risk prevention) would be the proportion (% of grid cells) of the assessed area (total number of grid cell) with at least 1 PBDs.

Temporal Scope guidance

Data on noise events can be entered in the register by the responsible institution several times in a year, for example whenever data become available.
Based on the calculation of pulse-block days, it is possible to derive time-based quantities such as:

- the number of PBDs calculated monthly, quarterly, and/or yearly;
- the % of days over a time window with impulsive sound sources (noise events). Here again, a country may decide to apply a minimum # of PBDs to account an area (e.g. a grid cell) in the calculation of the extent or proportion. A conservative version of this indicator would be the following: the proportion (% of days) with at least 1 PBDs in the assessed time window (e.g. 1 month) and area (e.g. a subregion).

Data analysis and assessment outputs

Statistical analysis and basis for aggregation

Basic descriptive statistics are needed to compute the indicator:

- the number of pulse-block days over a time window;
- the % of an assessment area with impulsive sound sources.

Further statistics are the trend analysis that maybe applied on different aggregated periods, for example: year to year; summer to summer, month of year N to month of year N+1 (and N+3, …) or others.

From a regional and sub regional perspective, once the noise register is established by a all countries, such data may be transferred to the ACCOBAMS Nosie Register. This is proposed as the basis for regional and sub regional aggregation of data which can feed regional assessment (QSR) as well as supporting countries in reporting to EcAp EO11.

Expected assessments outputs

The assessment outputs are the following:

- GIS maps showing the spatial and temporal distribution of noise sources over a year, or calculated monthly or quarterly; the value associated to each grid cell (block) in such maps is the total number of *pulse-block days* for a month, a quarter, or a year;
- Noise source coverage values: number of grid cells and % of the total cell number, or extent in km²with number of *pulse-block days*> 0;
- Trend analysis is possible across aggregated time periods (year, seasons, months, etc.).

Known gaps and uncertainties in the Mediterranean

As a relatively new Common Indicator within the context of marine environmental protection policy, its applicability beyond usual management of marine activities needs to be determined. The main uncertainties lie in the availability of declarative data (location, period and intensity of noise sources), although experience from the implementation of the MSFD in the last 10 years are encouraging.

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Another important issue is the perception that underwater acoustics is too complex and noise monitoring generally too expensive. However, if this might be true if we talk about the science of acoustics (the physics of sound, the engineering behind the hydrophones and recording systems, in-situ recordings, software for analysing measurements, etc.), this Common Indicator was conceived to cut out most of this complexity, and this not only simplifies extremely the way of monitoring, but also minimizes the costs of implementation. Therefore, an emphasis should be put on correctly disseminating the information on how this indicator is built.	
Contacts and version Date	
Key contacts within ACCOBAMS and UN Environment/MAP for further information **SECRETARIAT PERMANENT DE L'ACCOBAMS** JARDIN DE L'UNESCO, LES TERRASSES DE FONTVIEILLE MC-98000, MONACO www.accobams.org **UN Environment/Mediterranean Action Plan** Barcelona Convention Secretariat Vas. Konstantinou 48, Athens 11635, Greece Telephone: +30 210 7273116 jelena.knezevic@unep.org www.unepmap.org	

Version No	**Date**	**Author**
V.1	10/07/2016	ACCOBAMS
V.2	25/01/2019	ACCOBAMS in consultations with UN Environment/MAP

4. THE GUIDANCE FACTSHEET FOR THE CANDIDATE INDICATOR 27

6. The Guidance Factsheet for **Common Indicator 27 (EO11):** Levels of continuous low frequency sound with the use of models as appropriate is presented in the following tabular form.

<table>
<tr><td>Indicator Title</td><td colspan="2">Levels of continuous low frequency sound with the use of models as appropriate</td></tr>
<tr><td>Relevant GES definition</td><td>Related Operational Objective</td><td>Proposed Target(s)</td></tr>
<tr><td>Noise from human activities causes no significant impact on marine and coastal ecosystems.</td><td>Energy inputs into the marine environment, especially noise from human activities, are minimized</td><td>Noise levels at monitoring stations are below thresholds; The extent (% or km²) of the assessment area which is above levels causing disturbance to sensitive marine animal is below limits, or such limits are exceeded for a limited amount of time</td></tr>
<tr><td colspan="3">Rational</td></tr>
<tr><td colspan="3">Justification for indicator selector

Anthropogenic energy introduced by human activities into the marine environment includes sources of sound, light, heat and others among the electromagnetic field spectrum. The most widespread and pervasive is underwater sound (Dekeling et al., 2013a). Sound energy input can occur at varying spatial and temporal scales. Anthropogenic sounds may be of short duration (i.e. impulsive) or be long lasting (i.e. continuous). Lower frequency sounds can be transmitted far (tens to thousands of kilometres), whereas higher frequency sounds transmit less well in the marine environment (hundreds of meters to few kilometres (Urick, 1996). Most common sources of marine noise pollution include ship traffic, geophysical exploration and oil and gas exploitation, military sonar use and underwater detonations, telemetry devices and acoustic modems, scientific research involving the use of active acoustic sources, and offshore and inshore industrial construction works. Such activities are growing throughout the Mediterranean Sea (e.g.DeMicco; OWEMES, 2012; US Energy Information administration, 2013).

Marine organisms can be adversely affected both on short and long timescales and include acute or chronic impact and temporary or permanent effects (Richardson et al, 1995). Adverse effects can be subtle (e.g. temporary reduction in hearing sensitivity, stress effects causing reduced immunity, reproduction success or survival), or more obvious (e.g. injury, death). The former may be difficult to observe and evaluate while the latter may in some circumstances be related to acute short-range noise exposures.

This indicator addresses, particularly, the continuous (ca. chronic) low-frequency sound produced by marine activities. The major contributor to this type of ambient ocean noise is produced by maritime traffic. For this reason, it has been pointed as an important factor potentially reducing the acoustic space of marine animals, and particularly cetaceans which are known to communicate over very long ranges through acoustic signals. Many studies also shown negative effects on fish. The potential masking of biological signal due to ship noise is considered indeed as a big issue risk as it may be the cause of many other indirect impacts, such as reduced reproduction, reduced foraging success, and hence a long term degradation of the survival rate of populations(e.g. Blair et al. 2016; Tennessen & Parks 2015; Putland et al. 2017; Aguilar de Soto et al. 2006; Pirotta et al. 2012; Wysocki et al. 2006)</td></tr>
</table>

Scientific References

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Blair, H.B. et al., 2016. Evidence for ship noise impacts on humpback whale foraging behaviour. Biology Letters, 12(8). Available at: http://rsbl.royalsocietypublishing.org/content/12/8/20160005.abstract.

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

De Micco P. The prospect of Eastern Mediterranean gas production: An alternative energy supplier for the EU?

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Pirotta, E. et al., 2012. Vessel noise affects beaked whale behavior: results of a dedicated acoustic response study. PloS one, 7(8), p.e42535. Available at: http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=3411812&tool=pmcentrez&rendertype=abstract [Accessed October 6, 2012].

Putland, R.L. et al., 2017. Vessel noise cuts down communication space for vocalizing fish and marine mammals. Global Change Biology, (November). Available at: http://doi.wiley.com/10.1111/gcb.13996.
Tennessen, J.B. & Parks, S.E., 2015. Acoustic propagation modeling indicates vocal compensation in noise improves communication range for North Atlantic right whales. Endangered Species Research, 30(1), pp.225–237.

US Energy Information Administration. 2013. Overview of oil and natural gas in the Eastern Mediterranean region. Geology.

Wysocki, L.E., Dittami, J.P. &Ladich, F., 2006. Ship noise and cortisol secretion in European freshwater fishes. Biological Conservation, 128(4), pp.501–508. Available at: http://linkinghub.elsevier.com/retrieve/pii/S0006320705004350 [Accessed January 13, 2014].

Policy Context and targets

Policy context description

Shipping activities are regulated by the IMO, the United Nations agency with responsibility for many aspects of shipping, including safety, maritime security, environmental concerns, legal and technical matters and efficiency. IMO is the source of several legal instruments, and among these the MARPOL Convention was signed with the aim of minimising pollution in oceans and seas. MARPOL includes 6 Annexes, each one addressing a category of pollution produced by ships: oil emissions, noxious liquids, packaged harmful substances, sewage, garbage, air pollution. Unfortunately, MARPOL defines pollution as substance, not energy, contrary to many other regulation bodies including other UN-related bodies such as the UN Convention on the Law of the Sea (UNCLOS). Underwater noise is therefore not addressed by MARPOL. However, in recent years the Marine Environment Protection Committee (MEPC) of the IMO addressed underwater noise produced by shipping. As a result, guidelines were issues on the reduction of noise emission from ships. (IMO 2014; IMO 2013b; IMO 2013a). However, it is worth noting that such guidelines address noise radiated from single ships and the way to mitigate the emissions, while the general rising in ambient ocean noise due to increased shipping (i.e. an ecosystem approach) is not addressed.

Given the lack of global regulation of ship radiated noise, the MSFD and EcAp processes provide the first legal instrument for monitoring, assessing and setting targets, at least for their competence areas (the European Union and the Mediterranean region, respectively). All the policy document developed in the framework of such initiatives are therefore a novelty concerning the regulation of emissions of pollutant related to shipping. A closer cooperation with such global regulatory bodies as the IMO and MARPOL is certainly a major asset for the success of initiatives aimed at reducing ship radiated noise, the associated impacts, and therefore deliver good environmental status.

Beyond large scale regulation, many interesting initiatives are being proposed to strengthen the implementation of mitigation measures applied to shipping at a local scale. For example, some ports authorities are setting specific rules to foster ships complying with increasingly high environmental standards, including low noise emissions through reduced speed or displacement of ship lanes. One of the most known initiatives appears to be the port authority of Vancouver. Of course, the sum and synergy of increasing numbers of local initiatives has the potential to create a network big enough to produce positive effects at the ecosystem scale.

Targets

The early proposition contained in MSFD-related document was to adopt a decreasing trend in average noise levels. However, this appeared hard to implement as a trend could takes decades to be detected by robust statistical analysis, while actions may be taken already today to reduce noise radiated from ships, the contribution of shipping to marine noise, and finally the adverse effects on marine wildlife.

An interim list of targets was developed in the framework of the QUIETMED project, subject to further discussion and validation, or adjustments. This list includes operational and environmental targets. The difference between such two types of targets are that operational targets address actions that can be already implemented and for which we are confident that this will help moving towards (or maintaining) GES. On the other hand, environmental targets rather describe the sought characteristics of the environment with respect to the pressure factor (continuous noise from shipping in the case of Common Indicator 27). Therefore, environmental targets are more related to the units of measurements of the indicator (noise levels, spatial extents, etc.). Operational and environmental targets included in QUIETMED Deliverable 2.3 are the following: (operational) promoting the adoption of IMO guidelines on the reduction of ship radiated noise, and promoting other initiatives aimed fostering the emergence of low-noise ships (e.g. labelling, promoting the role of harbour authorities in regulating noise from ships, etc.); (environmental) threshold levels not exceeded > XX days/year; or (environmental) area with levels exceeding thresholds does not exceed XX% of the assessment area.

Policy documents

IMO, 2014. GUIDELINES FOR THE REDUCTION OF UNDERWATER NOISE FROM COMMERCIAL SHIPPING TO ADDRESS ADVERSE IMPACTS ON MARINE LIFE. 44(April).
IMO, 2013a. Noise from commercial shipping and its adverse impacts on marine life.66(March).

IMO, 2013b. PROVISIONS FOR REDUCTION OF NOISE FROM COMMERCIAL SHIPPING AND ITS ADVERSE IMPACTS ON MARINE LIFE.

International Convention for the Prevention of Pollution from Ships, 1973 as modified by the Protocol of 1978 (MARPOL 73/78).

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 5thEcAp Coordination Unit meeting
- 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
- Report of the Meeting of MED POL and joint-session MED POL/REMPEC, Malta 16-19, June 2015.
- http://195.97.36.231/dbases/MEETING_DOCUMENTS/15WG417_17_ENG.pdf
-

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).

Commission Decision of 1 September 2010 on criteria and methodological standards on good environmental status of marine waters (2010/477/EU).

Commission Decision 2017/848/EU of 17 May 2017 laying down criteria and methodological standards on good environmental status of marine waters and specifications and standardised methods for monitoring and assessment, and repealing Decision (2010/477/EU)

Indicator analysis methods

Indicator Definition

Exceedance level was thought to detect such phenomenon, as an additional indicator for GES assessment.

Annual average of sound pressure level (SPL) and 33% Exceedance Level in selected frequency bands (third-octave bands centred at 20, 63, 125, 250, 500, 2000), where:

- SPL means Sound Pressure Level in dB (re 1µPa
- The term “Exceedance Level” is defined by the international standard ISO 1996-1:2003(E) as the level exceeded during 33% of the analysed time window

Average SPL gives an overview of average noise conditions in the assessed time window (1 year); while the 33% Exceedance Level provides a view of the highest noise levels for about one third of a year, corresponding to roughly 4 months. The use of 33% Exceedance Level is based on the assumption that in the Mediterranean Sea marine traffic noise increases substantially in the Summer season (June to September) mainly due to leisure craft, but also to increased numbers of navigating ships due to better weather conditions. The 33% Exceedance level was thought to detect such phenomenon, as an additional indicator for GES assessment.

Concerning frequencies, they were chosen as follows:

- 20Hz,based on fin whale biological significance. 20 Hz is indeed the peak frequency of the vocalizations of fin whales and monitoring the 1/3 octave band centred at this frequency may help assessing the masking effect from anthropogenic noise sources
- 63 Hz, based on the frequency bands where noise from shipping is most likely to dominate over other sources (consistent with MSFD ambient noise criterion)
- 125 Hz, based on frequency bands where noise from shipping is most likely to dominate over other sources (consistent with MSFD ambient noise criterion)
- 250 Hz, based on frequency bands where noise from shipping is most likely to dominate over other sources according to Mediterranean data (e.g. Pulvirenti et al. 2014)
- 500 Hz, based on frequency bands where noise from shipping is most likely to dominate over other sources according to Mediterranean data (e.g. Pulvirenti et al. 2014)
- 2000 Hz, based sperm whale biological significance. Although sperm whale click peak frequency has been identified in 5000 Hz (Madsen et al., 2002 ; Watkins et al. 1980), its lower peak frequency limit has been defined in 2000 Hz. It seems more relevant to use the lower peak frequency limit because it is more likely to be affected by anthropogenic noise and it requires lower sampling rates to be recorded, reducing the cost of monitoring equipment and data archiving volume.

Methodology for indicator calculation

The calculation of the indicator requires to perform the following tasks:

- Analysing recordings from deployed acoustic equipment and computing graphs of sound levels against time, sound levels against frequency, or similar;
- Modelling the propagation of noise from continuous sources (ships) for estimating levels at large scales and for mapping the indicators in the assessment areas.

The metrics to employ are the following:

- Average Sound Pressure Level (arithmetic mean) over a year, calculated either from SPL samples obtained from the field or from a modelling process;
- 33% Exceedance level over a year, meaning the level corresponding to the 77th percentile of the distribution of SPL values obtained either from the fields or from a modelling process.

In practice, two simple statistics should be calculated: the arithmetic mean, and the 77th percentile. In the case of recordings, the samples to be used for statistical analysis are short cuts of sound recordings of fixed duration, where the number and duration of each sample is to be determined. Guidance for MSFD-Ambient Noise criterion says samples should not exceed 1 minute. For models, different approaches exist to obtain the required statistics: temporal approaches and probabilistic approaches. Regardless of the approach used for models, if any, it is recommended to consider available guidance on the use of models, such as: *Impacts of noise and use of propagation models to predict the recipient side of noise*(Borsani et al. 2015); *Review of underwater acoustic propagation models* (Wang et al. 2014); and the guidelines on noise modelling and mapping developed in the framework of the QUIETMED project (Deliverable 3.3), where practical implementation in a Mediterranean context is described.

Indicator units

Sound Pressure Levels expressed in **dB re 1µPa**

List of Guidance documents and protocols available

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.

Best practice guidelines on acoustic modelling and mapping. 2017/848/EU and ACCOBAMS premises, and generalisation for the EcAp process. Deliverable 3.3, QUIETMED project. DG ENV/MSFD Second Cycle/2016.

Best practices guidelines on signal processing algorithms for the preprocessing of the data and for obtaining the noise indicator. Deliverable 3.2, QUIETMED project. DG ENV/MSFD Second Cycle/2016.

ACCOBAMS, 2015. A basin-wide strategy for underwater noise monitoring in the Mediterranean. Report prepared by Alessio Maglio, Manuel Castellote and Gianni Pavan.

Borsani, J.F., Faulkner, R.C. & Merchant, N.D., 2015. Impacts of noise and use of propagation models to predict the recipient side of noise. Report prepared under contract ENV.D.2/FRA/2012/0025 for the European Commission. Centre for Environment, Fisheries & Aquaculture Science, UK. , (July), p.27. Available at: http://mcc.jrc.ec.europa.eu/document.py?code=201601081529.

Verfuß, U.K., Andersson, M., Folegot, T., Laanearu, J., Matuschek, R., Pajala, J., Sigray, P., Tegowski, J., Tougaard, J. BIAS Standards for noise measurements. Background information, Guidelines and Quality Assurance. Amended version. 2015.

Wang, L.S. et al., 2014. Review of underwater acoustic propagation models (April 2016), p.35.

Data Confidence and uncertainties

Many sources of uncertainty exist concerning both measurements and models: the characteristics of the sound recorder used,the calibration, the mooring conditions and on the location of deployment (near or far from shipping lanes, in shadow areas, etc.), as well as many steps and settings of the data processing. Also, modelling methods contemplate a large number of variability factors often hindering meaningful comparisons among different monitoring programs. Such uncertainty results in well-known shortcomings in the understanding of how anthropogenic noise may affect the environment.

However, despite these sources of uncertainty, many steps forward have been done since the beginning of the implementation of the EcAp process, and considerable effort was done to develop guidance and best practices. Many of these efforts were focussed in northern European waters and the North Atlantic, but recent QUIETMED project produced valuable work in the direction of laying down common methods and shared understanding of the several technical aspects.

Methodology for monitoring, temporal and spatial scope

Available Methodologies for Monitoring and Monitoring Protocols

General monitoring methodology: the combined use of measurements and modelling is recommended. Continuous sound recording should be done at fixed sites through sound recording stations. Acoustic modelling and mapping through appropriate analytical procedures producing estimations to be validated from field measures.

The use of in-situ acoustic measurements is essential for:

- Gathering fundamental field data to establish information on the ambient noise in a given location
- Reducing uncertainty on source levels to be used as the input for modelling;
- Increasing evidence base to improve management decisions.

The use of models is essential for:

- Reducing the time required to establish a trend (the expected trend in shipping noise, based on observations in deep water, is of the order of 0.1 dB/year; and therefore it takes many years, possibly decades, to reveal such small trends without the help of spatial averaging);
- Reducing the number of stations required to establish a trend over a fixed amount of time (similar reasoning to above), therefore reducing the cost of monitoring;
- Helping with the choice of monitoring positions and equipment (selecting locations where the shipping noise is dominant as opposed to explosions or seismic surveys being dominant);
- Producing noise maps, which are a valuable tool to quickly understand the ensonification levels over large areas, and a fundamental tool to calculate the extent of potentially impacted (non-GES) areas;
- Predicting future scenarios and therefore testing different noise reduction strategies, e.g. by answering simple questions such as what happens if we reduce by XX dB the noise of 1% (or 20% etc.) of the circulating ships? Will this be a significant reduction?

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 can be analysed once a year over the whole acoustic dataset obtained or periodically during the year. Models and mapping are computed through appropriate software once a year or with other suitable periodicity.

Contracting Parties within a subregion are recommended to work together to establish an ambient noise monitoring system. When defining such monitoring system, a number of aspects should be addressed (not exhaustive list): measuring equipment quality, calibration, deployment depth, mooring configuration.

Available data sources

It is expected that the European platform EmodNet shall include in the next future a section dedicated to under water noise data made available from monitoring stations placed in waters surrounding the EU (thus with some good coverage of the Mediterranean Sea).

Input environmental data for acoustic modelling (depth, seafloor, temperature and salinity profiles, etc.) are available at many freely available data repositories (EmodNet, Copernicus, NOAA, etc.).

Input ship data (AIS databases) for acoustic modelling (ship positions, speed, vessel type, etc.) can be accessed through AIS networks (marine traffic, AIShub, etc.).

Spatial scope guidance and selection of monitoring stations

Spatial scope: Contracting Parties should consider the whole maritime space under their jurisdiction for locating the acoustic devices, following the guidelines hereafter for selecting the location. Further, noise mapping based on sound propagation modelling provides an effective way of covering the whole maritime space of a country with limited costs.

Location of sampling sites:

- Monitoring in both high traffic and low traffic areas, also searching and including spots where the noise is supposed to be the lowest;
- Monitoring may be more cost effective if existing oceanographic stations included noise monitoring along with the other oceanographic variables already being monitored, such as European Multidisciplinary Seafloor Observation (EMSO) - European Seas Observatory Network of Excellence (ESONET-NoE);
- Consider local topography and bathymetry effects e.g. where there are pronounced coastal landscapes or islands/archipelagos it may be appropriate to place hydrophones on both sides of the feature;
- As far as possible avoid locations close to other sound producing sources that might interfere with measurements e.g. oil and gas exploration or offshore construction activities. Areas of particularly high tidal currents may also affect the quality of the measurement;
- Monitoring station should be primarily located in important cetacean habitat, as identified by ACCOBAMS (Resolution 4.15);
- Whenever possible use deep monitoring stations, either autonomous or cabled, to limit the influence of surface and sub-surface noise.

Temporal Scope guidance

Monitoring stations should be able to **continuously** record underwater sound. The temporal scheme for the monitoring may vary according to the type of equipment and the logistics for recovering and/or retrieving data. It is desirable that the deployments cover all the year, but there is no recommended retrieval periodicity with regards to moored equipment. Also, real-time equipment (either cabled stations or monitoring stations transmitting data through satellite or other wireless connection) may be used; The main advantages of these systems are the constant availability of data from land and the constant monitoring of the system status, thus resulting in reduced risk of losing data in case of damage of equipment at sea compared to bottom recorders, and optimised maintenance which is done only when required.

Data analysis and assessment outputs

Statistical analysis and basis for aggregation

Appropriate analysis software (usually algorithms developed in some programming language as Matlab) is used to derive simple statistics: the arithmetic mean and 33% Exceedance level. Also, a trend analysis is possible. The arithmetic mean was originally proposed by TG-Noise with regards to the implementation of ambient noise monitoring for the MSFD. In TG-Noise guidance (Dekeling et al. 2014) different methods were tested and the result was that compared to the geometric mean, the median and the mode, the arithmetic mean has the following advantages:

- the arithmetic mean includes all sounds, so there is no risk of neglecting important ones;
- the arithmetic mean is independent of sample duration (the duration of the short cut of sound recording).

Even considering the robustness to sample duration, the TG-Noise recommended that the duration of single short cuts of sound recording (the samples for calculation of statistics) should not exceed 1 minute. Despite such detail was not addressed in the noise monitoring strategy developed by ACCOBAMS (2015), it seems consistent adopting this recommendation for the whole Mediterranean Sea. In addition, ACCOBAMS considers that values in percentile appear very useful to convey information about how much time noise levels are maintained, welcoming the advice from different works on underwater noise monitoring (e.g. Merchant et al., 2013). In this regard, the adoption of the 33% Exceedance Level addresses the potential seasonal rising in ambient noise due to recreational craft, which is suspected to be heavy in many coastal areas of the Mediterranean region. Finally, aggregation could be done through transboundary cooperation at the sub-regional level.
Expected assessments outputs The assessment outputs are the following: - Levels and maps of mean sound pressure level over a year or other suitable temporal windows; - Levels and maps of 33% exceedance level over a year or other suitable temporal windows; - Trend analysis across years or other periods (any robust statistical technique able to detect a trend can be used).
Known gaps and uncertainties in the Mediterranean The Mediterranean presents a majority of deep-water environment whose soundscape has been poorly studied, although some fixed deep monitoring observatories (2 stations of the European Multidisciplinary Seafloor Observation/ European Seas Observatory Network of Excellence - EMSO/ESONET network, respectively 1 in the NW Mediterranean and 1 in the Ionian Sea) provide long term acoustic data since many years. Obviously, many other temporary deployments from the ‘90s to date were done and data are available for reviewing levels, results, and more with a view of establishing baselines. However, common shortcomings (lack of standards for calibration, and the many source of variability highlighted above in this factsheet), may prevent from extracting meaningful information from such review concerning the Common Indicator 27. Further, the poor AIS coverage in some parts of the Mediterranean, especially the southern part, may affect the quality of monitoring through modelling techniques. However, the work done in the last 10 years on underwater noise from an ecosystem perspective enabled a better understanding. The Mediterranean present a majority of deep-water environment whose soundscape has been poorly studied, although some fixed deep monitoring observatories (2 stations of the EMSO/ESONET network, 1 in the NW Mediterranean, 1 in the Ionian Sea) provide long term acoustic data since many years. Obviously, many other temporary deployments from the ‘90s to date were done and data are available for reviewing levels, results, and more with a view of establishing baselines. However, common shortcomings (lack of standards for calibration, and the many source of variability highlighted above in this factsheet), may prevent from extracting meaningful information from such review concerning the Common Indicator 27. Further, the poor AIS coverage in some parts of the Mediterranean, especially the southern part, may affect the quality of monitoring through modelling techniques. However, the work done in the last 10 years on underwater noise from an ecosystem perspective enabled a better understanding, and thus a better management and mitigation, of the different sources of uncertainties.

Contacts and version Date		
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Version No	**Date**	**Author**
V.1	10/07/2016	ACCOBAMS
V.2	25/01/2019	ACCOBAMS in consultations with UN Environment/MAP