Assessment of IMAP 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 animal

Geographical scale of the assessment	The Sub-regions within the Mediterranean region
Contributing countries	Data for the following countries available either reported to the International Noise Register (INR-MED) of through the Noise Hotspots project led by ACCOBAMS: Algeria, Cyprus, Egypt, France, Greece, Israel, Italy, Lebanon, Lybia, Monaco, Malta, Montenegro, Morocco, Spain, Tunisia, Türkiye,
Mid-Term Strategy (MTS) Core Theme	Enabling Programme 6: Towards Monitoring, Assessment, Knowledge and Vision of the Mediterranean Sea and Coast for Informed Decision-Making
Ecological Objective	EO11. Energy including underwater noise
IMAP Common Indicator	cCI26. Proportion of days and geographical distribution where loud, low, and mid-frequency impulsive sounds exceed levels that are likely to entail significant impact on marine animal
GES Definition (UNEP/MED WG473/7) (2019)	Noise from human activities causes no significant impact on marine and coastal ecosystems
GES Targets (UNEP/MED WG.473/7) (2019)	Number of days with impulsive sounds sources, their distribution within the year and spatially within the assessment area, are below thresholds
GES Operational Objective (UNEP/MED WG.473/7) (2019)	Energy inputs into the marine, environment, especially noise from, human activities, are minimized

Available data

688. Data are initially obtained from the Impulsive Noise Registry (INR-MED) managed by ACCOBAMS. The registry is a tool defined in the Proposal of IMAP Guidance Factsheet for cCI26 . The INR-MED collates data reported by the countries in a standard format that is aligned with the requirements indicated in the Proposal of the IMAP Guidance Factsheet for cCI 26.

689. Data have been provided through the INR-MED by a few countries so far i.e. by France, Greece, Malta, Greece, Lebanon and Montenegro. They are related to three kinds of sound sources: seismic surveys, explosions, sonar or acoustic deterrents. These data cover, with many gaps, the period since 2016 onwards. They concern 247 explosions, 13 seismic surveys and 9 occurrences of sonar or acoustic deterrent use. These are official data which are reported in the correct format and most of them (92%) satisfy the minimum IMAP quality requirements.

690. To complete this process, data from the ACCOBAMS Noise Hotspot assessments i.e. from the 2nd edition which was issued in 2022 and covers the period from 2016 to 2021 (ACCOBAMS-MOP8/2022/Inf.43), are also used. These data were collected directly by a group of experts appointed by the ACCOBAMS Secretariat for the period 2016-2021 and follow theoretically the same standards used for the impulsive noise registry. However, only 170 out of 388 impulsive noise events (43%) collected under the Noise Hotspot initiative were considered good enough to be used for the present initial assessment. These noise events are mainly seismic surveys (N = 53) and port extension works for which pile driving and/or explosions were used (N = 117). They are distributed in the four Mediterranean Sub-regions and concern almost all countries bordering the Mediterranean Sea, thus completing data available from the INR-MED.

691. Globally, 439 impulsive noise events were used for analyses. The annual distribution of noise events is mapped in Figures 4.8.1 to 4.8.6 hereafter using a 20 km x 20 km spatial grid. It should be noted that a 20-km fixed buffer was used from point noise source (e.g. pile driving in ports) in order to account for propagation of noise. The 20-km buffer is selected based on scientific literature (Merchant et al., 2017; Tougaard et al., 2009). Furthermore, for noise sources described with polygons (such as seismic surveys), it was considered that using polygons for describing a moving point source (the seismic vessel using the airguns) is already an overestimation of the area where the noise is produced, and hence no additional buffer was applied. Hence, the below figures show the distribution, over a 20 km x 20 km spatial grid, of buffered point sources for port works and polygons for seismic surveys and sonar and acoustic deterrents.

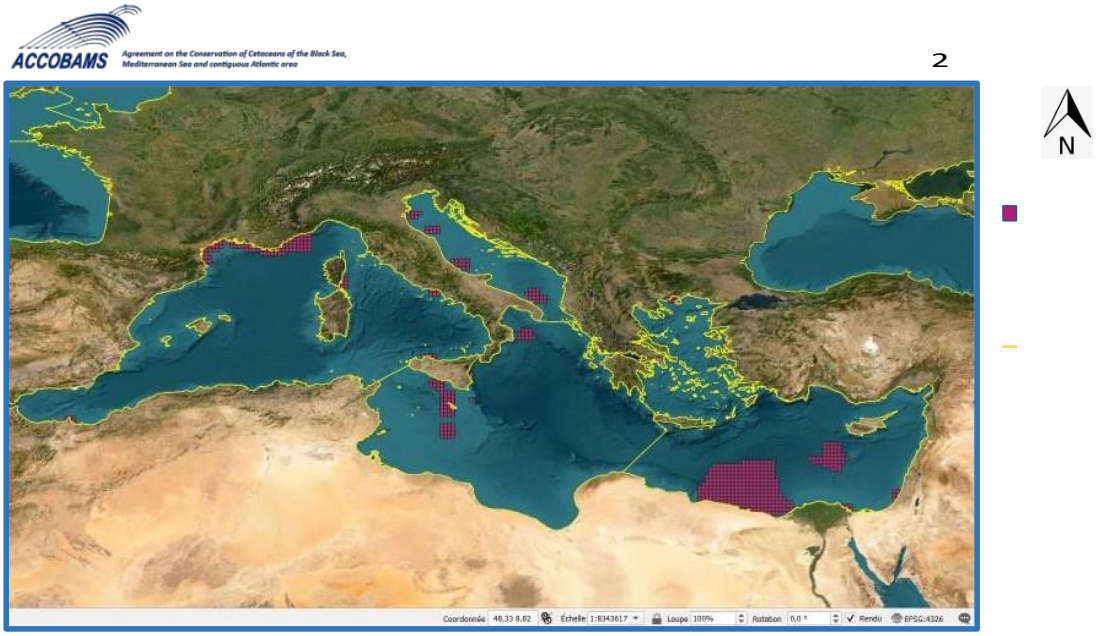

Figure 3.1.9.1. Impulsive noise events data for 2016. Each purple cell indicates the position of impulsive noise events, meaning that the impulsive noise emissions occurred during at least 1 day in that cell (ACCOBAMS-MOP8/2022/Inf.43).

Figure 3.1.9.2. Impulsive noise events data for 2017. Each purple cell indicates the position of impulsive noise events, meaning that the impulsive noise emissions occurred during at least 1 day in that cell.

Figure 3.1.9.3. Impulsive noise events data for 2018. Each purple cell indicates the position of impulsive noise events, meaning that the impulsive noise emissions occurred during at least 1 day in that cell.

Figure 3.1.9.4. Impulsive noise events data for 2019. Each purple cell indicates the position of impulsive noise events, meaning that the impulsive noise emissions occurred during at least 1 day in that cell.

Figure 3.1.9.5. Impulsive noise events data for 2020. Each purple cell indicates the position of impulsive noise events, meaning that the impulsive noise emissions occurred during at least 1 day in that cell.

Figure 3.1.9.6. Impulsive noise events data for 2021. Each purple cell indicates the position of impulsive noise events, meaning that the impulsive noise emissions occurred during at least 1 day in that cell.

Setting the GES/non GES boundary value/threshold for the initial environmental assessment of cCI 26

The assessment for Candidate Indicator 26 is based on data of impulsive noise events reported by the Contracting Parties to the ACCOBAMS through the International Noise Register for the Mediterranean Sea region managed by ACCOBAMS (INR-MED), as well as by using data on further impulsive noise events generated through dedicated activities coordinated by the ACCOBAMS Secretariat which are aimed at enhancing the gathering of impulsive noise event data.

For the initial assessment of the noise, the following low and mid-frequency impulsive noise events considered: underwater explosions, geophysical surveys with the use of airguns, sonar or acoustic deterrents, pile driving. The geographical position of such noise sources, the duration of the event (start and end date) and the intensity (in dB re 1µPa or proxy) are the necessary data for the analysis of the geographical and temporal distribution of noise events. This analysis served as an indication of the anthropogenic pressures.

Further, by including information about the habitat of noise-sensitive species, it was possible to move towards the assessment of whether the risk of the negative impacts occurring on populations of such species is acceptable. The definition of the GES target proposed by EU TG-Noise was applied for the present initial assessment of cCI 26 within the preparation of the 2023 MED QSR.

Considering the available data on impulsive noise events, the statistical calculations related to proportion of days and geographical distribution of low, and mid-frequency impulsive sounds were undertaken as far as possible in line with the Proposal of the IMAP Guidance fact sheet for cCI 26, while for performing the assessment it was necessary to calculate the extent of exposure, an additional indicator, i.e., the extent of habitat of noise-sensitive species which is above the Level of Onset of Biological Effects (LOBE), on average over a year, as outlined in the TG-Noise methodology (2022). For the calculation of the extent of exposure, it is necessary to account for the propagation of noise from the source (either by modelling or other methods such as applying a buffer zone) and to consider the footprint of an impulsive noise event, where the footprint is limited by the isoline at which the LOBE is reached.

692. For the purposes of the 2023 MED QSR a Tolerable Status of the environment is considered when 10% or less of the habitat of noise-sensitive species is impacted by impulsive noise events over a year. For the present initial assessment, this threshold (10%) is used for the four IMAP Sub-regions in the Mediterranean Sea.

693. Based on scientific works which indicate that when the exposure to underwater sound is permanent, the displacement of animals due to acoustic disturbance can be considered as a habitat loss (e.g., Brandt et al., 2018; Graham et al., 2019; Thompson et al., 2013), it was considered that the present initial assessment methodology translates the loss of habitat due to acoustic disturbance into a decline of population following a linear model as suggested by Tougaard et al., 2013.

694. In other words, if the 10% of the habitat of a representative noise-sensitive species is impacted by noise, it is expected that the population will decline by 10% in the long-term. Considering the risk of extinction, 10% is considered sufficiently conservative and precautionary to be selected as the boundary between tolerable and non-tolerable status of a Sub-region i.e., as the boundary value/threshold between the GES and non GES.

Results of the initial IMAP Environmental Assessment of cCI 26 in the Mediterranean region

695. Data collected through the Noise Register lacked geographical representativeness (data from only 5 countries: France, Malta, Greece, Lebanon and Montenegro) and had to be integrated with data collected from dedicated activities led by ACCOBAMS (Noise Hotspot data[126]). Under the 'Noise Hotspot' project, data related to impulsive noise events were found for the period 2016-2021 in waters in front of most Mediterranean countries. However, these data presented uncertainties or gaps in the

[126] ACCOBAMS-MOP8/2022/Inf.43

source level and duration in days of activities that made it impossible either to apply propagation modelling to noise events and compute refined noise footprints, or to compute the number of days with impulsive noise events in the Mediterranean region, as whole, or in its Sub-regions.

696. By pooling together data from the International Noise Register (data from reporting countries) and the Noise Hotspot project (data from scientific study), a database was obtained covering the four Mediterranean Sub-regions, and with sufficient quantity and quality of data to carry out an initial assessment for cCI26.

697. The value of LOBE was not assigned due to heterogeneity of data, preventing the use of refined acoustic propagation modelling to calculate the noise footprint of the impulsive noise events. Instead, as mentioned above, a 20-km fixed buffer was used from point noise source (e.g. pile driving in ports) in order to account for propagation of noise. The 20-km buffer is selected based on scientific literature (Merchant et al., 2017; Tougaard et al., 2009). Furthermore, for noise sources described with polygons (such as seismic surveys), it was considered that using polygons for describing a moving point source (the seismic vessel using the airguns) is already an overestimation of the area where the noise is produced, and hence no additional buffer was applied. Moreover, without consideration of the duration in days for many noise events (the duration in day lacks in 38% of data), it was impossible to calculate the daily cumulated area affected by noise (daily exposure), which is at the basis of the calculation of the average extent of habitat affected by noise over a year i.e. the extent of exposure.

698. Considering these issues, the annual surface of the four Mediterranean Sub-regions with impulsive noise events was computed by summing up the areas of all the noise events described by polygons and buffered point sources, per sub-region. Subsequently, the proportion of potentially usable habitat area (PUHA i.e. Potentially Usable Habitat Area, following habitat models developed by Azzellino et al., 2011), found on areas concerned by noise events, is computed for selected cetacean species, namely the fin whale for the Western Mediterranean sub-region, while the bottlenose dolphin, the sperm whale and the Cuvier's beaked whale for the four Sub-regions. The result of this calculation is the amount of habitat impacted by noise per Sub-regions and for the whole Mediterranean since 2016 i.e., the extent of exposure, which provides an insight of the risk of decline in population of selected species of cetaceans.

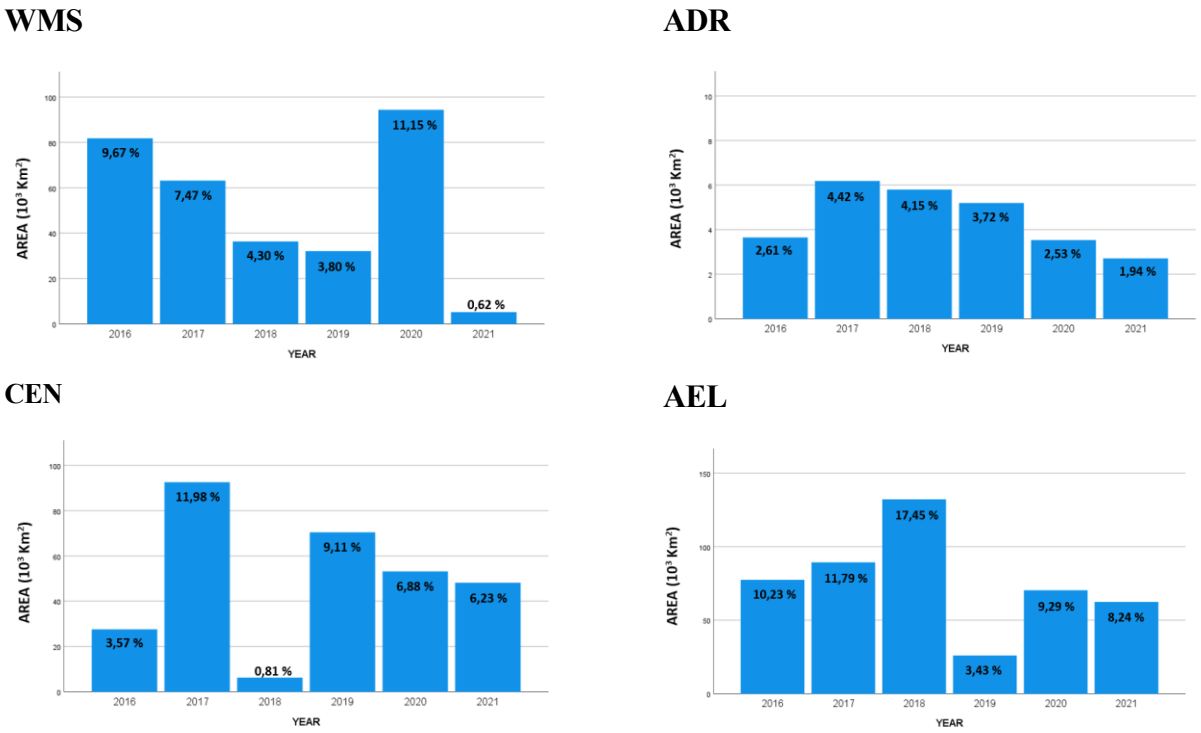

Figure 3.1.9.7. % of sub-regions covered by noise events per year since 2016: **WMS**= Western Mediterranean; **ADR** = Adriatic Sea; **CEN** = Ionian and Central Mediterranean Seas; **AEL**= Aegean and Levantine Seas.

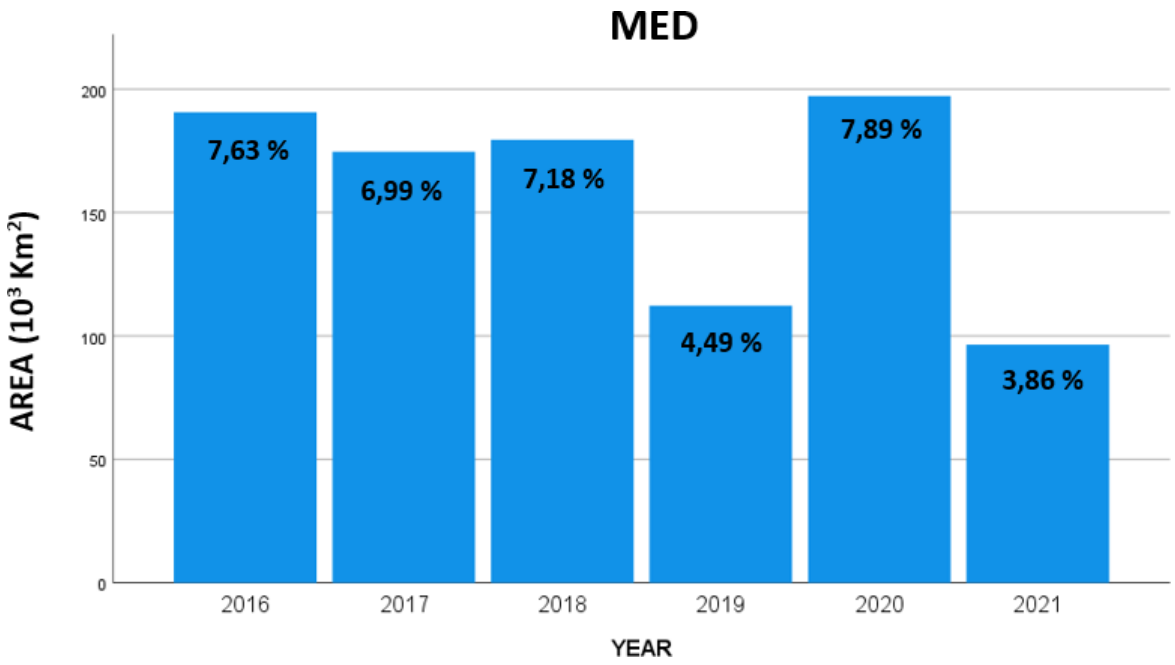

Figure 3.1.9.8. % of the Mediterranean region covered by noise events per year since 2016.

699. To overlap noise event areas to the species habitat an analysis grid is used of about 20 km mesh size (i.e. 10' x 10' grid cells) and the concept of PUHA, here applied as habitat proxy. The PUHA is computed from presence/absence habitat models using physiographic predictors as covariates (depth and slope statistics) which estimate the presence probability of the representative cetacean species in the area of interest. Based on the presence probability for a species, called Habitat Suitability (HS), the usable habitat (in km²), is calculated in every cell unit of the analysis grid by multiplying the HS for the area (km²) of the cell unit. The PUHA is then calculated (in km²) for the subregions by summing up the usable habitats from single grid cells in the different subregions.

700. Table 3.1.9.1 shows the percent of habitat (PUHA) of a species which is affected by impulsive noise for every year from 2016 to 2021. Four species are considered: bottlenose dolphin, sperm whale and Cuviers' beaked whale, and only for the WMS subregion the fin whale.

Table 3.1.9.1: Summary of the percent impacted PUHA for the four selected cetacean species (e.g. bottlenose dolphin, sperm whale and Cuviers' beaked whale, and fin whale). For the year 2018, the percent of impacted PUHA for sperm whale and Cuvier's beaked whale is highlighted in red and percent of impacted PUHA of bottlenose dolphin, being close but lower than the 10% GES/non GES boundary limit is highlighted in light blue.

IMAP SUB-REGIONS	AFFECTED AREA (% POTENTIALLY USABLE HABITAT AREA IMPACTED BY IMPULSIVE NOISE) PER YEAR IN THE PERIOD 2016-2021						
	Bottlenose dolphin						
	2016	**2017**	**2018**	**2019**	**2020**	**2021**	**Median**
ADR	4,81	6,59	6,48	6,27	3,03	2,88	5,54
AEL	4,76	5,21	**8,62**	1,17	4,27	1,39	4,52
CEN	1,28	1,45	0,66	4,02	2,9	2,48	1,97
WMS	1,52	1,34	1,26	1,48	1,63	0,45	1,41
	Fin whale						
	2016	**2017**	**2018**	**2019**	**2020**	**2021**	**Median**
WMS	0,99	1,02	0,67	0,74	1	0,23	0,87
	Sperm whale						
	2016	**2017**	**2018**	**2019**	**2020**	**2021**	**Median**
ADR	1,48	2	1,97	1,77	0,69	0,64	1,63
AEL	**8,2**	2,59	**11,51**	0,88	3,36	2,12	3,11
CEN	0,63	0,83	0,55	7,39	5,62	5,47	3,15
WMS	0,84	0,94	0,47	0,49	0,78	0,16	0,63
	Cuvier's beaked whale						
	2016	**2017**	**2018**	**2019**	**2020**	**2021**	**Median**
ADR	1,41	2,44	2,37	1,78	0,25	0,28	1,59
AEL	6,18	4,77	**10,15**	0,97	4,75	1,95	4,76
CEN	1,27	1,64	0,83	6,1	4,88	4,41	3,02
WMS	1,22	1,17	0,99	1,19	1,49	0,38	1,18

701. It can be observed that in the 2016-2021 average scenario (median level), the 10% GES/non GES boundary limit was not exceeded, being very far for all the considered species. However, for some year (e.g. in 2018), the 10% GES/non GES boundary limit might have been exceeded in the Aegean-Levantine Sub-region (AEL) concerning the habitat of sperm whale and Cuvier's beaked whale. In such a case, the environmental status may be considered non tolerable for the year 2018 i.e., the non GES can be indicated.

702. For the Western Mediterranean (WMS), the Adriatic Sea (ADR) and the Central Mediterranean Sea (CEN), the environmental status appears as tolerable for all years.

703. For the years 2016, 2017, 2019, 2020, 2021 and for all the 4 cetacean species considered (bottlenose dolphin, fin whale, sperm whale, Cuvier's beaked whale), all subregions are below threshold, i.e., less than 10% of the potentially usable habitat area is affected by noise events as calculated following the adapted assessment methodology.