UNITED NATIONS

EP

UNEP/MED WG.627/8/Rev.1

05 June 2025
Original: English

Meeting of the MED POL Focal Points

Athens, Greece, 17-19 June 2025

Agenda item 4: **b. Enhanced Integrated Monitoring and Assessment Programme (IMAP) (Pollution and Marine Litter cluster, Common Indicators updated fact sheets, assessment criteria/thresholds)**

Updated Guidance Factsheets for IMAP EO 11 (Candidate Common Indicators 26 and 27)

UNEP/MAP
Athens, 2025

Note by the Secretariat

At the 19th Meeting of the Contracting Parties (COP 19) held in February 2016, the Integrated Monitoring and Assessment Programme (IMAP) of the Mediterranean Sea and Coast and Related Assessment Criteria was adopted through Decision IG.22/7. This decision established regionally agreed descriptions of Good Environmental Status (GES), common indicators, targets, and a timeline for implementation.

In alignment with IMAP, Guidance Factsheets for the IMAP Pollution Common Indicators were developed, reviewed, and endorsed by the Meeting of the Ecosystem Approach Correspondence Group on Pollution Monitoring (CorMon on Pollution Monitoring) in Marseille, France (October 2016), and the Meeting of the MED POL Focal Points in Rome, Italy (May 2017). Subsequently, these Guidance Factsheets were approved by the 6th Meeting of the Ecosystem Approach Coordination Group in Athens, Greece (September 2017), and utilized in the preparation of the 2017 Mediterranean Quality Status Report (2017 MED QSR).

Pursuant to Decision IG.22/7 (COP 19, 2016), and Decision IG.23/6 (COP 20, 2017) concerning the 2017 Mediterranean Quality Status Report (MED QSR), the Guidance Factsheets were updated in 2019 for Common Indicators 13, 14, 17, 18, 20, and 21, which pertain to Ecological Objectives 5 (Eutrophication) and 9 (Contaminants). Additionally, initial Guidance Factsheets were developed for Candidate Common Indicators 26 and 27, related to Ecological Objective 11 (Energy, including underwater noise). These updates were approved by the Meeting of MED POL Focal Points (May 2019) and the 7th Meeting of the Ecosystem Approach Coordination Group (September 2019), supporting IMAP Pollution implementation by the Contracting Parties over the past three biennia.

Furthering the progress within the preparation of the 2023 Mediterranean Quality Status Report (2023 MED QSR), Decision IG.26/14 on the Programme of Work and Budget for 2024–2025, (COP 23, 2023), mandated MED POL to deliver "e) IMAP pollution and marine Cluster CIs Guidance" under activity 6.2.2.

Building upon the achievements as of 2019, the present document outlines the revision of the Guidance Factsheets for Candidate Common Indicators 26 and 27, incorporating achievements in monitoring and assessment practices, methodologies, and environmental criteria as approved for the preparation of the 2023 MED QSR by the Meetings of the Ecosystem Approach Correspondence Group on Pollution, MED POL Focal Points, and Ecosystem Approach Coordination Groups held in 2023.

At the time of finalizing the documents for the MED POL Focal Points Meeting, the outcomes of the Joint Meeting of the Ecosystem Approach Correspondence Groups on Pollution and Marine Litter Monitoring (Anavyssos, Greece, 27–28 May 2025) was not yet held. The revised version of this document now includes targets for IMAP Candidate Common Indicators 26 and 27, as reviewed in Meeting Document UNEP/MED WG. 626/3/Rev.1, and subsequently endorsed by the Joint Meeting. Following the conclusions of this meeting, the revised GES targets are included in the revised IMAP Pollution Indicators Guidance Factsheets. Subsequently, the revised present document, reflecting the revised targets and other revised elements, as the outcome of the Joint Meeting (shown in bold and yellow highlighted text), is submitted to the MED POL Focal Points Meeting for no objection endorsement of the updated Guidance Factsheets for IMAP Candidate Common Indicators 26 and 27, with a view to their submission for approval by the 12th EcAp Coordination Group in September 2025.

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1. Introduction

1. This document presents the revised Guidance Factsheets for IMAP Candidate Common Indicators 26 and 27 in accordance with Decision IG.26/3 (COP 23, 2023) concerning the 2023 Mediterranean Quality Status Report (MED QSR) and the Renewed Ecosystem Approach Policy in the Mediterranean.

2. The current revision builds upon achievements endorsed for the preparation of the 2023 Mediterranean Quality Status report (2023 MED QSR) by the 2023 Meetings of MED POL Focal Points and the Integrated Ecosystem Approach Correspondence Group. It also responds to the request of 2019 Meeting of MED POL Focal Points for further elaboration of IMAP Guidance Factsheets for IMAP Candidate Common Indicators 26 and 27 to incorporate evolving scientific knowledge.

3. These foundational achievements determining the revision of the IMAP Guidance Factsheets for Candidate Common Indicators 26 (impulsive noise) and 27 (continuous noise) include:

a) Development, Testing, and Implementation of Initial GES Assessment Methodologies for Impulsive and Continuous Noise

i. Assessment methodologies were established for evaluating IMAP Candidate Common Indicators 26 and 27 within the preparation of the 2023 Mediterranean Quality Status Report (MED QSR). These methodologies were developed based on the work of the EU Technical Group on Underwater Noise, with contributions from ACCOBAMS and UNEP/MAP-SPA/RAC.

ii. Specifically, the assessment methodology applied in the 2023 MED QSR and included in the IMAP Guidance Factsheets indicates:

- For IMAP Candidate Common Indicator 26, threshold levels should be applied to the percentage of habitat occupied by noise-sensitive species affected by impulsive noise events, following a risk-based approach.
- For IMAP Candidate Common Indicator 27, a single threshold should be applied to the percentage of habitat of noise-sensitive species affected by continuous noise.

b) Strengthening Assessment Criteria, including:

i. Establishment of threshold values to maintain Good Environmental Status (GES) for both short-term and long-term exposure to impulsive noise events.

ii. Definition of a single threshold to maintain GES for exposure to continuous noise events.

iii. Classification of GES and non-GES status based on the application of these thresholds in noise assessments.

iv. Updating of statistical analyses and temporal scopes to support assessment methodologies for IMAP Candidate Common Indicators 26 and 27.

c) Incorporation of New Scientific and Policy Developments

Advancements since 2019 have been integrated to support the aforementioned achievements in IMAP noise assessments, as requested by the 2019 Meeting of MED POL Focal Points.

2. Guidance Factsheet on IMAP Candidate Common Indicators 26 and 27

4. The revision of IMAP **Candidate 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 table bellow.

Indicator Title	Candidate 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[1]	Related Operational Objective	Proposed Target(s)[2]
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	State: The extent (%) of ~~days with impulsive sounds sources, their distribution within the year and spatially~~habitat of noise-sensitive species within the assessment area~~, are~~ that is impacted by impulsive noise events is below thresholds.

~~Rational~~Rationale

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~~2014). 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 in the Mediterranean Sea include ship traffic, geophysical exploration and oil and gas exploitation, military and civil 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).~~ (ACCOBAMS 2016; ACCOBAMS al., 2022).

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. ~~Concerning noise source-specific impact, it~~There is a robust base of scientific evidence with regards to the effects of underwater impulsive noise on marine fauna, and especially cetaceans. Cetaceans' reliance on sound for communication, foraging, mating, and navigation makes them ideal indicators of acoustic disturbance. It has been demonstrated indeed ~~that naval exercises~~those naval exercises involving the use of mid-frequency active sonars that ~~caused several~~ are related to mass stranding events of cetaceans and especially Cuvier's beaked whales~~ along the coasts of the Mediterranean Sea and in~~. Furthermore, geophysical surveys, pile ~~driving~~ ~~and~~driving and other ~~sea areas at least during the last 20 years~~ loud impulsive noise signals have been correlated to a wide range of negative behavioural and physiological effects in fin whales and other baleen whales, sperm whales, different species of beaked whales, pilot whales and more. (e.g~~. Frantzis, 1998; Fernandez~~.: Benhemma-Le Gall et al., ~~2004; Martin~~2021; Blackwell et al., ~~2004; Agardy et al., 2007;~~ 2015; Borsani et al., 2008; Carroll et al., 2017; Castellote et al., 2012; Deruiter et al., 2013; Filadelfo et al., 2009~~). Further, this correlation is suspected also for the case of geophysical surveys (e.g.~~; Frantzis, 1998; Goldbogen et al., 2013; Gomez et al., 2016; Isojunno et al., 2020; Parsons, 2017; Sciacca et al., 2016; 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~~

[1] Following the decisions to be made at the present meeting regarding the GES definition and minor adjustments to the Targets, as outlined in working document UNEP/MED WG.626/3/Rev.1, the revised Targets and GES definition will be incorporated into the revised IMAP Pollution Indicators Factsheets.

[2] ibidem

~~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~~, 2019; Tougaard et al., 2013; Tyack & Thomas, 2019; Weir, 2008).

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

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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:

1. For the Barcelona Convention, the Ecosystem Approach process (EcAp), started in 2008;
2. 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 IMAP Ecological Objectives (EOs), and respective operational objectives and indicators agreed through Decision 20/4 (~~17th Meeting of Contracting Parties,~~ COP 17, Paris, 2012), EO11 addresses underwater noise produced by human activities. However, ~~during the COP 18 (Istanbul, 2013),~~ Decision 21/3 ((COP18, Istanbul, 2013) provided a specific list of descriptions of good environmental status and targets for the other EO~~o~~s, contrary to EO11, considered not yet sufficiently understood to allow a proper definition of good environmental status.

Therefore, in the period 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 (especially pile driving, explosions, seismic pulses~~, etc.),~~ and sonar), 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~~ by the Integrated CORMON Meeting i~~n Athens~~ (Athens, 30 March~~-30~~ – 1 April ~~01~~, 2015), which was finally adopted ~~by Parties~~ during the COP19~~. Finally, during~~ (Athens, 2016). Also, ~~at~~ the COP19 assigned to ACCOBAMS~~, ACCOBAMS and the UNEP/MAP signed an~~ a ~~MoU covering~~ the issues related to ~~of~~ underwater noise based on the Memorandum of Understanding ~~was~~ signed between ~~y~~ ACCOBAMS and UNEP/MAP with the aim of strengthening the cooperation between the two organisations to move forward with the implementation of EO11.

After 2016, several initiatives have been undertaken by ACCOBAMS, including the participation to European projects (QUIETMED in the period 2017-2018, QUIETMED-2 in the period 2019-2020, and QUIETSEAS in the period 2021-2022), the execution of dedicated studies, the implementation of monitoring programs, the contribution to the development of technical guidance relative to both EcAp and the EU-MSFD, and finally the coordination of the first basin-wide assessment of underwater noise pollution relative to EO11 under the scope of the 2023 Mediterranean Quality Status Report, (2022-2023).

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~~ and mitigation measures related to single industrial activities. The novelty of the MSFD and EcAp processes is that the emphasis is put on the ~~human activities generating noise. This is likely due to the fact that managing~~status of the ecosystem and hence on the cumulative impact of all human activities ~~in the sea is theoretically easier than managing impact. However, the effectiveness of such an approach rely on a good understanding of the relationship between noise and impact, which is very often not the case~~occurring in the maritime space.

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~~based", contrarily to the MSFD and EcAp, which are "ecosystem-based". The main difference between project-based and ecosystem-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, countries'~~y'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~~decades. This Factsheet addresses~~d~~ exactly this point and provides the required methodological elements for the monitoring and assessment of underwater impulsive noise and hence the implementation of the ecosystem approach to the management of activities producing impulsive noise.

Targets

The primary activity under IMAP ~~c~~Candidate Common I~~i~~ndicator 26 should be the setting up by country~~ies~~ of a database ("a noise register[3]") 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~~. Furthermore, by including information about the habitat of noise-sensitive species, it is possible to move towards the assessment of whether the risk of the negative impacts occurring on populations of such species is acceptable. Therefore, a threshold system was tested ~~has been set~~ to define the acceptable risk level related to the occurrence of impulsive noise events within the 2023 MED QSR.~~.~~

The initial threshold system ~~set~~ is based on the impulsive noise assessment methodology outlined in the 2023 MED QSR which was accepted by the ~~Contracting Parties (~~Integrated Meeting of the Ecosystem Approach Correspondence Groups~~,~~ (27-28 June 2023, Athens, Greece)~~;~~ and the Meeting of the MAP Focal Points~~,~~ (12-15 September 2023, Istanbul, Türkiye)~~; Meeting of the MED POL Focal Points, 24-26 May 2023 Athens, Greece)~~. The MED QSR 2023 impulsive noise methodology is in turn based on previous activities carried out by ACCOBAMS and UNEP/MAP - SPA/RAC under the QUIETMED and QUIETSEAS projects (Azzellino et al., 2021; Maglio et al., 2020; Maglio, Frey, et al., 2018) as well as by the European Commission technical group on underwater noise (Sigray et al., 2023).

The thresholds are applied to the % of habitat of noise-sensitive species which is affected by impulsive noise events. ~~Based on that, t~~To achieve or maintain the Good Environmental Status, the following thresholds should be applied as follows~~set by Contracting Parties~~:

[3] See for example: http://underwaternoise.ices.dk/map.aspx ; ~~http://accobams.noiseregister.org/~~ https://quietseas.ctnaval.com/

3. **For short-term exposure (1 day, i.e., daily exposure)**, the maximum proportion of a habitat area utilized by a species of interest that is accepted to be exposed to impulsive noise levels higher than the Level of Onset of Biological Effects (LOBE)[4], over 1 day, is 20% or lower (≤20%).

~~3.~~4. **For long-term exposure (1 year)**, the average exposure is calculated. The maximum proportion of a habitat area (calculated as the mean of the daily proportions over one year) utilized by a species of interest that is accepted to be exposed to impulsive noise levels higher than LOBE, over 1 year on average, is 10% or lower (≤10%).

5. These threshold values ~~have been~~were used for the initial impulsive noise assessment within the 2023 Mediterranean Quality Status Report ~~(QSR 2023), and especially in the Chapters dedicated to Candidate Common Indicators 26 and 27.~~

The thresholds are given as a range (X% or lower) in order to take regional and sub-regional specificities into account. According to the setup and purposes of the assessment, a single thresholds value is picked up ~~by the assessor~~ within the given ranges. Hence, threshold levels lower than 10% and 20% can be set according to local or regional specificities.

Policy documents

ACCOBAMS Resolution 7.13 - Anthropogenic Noise. ACCOBAMS-MOP7/2019/Doc38/Annex15/Res.7.13. 2019

ACCOBAMS Resolution 8.17 - Anthropogenic Noise. ACCOBAMS-MOP7/2019/Doc38/Annex15/Res.7.13. 2023

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).

Decision IG.21/3 (COP18,2013) ~~18th COP to the Barcelona Convention, Istanbul, Turkey,~~ on~~-~~ Ecosystems Approach including adopting definitions of Good Environmental Status (GES) and Targets (UNEP(DEPI)/MED IG.21/9).

~~19th COP to the Barcelona Convention, Athens, Greece, 2016~~ Decision IG.22/7 (COP19, 2016) on ~~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).

Decision IG.25/1 (COP22, 2021) on UNEP/MAP Medium-Term Strategy 2022-2027.

Decision IG.22/7 (COP19, 2016) on the Integrated Monitoring and Assessment Programme of the Mediterranean Sea and Coast and Related Assessment Criteria.

Decision IG.23/6 (COP20, 2017) on 2017 Mediterranean Quality Status Report.

Decision IG.24/4 (COP21, 2019) on Assessment Studies.

[4] The LOBE level, meaning Level of Onset of Biological Effect, is expressed in suitable sound metrics (e.g., sound pressure level or sound exposure level) and should be defined under the guidance of national and/or regional expert groups.

Decision 26/3 (COP23, 2023) on the 2023 Mediterranean Quality Status Report and a Renewed Ecosystem Approach Policy in the Mediterranean.

~~Report of the following Meetings:~~ UNEP/MAP ~~COP17-18-19~~ to COP22

~~– 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 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.~~

~~– https://wedocs.unep.org/bitstream/handle/20.500.11822/21889/17ig23_23_eng.pdf~~

~~– https://www.unep.org/unepmap/meetings/cop-decisions/cop21-outcome-documents~~

~~– https://www.unep.org/unepmap/meetings/cop-decisions/cop22-outcome-documents~~

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)~~

Indicator analysis methods

Indicator Definition

The indicator is defined by the number of days and the spatial extent 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, the~~a~~ sub~~-~~-regional and ~~regional scales.~~the whole region . Not all impulsive noise sources are to be accounted for, only those exceeding ~~thresholds~~minimum levels are considered ~~as~~ to have ~~ing~~ 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~~Noise levels inducing the onset of significant impact are defined in the “Basin-wide Strategy for U~~u~~nderwater N~~n~~oise M~~m~~onitoring in the Mediterranean” (ACCOBAMS, 2015~~).~~) and are still considered valid. The values ~~contained~~ as provided in this ~~that~~ document need ~~are~~ to be used to decide whether new noise event should or not be registered in the noise register. This definition was applied for the initial impulsive noise assessment in ~~is used in the noise Chapter of~~ the 2023 MED QSR ~~2023 and~~ . I~~i~~t concerns the quantities considered for monitoring the pressure on the marine environment from underwater impulsive noise.

Methodology for indicator calculation

The calculation is given by:

The geographical extent of the occurrence of noise events, and the sum of all non-overlapping days ~~where~~of such 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.~~ (for example a grid cell in a spatial grid, a sub-division, sub-region, region).

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 single assessment ~~areas as a whole:~~units or per sub-regions,~~ the whole~~ region, or subdivisions decided at the country level.

The “Basin-wide Strategy for U~~u~~nderwater N~~n~~oise M~~m~~onitoring in the Mediterranean” (ACCOBAMS, 2015) proposed to use of a 20x20 km spatial grid. However, recent developments (especially the results of the ~~thanks to the~~ QUIETMED project) led to the proposal~~e~~ of 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

For the spatial aspect:

1. The ~~indicator unit~~ daily proportion of the assessment area (%) which is ~~called **_pulse block days_** (PBDs), meaning the number of~~covered by noise events, taking the sum of the area of each grid cell considered as impacted by noise events
2. The average proportion (%) over 1 year, i.e., the sum of all the daily proportions divided by 365(6)

For the temporal aspect: The sum of all non-overlapping days of occurrence of impulsive noise events in ~~an~~a unit area ~~(block),~~and in a given period~~.~~[5].

List of Guidance documents and protocols available

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

End Report on GES criteria assessment at basin scale with focus on the consistency and coherence of approaches at national levels (including operational targets definition) - Deliverable 2.3 (Maglio, Frey, et al., 2018)

Joint proposal of a methodology to establish thresholds for impulsive noise in the Mediterranean Sea Region. QUITEMED2 D5.1. GA No. 110661/2018/794481/SUB/ENV.C2, (2021) -63pp (Azzellino et al., 2021)

Methodological framework for regional and sub- regional risk-based assessment for impulsive noise in the Mediterranean region. *QUIETMED2 – D4.1.* (Maglio et al., 2020)

~~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 et al., 2014)

~~ACCOBAMS, 2015.~~ 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

[5] This definition was formerly called ***pulse-block days*** (PBDs).

premises, and generalisation for the EcAp process. Deliverable 3.4, QUIETMED project. (Maglio, Salivas, et al., 2018)

Setting EU Threshold Values for impulsive underwater sound Technical Group on Underwater Noise (TG NOISE) MSFD Common Implementation Strategy. https://doi.org/10.2760/60215 (Sigray et al., 2023).

~~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~~ Candidate Common Indicator 26 monitoring, 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 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~~Oil & 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 may~~be~~ not be 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 monitoring (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 C~~c~~andidate 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 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~~pinnipeds and 30-160KHz for delphinids (Carretta et al, 2008, Lepper et al, 2004, Lurton, 2010, OSPAR, 2009).

What information to collect to ~~enter~~be entered into the register:

Data	**Units and/or comments**	**Priority**
Position	~~G~~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

Minimum ~~thresholds~~levels (Source intensity) for including a noise event in the register:

~~4.~~6. For low frequency sources: no ~~thresholds~~minimum level, i.e. all sources to be registered
~~5.~~7. 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 µPa² m² 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, but also industries, etc.).

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).~~(https://quietseas.ctnaval.com/)

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**~~ **Environmental Information Ministry of Energy and Infrastructure**
http://www.sigetap.tn
http://www.ypeka.gr
http://www.beph.net

Second Hotspots Report: updated overview of the noise hotspots in the ACCOBAMS Agreement area. ACCOBAMS-MOP8/2022/Inf43. EIGHTH MEETING OF THE PARTIES TO ACCOBAMS, Malta, 29 November – 2 December 2022. (Muller et al., 2022)

Further data repositories are open data platform developed by different organisations, where the most relevant appear to be~~ the following~~: EMOD~~mod~~n~~N~~et (EU funded platform https://emodnet.ec.europa.eu/en). From EMODn~~modN~~et it is possible to access data gates for marine human activities, including marine renewable energy plants, platforms, cables, dredging and others.

For military activities, as a first approach, the *notice to mariners*[6] can be monitored to gather information on possible military activities (military areas information is also included in EMODnet). Notice to mariners are indeed freely available information for navigation.

Spatial scope guidance and selection of monitoring stations

No monitoring stations are 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~~ with noise events per unit ~~of~~ area ~~of a spatial management system~~, where unit area may be, for example, a cell of the regular spatial grid. If a noise event lasts several days in the same ~~block (ca.~~unit area), the ~~pulse-block day~~ number of days is equal to the ~~number of days of~~ duration (in days) 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 (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:~~
~~6. the number of PBDs calculated monthly, quarterly, and/or yearly;~~

[6] 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

~~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~~:~~ (Cf Indicator units, above):

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

~~Further statistics are the trend analysis that maybe applied on different aggregated periods,~~The basis for ~~example: year to year; summer to summer, month of year N to month of year N+1 (and N+3, …) or others.~~aggregation is the national Noise Register. 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~~Noise Register. This is proposed as the basis for regional and sub regional aggregation of data which can feed regional assessment (e.g., the MED QSR) as well as supporting countries in reporting data related to EcAp EO11.

~~Based on the methodology used in the noise chapters of the MED QSR 2023, w~~With regards to data analysis for the assessment of the environmental status of a maritime area, the methodology applied for the initial assessment within the 2023 MED QSR needs to be considered. The indicator needs to be combined with information concerning the habitat of noise sensitive-species, in order to calculate the proportion of such habitat which is affected by impulsive noise. Using the entries in the noise register, the time steps are counted in the unit of days. In total 365 (366) evaluations are done corresponding to one assessment per day per calendar year. Notable, is that the evaluation can be limited to months, years, seasons, or sensitive times, but always based on days.

- The first step is to determine ~~what~~the proportion of the assessment area which is exposed to levels higher than the Level of Onset of Biological Effects (LOBE). This is done for every day of the year. This will result in an exposure map for the whole area covered by the registry.
- The next step is to determine the extent of the habitat of selected noise-sensitive species in the assessment area ($A_{Habitat}$). This can be done by applying ~~with~~ different methods, including refined habitat modelling and/or other GIS analyses. This part should be addressed consistently with relevant indicators ~~under~~ of EO1 (Biodiversity).
- The next step is to determine the extent of the habitat which is exposed to noise higher than LOBE (A_{LOBE}).
- Dividing the exposed part of the habitat area, A_{LOBE}, by the total area of the habitat area, $A_{Habitat}$, results in the fraction of habitat exposed, $F_{Habitat}$. The daily fraction can be expressed as follows

$$F_{Habitat}(t_i) = \frac{A_{LOBE}(t_i)}{A_{Habitat}} \cdot 100,$$

where t_i represents each individual day *i* within the assessment period. The daily fraction of the habitat area per day or assessment period can vary between 0% and 100%.

~~Following these steps~~ This shall result in 365 (366) estimates of $F_{habitat}$. Hence, the average fraction of exposed area above LOBE during the assessment period can be determined.

Further details are provided in the thematic noise assessments and the 2023 MED QSR Pollution Assessment.

Expected assessments outputs

The assessment outputs are the following: - Summary statistics: number of days with impulsive noise, extent of assessment area covered by noise events (in km² or %) - 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;~~ (exposure maps); ~~- 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.).~~Assessment statistics: % of affected habitat ($F_{habitat}$) per species considered, per assessment area (e.g., sub-division, sub-region, region).
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~~15 years as well as the recent activities on IMAP-EO11 are encouraging. Another important issue is the general 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 Candidate Common Indicator 26 was conceived to cut out most of ~~this~~the complexity~~, and this not only simplifies~~ which can be found in the science related to underwater acoustics, simplifying extremely the ~~way of~~ monitoring~~, but also minimizes~~ methodology and minimizing the costs of implementation. Therefore, an emphasis should be put on correct~~ly~~ disseminati~~ng~~on of the information on how this indicator is built. By building on the achievements up to 2023, during the preparation of the 2023 MED QSR, several knowledge gaps were identified in the monitoring and assessment of Candidate Common Indicators 26 and 27, which need to be addressed following the recommendations of the 2023 MED POL Focal Points Meeting. Improving - underwater noise data quality and availability is essential in addressing existing knowledge gaps. In this regard, the following specific actions should be undertaken by the Parties: o A contribution should be provided to the ACCOBAMS regional register for impulsive noise sources, especially by sharing national data, along with the development of a cooperation mechanism to identify the source of long-distance underwater noise in order to address its long-distance effects; o Reporting noise generating military activities is needed to provide an actual and precise assessment reflecting the real situation; o An alternative approach needs to be tested by applying specific assessments for species and their habitats. For such an exercise, Important Marine Mammal Areas (IMMA) could be used as defined habitats.
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
Final Version	31/05/2019	Acknowledged by the Meeting of MED POL FPs
V.4	28/05/2025	Joint CorMon Pollution and ML Meeting
V.5		Approved by the Meeting of MED POL FPs
Final Version		Approved by the 12th Meeting of EcAp Coordination Group

5. The revision of IMAP **Candidate Common Indicator 27 (EO11)**: **"**Levels of continuous low frequency sound with the use of models as appropriate" is presented in the table bellow.

Indicator Title	Candidate Common Indicator 27. Levels of continuous low frequency sound with the use of models as appropriate	
Relevant GES definition[7]	**Related Operational Objective**	**Proposed Target(s)**[8]
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	State: ~~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.
~~Rational~~Rationale		
Justification for indicator selector Anthropogenic energy introduced by human activities into the marine environment includes ~~sources of~~ sound, light~~, heat~~ and ~~others among the~~other electromagnetic ~~field spectrum.~~fields, heat and radioactive energy. The most widespread and pervasive is underwater sound (Dekeling et al., ~~2013a~~2014). 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 in the Mediterranean Sea include		

[7] Following the decisions to be made at the present meeting regarding the GES definition and minor adjustments to the Targets, as outlined in working document UNEP/MED WG.626/3/Rev.1, the revised Targets and GES definition will be incorporated into the revised IMAP Pollution Indicators Factsheets.

[8] ibidem

Indicator Title	Candidate Common Indicator 27. Levels of continuous low frequency sound with the use of models as appropriate

ship traffic, geophysical exploration and oil and gas exploitation, military and civil 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).~~ (ACCOBAMS, 2016;ACCOBAMS, 2022).

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)~~ This indicator addresses the continuous low-frequency sound produced by marine activities. The major contributor to this type of ambient ocean noise is produced by maritime traffic (Hildebrand, 2009; Hildebrand & Jesus, 2021; Jalkanen et al., 2022). For this reason, it has been pointed as an important factor potentially inducing degradation of the acoustic habitat of marine animals, and particularly cetaceans which are known to communicate over very long ranges through acoustic signals. Many studies also showed negative effects on fish. The degradation of the acoustic habitat may result in masking of the biological signals, displacement, reduced fitness and other effects that may have indirect impacts on popu~~o~~lations, such as reduced reproduction, reduced foraging success, and hence a long term degradation of the survival rate of populations (Aguilar de Soto et al., 2006; Benhemma-Le Gall et al., 2021; Blair et al., 2016; Erbe et al., 2019; Pirotta et al., 2012; Putland et al., 2017; Tennessen & Parks, 2015; Williams et al., 2014; Wysocki et al., 2006).

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~~Dekeling, R.P.A., Tasker, M.L., Van der Graaf, A.J., Ainslie, M.A, Andersson, M.~~
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Indicator Title	Candidate Common Indicator 27. Levels of continuous low frequency sound with the use of models as appropriate

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Policy Context and Targets

Policy context description

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Shipping activities are regulated by ~~the~~ the International Maritime Organization (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).~~As a result, guidelines on the reduction of noise emission from ships were first issued in 2014, and ~~(now revoked),~~ then revised in 2023 (IMO, 2023). 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 specifically addressed.

~~Given the lack of global regulation of ship radiated noise, the~~The MSFD and EcAp processes are ~~provide~~ the first legal instruments for monitoring, assessing and setting targets, at least for their competence areas (the European Union and the Mediterranean region, respectively). All the policy documents developed in the framework of such initiatives are therefore a novelty concerning the regulation of emissions of pollutants 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 and~~,~~ the associated impacts, thus ~~and therefore~~ delivering 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~~

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~~exceeded > XX days/year; or (environmental) area with levels exceeding thresholds does not exceed XX% of the assessment area.~~The target is defined through a threshold system ~~combining~~that combines data on shipping noise and information about the habitat of noise-sensitive species. This way, it is possible to move towards the assessment of whether the risk of the negative impacts occurring on populations of such species is acceptable.

This ~~e~~threshold system set is based on the continuous noise assessment methodology outlined in the 2023 MED QSR which was accepted by the Contracting Parties of the Barcelona Convention (the Meeting of ~~(~~Integrated ~~Meeting of the~~ Ecosystem Approach Correspondence Groups, 27-28 June 2023, Athens, Greece)~~; Meeting of the MAP Focal Points, 12-15 September 2023, Istanbul, Türkiye; Meeting of the MED POL Focal Points, 24-26 May 2023 Athens, Greece)~~. The ~~MED QSR 2023~~ methodology applied for cCI27 assessment within the 2023 MED QSR is in turn based on previous activities carried out by ACCOBAMS and UNEP/MAP-SPA/RAC under the QUIETMED and QUIETSEAS projects (Azzellino et al., 2023; Maglio et al., 2021; Maglio, Frey, et al., 2018) as well as by the European Commission technical group on underwater noise (Borsani et al., 2023).

A single threshold ~~One threshold~~ is defined and it applies to the % of habitat of noise-sensitive species ~~which is~~ affected by continuous noise. Based on that, to achieve or maintain the Good Environmental Status, the following thresholds should be observed ~~set~~ by the Contracting Parties:

1. **No more than 20% of the habitat of selected species should experience ~~with~~ noise levels above the Level of Onset of Biological Effects (LOBE) ~~not to be~~ exceedinged in any given month (based on the average noise level for that ~~in a~~ month) during t~~of the~~ assessment year**.

The threshold valuess are expressed ~~given~~ as a range (X% or lower) in order to take regional and sub-regional specificities into account. Assessors select a specific threshold value within this range based on the assessment's context and purpose.~~According to the set up and purposes of the assessment, a single thresholds value is picked up by the assessor within the given ranges~~. While the threshold is determined using available data, it may be adjusted as new scientific knowledge emerges.~~The threshold value is based on available information but with new knowledge it can ould be changed.~~

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.~~

ACCOBAMS Resolution 7.13 - Anthropogenic Noise. ACCOBAMS-MOP7/2019/Doc38/Annex15/Res.7.13. 2019

ACCOBAMS Resolution 8.17 - Anthropogenic Noise. ACCOBAMS-MOP7/2019/Doc38/Annex15/Res.7.13. 2023

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)

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Decision IG.21/3 (COP18,2013) ~~18th COP to the Barcelona Convention, Istanbul, Turkey,~~ on Ecosystems Approach including adopting definitions of Good Environmental Status (GES) and Targets (UNEP(DEPI)/MED IG.21/9). ~~19th COP to the Barcelona Convention, Athens, Greece, 2016~~ Decision IG.22/7 (COP19, 2016) on ~~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). Decision IG.25/1 (COP22, 2021) on UNEP/MAP Medium-Term Strategy 2022-2027. Decision IG.22/7 (COP19, 2016) on the Integrated Monitoring and Assessment Programme of the Mediterranean Sea and Coast and Related Assessment Criteria. Decision IG.23/6 (COP20, 2017) on 2017 Mediterranean Quality Status Report. Decision IG.24/4 (COP21, 2019) on Assessment Studies. Decision 26/3 (COP23, 2023) on the 2023 Mediterranean Quality Status Report and a Renewed Ecosystem Approach Policy in the Mediterranean. ~~Report of the following Meetings: UNEP/MAP COP17-18-19: to COP22~~ ~~– 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 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.~~ ~~https://wedocs.unep.org/bitstream/handle/20.500.11822/21889/17ig23_23_eng.pdf~~ ~~https://www.unep.org/unepmap/meetings/cop-decisions/cop21-outcome-documents~~ ~~https://www.unep.org/unepmap/meetings/cop-decisions/cop22-outcome-documents~~ 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).~~ International Convention for the Prevention of Pollution from Ships, 1973 as modified by the Protocol of 1978 (MARPOL 73/78). IMO (2023). Revised Guidelines for the reduction of underwater radiated noise from shipping to address adverse impacts on marine life.	
Indicator analysis methods	

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Indicator Definition

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

~~Annual~~is the 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), on a monthly basis, where:

SPL means Sound Pressure Level in dB (re 1µPa)

Additionally, the 33%-Exceedance Level may be calculated on an annual basis. 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~~is 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~~~~is~~are the following:

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- Average Sound Pressure Level (~~arithmetic mean) over a year,~~central tendency) calculated monthly, either from ~~SPL samples~~recordings obtained from the field or ~~from~~based on a modelling process;
- Additionally, 33~~% ~~%-Exceedance level over a year may be used, meaning the level corresponding to the ~~77th~~67th percentile of the distribution of SPL values. This indicator appears as useful especially in case of analysis of recordings from long-term monitoring stations (1 year data) to highlight the effect of leisure craft.

When processing audio files obtained ~~either from the fields or from a modelling process.~~ in the field, 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 may vary. As a general rule, samples of~~r~~ maximum 1 minute should be used.

~~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.~~For models, different approaches exist to obtain the required statistics: temporal approaches and probabilistic approaches. Regardless of the approach used for models, it is recommended to consider available guidance on the use of the models (see here-below the section "List of Guidance documents and protocols available"~~, below~~). **Further details are also provided in the thematic noise assessments and the 2023 MED QSR Pollution Assessment**.

Indicator units

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

List of Guidance documents and protocols available

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

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. (Taroudakis et al., 2018)

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. (Vukadin et al, 2018)

~~ACCOBAMS, 2015.~~ 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.

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End Report on GES criteria assessment at basin scale with focus on the consistency and coherence of approaches at national levels (including operational targets definition) - Deliverable 2.3. No. 11.0661/2016/748066/SUB/ENV.C2. (Maglio et al, 2018)

~~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~~.~~ (Borsani et al, 2015)

~~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.~~
Proposal of a methodology to establish thresholds values for D11C2 in the Mediterranean and Black Sea regions. QUIETSEAS D5.2. (Azzellino et al, 2023)

QUIETSEAS Deliverable 9.1. Guidelines for Competent Authorities on a reporting method for continuous noise appropriate for the GES assessment and the establishment of thresholds.

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

Review of risk-based approaches and frameworks for D11C2. QUIETDSEAS D3.1. (Maglio et al, 2021).~~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

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(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 projects (QUIETMED ~~project~~, QUIETMED2 and QUIETSEAS) 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. Notable is that models are necessary to carry out GES assessment. 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~~the necessary 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	

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addressed ~~-~~(not exhaustive list): measuring equipment quality, calibration, deployment depth, mooring configuration.

Available data sources

Since 2020, the NETCCOBAMS platform provide maps of underwater continuous noise (based on shipping noise) in the whole ACCOBAMS Area (Mediterranean Sea, Black Sea, Atlantic area contiguous to the Mediterranean Sea).

It is expected that the European platform EMOD~~mod~~n~~N~~et 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 (EMOD~~mod~~n~~N~~et, Copernicus, NOAA, etc.).

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

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~~

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~~damage of equipment at sea compared to bottom recorders, and optimised maintenance which is done only when required.~~

With regards to modelled noise data, as the defined Target is to assess the % of habitat affected by continuous noise on a monthly basis, noise maps should be produced at least for 1 month and ideally for all months.

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 means 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:~~such as Matlab and others) is used to derive average SPL (and 33%-Exceedance Levels). Considering the methodology ~~adopted~~ applied for cCI 27 within the 2023 in MED QSR~~2023 for CI27~~, any statistics reflecting the central tendency of the monthly scenario can be chosen (e.g., the median, the arithmetic mean, or other metric reflecting the central tendency).

- For the ~~arithmetic mean includes all sounds, so there is no risk~~processing of ~~neglecting important ones;~~
- ~~the arithmetic mean is independent of~~ acoustic data, a 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~~ of short cuts (segments) of sound recording (the samples for calculation of statistics) should be used to compute the noise metrics. As a general rule, the duration of single segments 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~~, unless otherwise decided and justified.

~~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. The tool NETCCOBAMS is now being implemented by ACCOBAMS with this purpose for continuous noise. The NETCCOBAMS platform can host data about underwater noise levels in HDF5 format, as outlined in the Continuous Noise Data Call (issued in 2022 in the framework of the QUIETSEAS project)

With regards to data analysis for the assessment of the environmental status of a maritime area, the indicator need to be combined with information concerning the habitat of noise sensitive-species, in order to calculate the proportion of such habitat which is affected by impulsive noise.

~~Thanks to~~By using models, it is possible to obtain noise maps providing an estimate of average noise levels over the areas assessed.The temporal resolution of the assessment (Temporal Assessment Window, TAW) is monthly:

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- The first step is to determine the parts of the assessment area which are exposed to levels higher than the Level of Onset of Biological Effects (LOBE). This is done for every month of the year. This will result in an exposure map for the whole area which is assessed.
- The next step is to determine the extent of the habitat of selected noise-sensitive species in the assessment area ($A_{Habitat}$). This can be done with different methods, including refined habitat modelling and/or other GIS analyses. This part should be addressed consistently with relevant indicators under EO1 (Biodiversity).
- The next step is to determine the extent of the habitat which is exposed to noise higher than LOBE (A_{LOBE}).
- Dividing the exposed part of the habitat area (A_{LOBE}) by the total habitat area ($A_{Habitat}$) results in the fraction of habitat exposed, $F_{Habitat}$, which is expressed as:

$$F_{Habitat}(t_i) = \frac{A_{LOBE}(t_i)}{A_{Habitat}} \cdot 100\%,$$

where t_i represents an individual month i within the assessment period (1 year). The daily fraction of the habitat area per month can vary between 0% and 100%.

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~~;~~ (month, season, year);
- 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).~~ Noise maps, i.e. maps showing the distribution of estimated noise levels across the assessed area.
- Noise exposure maps, i.e., maps showing the areas where the LOBE level is exceeded.
- Assessment statistics: % of affected habitat ($F_{habitat}$) per species considered, per assessment area (e.g., sub-division, sub-region, region), calculated on a monthly basis.

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.~~

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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.

By building on the achievements up to 2023, during the preparation of the 2023 MED QSR, several knowledge gaps were identified in the monitoring and assessment of Candidate Common Indicators 26 and 27, which need to be addressed following the recommendations of the 2023 MED POL Focal Points Meeting. Improving underwater noise data quality and availability is essential in addressing existing knowledge gaps, as outlined in the Guidance Factsheet for IMAP Ccandidate Common Indicator 26.

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
Final Version	31/05/2019	Acknowledged by the Meeting of MED POL FPs
V.3	28/05/2025	Joint CorMon Pollution and ML Meeting
V.4		Approved by the Meeting of MED POL FPs
Final version		Approved by the 12th Meeting of EcAp Coordination Group