QUIETMED – Joint programme on noise (D11) for the implementation of the Second Cycle of the MSFD in the Mediterranean Sea.

Deliverable

D2.3 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)

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Abstract

This document is the Deliverable "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) and conclusions on generalization to other contracting parties of the Barcelona Convention (December 5th)" of the QUIETMED project funded by the DG Environment of the European Commission within the call "DG ENV/MSFD Second Cycle/2016". This call funds the next phase of MSFD implementation, in particular to achieve regionally coherent, coordinated and consistent updates of the determinations of GES, initial assessments and sets of environmental targets by July 2018, in accordance with Article 17(2a and 2b), Article 5(2) and Article 3(5) of the Marine Strategy Framework Directive (2008/56/EC). The QUIETMED project aims to enhance cooperation among Member States (MS) in the Mediterranean Sea to implement the Second Cycle of the Marine Directive and in particular to assist them in the preparation of their MSFD reports by 2018 through: i) promoting a common approach at Mediterranean level to update GES and Environmental targets related to Descriptor 11 in each MS marine strategies ii) development of methodological aspects for the implementation of ambient noise monitoring programs (indicator 11.2.1) iii) development of a joint monitoring programme of impulsive noise (Indicator 11.1.1) based on a common register, including gathering and processing of available data on underwater noise.

This public document addresses the arguments that should support the achievement of a common understanding of criteria for Good Environmental Status, and a shared view of the assessment methodology with respect to both continuous and impulsive noise. The first part of the document presents a review of methodologies and approaches for assessment of environmental status, including outside the strict MSFD framework, and an in-deep analysis of the Commission Decision 2017/848 on criteria and methodological standards for monitoring and assessment of GES.

Then, proposals are developed of a common ground for the definition of GES in the Mediterranean Sea. In this part, a focus is also put on the methodology for the assessment of noise criteria for the determination of the environmental status. To this end, we develop both the methodological standards outlined in the Commission Decision 2017/848, and the recommendations formulated in quietMed Deliverable 2.1 on "Lessons learned of national 2012 assessment and GES definition" on how to move towards a more coherent and shared understanding of GES and assessment methods. The principle proposition of this part of the document is the adoption of a risk-based definition of GES, where biological and ecological risks caused by anthropogenic underwater noise are considered in the definition of GES.

The topic of thresholds is also addressed. This deliverable proposes the principles for considering thresholds in the assessment of noise criteria and therefore in the determination of GES. In particular, this document supports and develops the concept, proposed in D2.1, of a catalogue of risks (biological and ecological risks) that should be shared at the regional level, where countries can select the risks that are deemed adapted to their specificities. It is proposed that threshold values be associated to the risks listed in this catalogue.

Further, this document discusses the possibility to build the catalogue of risks, and the associated thresholds, upon the characteristics of areas designated both at the national and international level for the protection of species that are also acknowledged as noise-sensitive. In practice, this proposition would mean that the risks and associated threshold values are selected for the assessment according to noise-sensitive species that live in such areas as MPAs (including the maritime NATURA 2000 network), Critical Cetacean Habitats (CCHs), Important Marine Mammal Areas (IMMAs), and Special Protection Areas of Mediterranean Importance (SPAMIs, including the Pelagos Sanctuary) which are distributed in the Mediterranea basin.

Finally, this Deliverable addresses the topic of environmental targets. First, we discuss the recommendations contained in D2.1 about what targets should be focussed on. And secondly, we propose practical elements for the consideration of baselines, and for the setting the targets. The document ends with a discussion of an integrated assessment of Descriptor 1 (biodiversity) and 11.

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List of Abbreviations

CTN	Centro Tecnológico Naval y del Mar
IEO	Instituto Español de Oceanografía
UPV	Universitat Politècnica de València
SHOM	Service Hydrographique et Océanographique de la Marine
ISPRA	Ispra Instituto Superiore per la Protezione e la Ricerca Ambientale
IZVRS	Inštitut za vode Republike Slovenije
ACCOBAMS	Permanent Secretariat of the Agreement on the Conservation of Cetaceans of the Black Sea, Mediterranean Sea and Contiguous Atlantic Area
UoM	The Conservation Biology Research Group, the University of Malta
IOF	Institute of Oceanography and Fisheries
FORTH	Foundation for Research and Technology - Hellas
MSFD	Marine Strategy Framework Directive

1 Introduction.

The first cycle implementation of the Marine Strategy Framework Directive (MSFD) exposed a number of shortcomings, namely a general lack of coherence in the definition of Good Environmental Status (GES) and the assessment methodology deployed. Based on the findings of the first cycle, the European Commission (EC) put forth a number of recommendations that would improve the level of consistency for the Second Cycle set to start in 2018. The findings of the EC further suggest, that there is a necessity for Member States (MS) to enhance cooperation mechanisms and to ensure a better link between national and regional strategies. The QuietMed project aims to do just that. The underlining aim of the Project is to "…improve the level of coherence and the comparability of the implementation of the Second Cycle of the Marine Directive (MSFD) as regards Descriptor 11- underwater noise implementation in the Mediterranean Sea Basin Region by enhancing cooperation among Member States (MS), the Barcelona Convention and other third non-EU countries."[1] Furthermore, the Project seeks to establish common definitions of GES, as mandated by Activity 2, and additionally produce guidance on a coherent assessment methodology.

Specific objectives of the project are as follows:

- ✓ Achieve a common understanding and GES assessment (MSFD, Article 9) methodology (both impulsive and continuous noise) in the Mediterranean Sea.
- ✓ Develop a set of recommendations to the MSFD competent authorities for review of the national assessment made in 2012 (MSFD, Article 8) and the environmental targets (MSFD, Article 10) of Descriptor 11- Underwater Noise in a consistent manner taking into account the Mediterranean Sea Region approach.
- ✓ Develop a common approach to the definition of threshold at MED level (in link with TG Noise future work and revised decision requirements) and impact indicators.
- ✓ Coordinate with the Regional Sea Convention (the Barcelona Convention) to ensure the consistency of the project with the implementation of the EcAp process
- ✓ Promote and facilitate the coordination of underwater noise monitoring at the Mediteranean Sea level with third countries of the region (MSFD Article 6), in particular through building capacities of non-EU Countries and taking advantage of the ACCOBAMS-UNEP/MAP cooperation related to the implementation of the Ecosystem Approach Process (EcAp process) on underwater noise monitoring.
- ✓ Recommend methodology for assessments of noise indicators in the Mediterranean Sea basin taking into account the criteria and methodological standards defined for Descriptor11 (Decision 2010/477/EU, its revision and Monitoring Guidelines of TG Noise).
- ✓ Establish guidelines on how to perform sensor calibration and mooring to avoid or reduce any possible mistakes for monitoring ambient noise (D 11.2.1). These common recommendations should allow traceability in case the sensor give unexpected results and help to obtain high quality and comparable data.

[1] Project description, pg. 84.

- ✓ Establish guidelines on the best signal processing algorithms for the preprocessing of the data and for obtaining the ambient noise indicators (D 11.2.1).
- ✓ Implement a Joint register of impulsive noise (D11.1.1) and hotspot map at Mediterranean Sea Region level by impulsive noise national data gathering and joint processing.
- ✓ Enhance collaboration among a wide network of stakeholders through the dissemination of the project results, knowledge share and networking.

To achieve the objectives outlined above, QuietMed has divided its work into five distinct, yet interconnected, working activities. While Activity 1 is concerned with project coordination, planning and monitoring, activities 2 and 3 are of special interests to this report and will be addressed shortly. Activities 4 and 5 will review the scientific work that has been done in the Mediterranean in regard to definition threshold and the advantages and disadvantages of the approaches taken. Activity 5 will moreover address underwater noise monitoring methodologies across the globe and will also aim to provide an evaluation on the suitability of the methodologies deployed.

Activity 6 and 7, more technical and practice-orientated in nature, are mandated to establish guidelines on how to reduce, and if possible elude, mistakes in underwater noise monitoring across multiple devices. Activity 7 will set out to test hardware calibration as addressed and amended in Activity 6. Activity 7 will thus draw on Pilot projects in Malta, Crete (northern and southern parts of Crete) and in Spain.

Activities 8 and 9 are tasked with the development of a much-needed common noise registry for impulsive noise. While Activity 8 will be limited to a preparatory study, aimed at discussing and designing a common registry largely based on the Mediterranean Noise Registry Demonstrator produced by ACCOBAMS, Activity 9 will concern itself with the implementation of the latter. Furthermore, the Noise Registry will pay tribute to the data information treatment approaches suggested by DIKES and will attempt to ensure compatibility with other regional and subregional initiatives (e.g. OSPAR), a shortcoming that became evident in the first implementation cycle.

Activity 10, based on activities 8 and 9, will concern itself with building the joint register and hotspot map of impulsive underwater noise indicator in the Mediterranean Sea Region. The diffusion of the results of the proceeding activities will remain the task of activities 11, 12 and 13. Whereas Activity 11 will set up the tools for an effective and efficient communication and dissemination strategy, Activity 12 will foster collaboration and coordination with other relevant projects in the region who share similar objectives. Activity 13 will include a 2-day and 3-day training workshop; whereas the former will be aimed at involving national representatives from third countries the latter will be organized with experts from national research institutions of third countries tasked with addressing the practical elements of the implementation of underwater noise monitoring programmes.

As previously alluded to, of special interest to this report are activities 2 and 3. Activity 2 set out to extensively review the national assessments of Descriptor 11-Underwater Noise of 2012 and develop recommendations that would ensure a more consistent manner while taking into account regional approaches. Recalling the recommendations put forward by the EC following

the first implementation cycle, the document "D2.1 Report on lessons learned of national 2012 assessment and GES definition" addresses intricacies of defining GES. Of central importance to this research endeavour however is Activity 3. Ideally, Activity 2 has managed to not only highlight the converging approaches by MS in their definition of GES and environmental targets, but furthermore been able to lay the foundation for a common understanding of GES for the implementation of the second cycle of the MSFD in the Mediterranean Sea. Going a step further, Activity 3 will review some of the assessment methodologies deployed for other parts of the Sea and will be able to contribute to a common understanding of GES definition and assessment methods. Surely, a common understanding of assessment methodology will not be based on the input of a single approach, rather, a shared vision will ideally include a common framework which allows MS to account for national and subregional specificities without resulting in incoherent assessment tools. In short, this document reports on the consistency of the definition of GES and the assessment of noise criteria for GES determination. A list of elements are proposed and discussed that should help building a common ground for GES assessment and target definition at the Mediterranean level.

1.1 Material collection and outline of the objectives

The findings of this document are based on publicly and readily made available sources. The first focus has been to presents instead an in-deep analysis of the provisions set out by the 2017/848 Commission Decision on criteria and standards for MSFD implementation, and a comparison with the repealed 2010/477 Commission Decision.

Further, this report considers the work done by the working on group on good environmental status (WG-GES), and the 2017 OSPAR Intermediate Assessment, which include for the first time a regional overview of impulsive noise in waters around the European Union.

This document is a first step towards a shared view of GES and the assessment methodology, including both impulsive and continuous noise.

The list of main documents considered here is presented hereafter.

Authors	Title	Year
TG-Noise	Bucharest meeting report	2018
OSPAR	Distribution of Reported Impulsive Sounds (OSPAR Intermediate Assessment)	2017
European Commission	Commission Decision 2017/848	2017
WG-GES	Draft guidance for assessments under Article 8 of the MSFD	2017
TG-Noise	Torredolones workshop report	2017
TG Noise	Hamburg workshop report	2016
TG-Noise	Monitoring Guidance for Underwater Noise in European Seas. Parts I, II and III	2014
WG-GES	Common Understanding of (Initial) Assessment, Determination of Good Environmental Status (GES) & Establishment of Environmental Targets (Articles 8, 9 & 10 MSFD)	2011
European Commission	Commission Decision 2010/477	2010

2 Review of the assessment methodologies for definition of GES

2.1 Recommendations for national GES assessment methodologies as stipulated by new Commission Decision (EU) 2017/848

Having adopted Directive 2008/56/EC in 2008 Member States agreed on establishing a framework for community action in the area of marine environmental policy. Adopted in 2010, European Commission (EC) Decision 2010/477/EU laid out a set of criteria that Member States should use in their determination of good environmental status (GES) as applies to their waters. Pursuant to Article 8(1) of Directive 2008/56/EC (MSFD) Member States submitted reports on the environmental status of their waters and tendered to the Commission notification of their determination of good environmental status and their respective environmental targets. In accordance to Article 12 of Directive 2008/56/EC the Commission evaluated the country reports and concluded that further efforts are required to reach good environmental status by 2020 as indicated within the MSFD.

Commission Decision 2017/848 adopted in May of 2017, taking into consideration the Commissions review conducted in 2012 and other consultative processes, repeals Decision 2010/477/EU. The most recent Decision likewise lays down a set of criteria and methodological standards that Member States should draw on when determining a set of characteristics for good environmental status, as stipulated by Article 9(1) of Directive 2008/56/EC. The Decision further stipulates the setting of thresholds at the Union level, while having regard for regional and sub regional cooperation. These measures are nevertheless to be in conformity to EU legislation. Decision 2017/848 further specifies the Member States' need to set such standards by July 15th, 2018. If the respective member is unable to establish such thresholds, lists of criteria or methodological standards, the Commission must be notified no later than October 15th, 2018 and provided a justification from any deviations.

Of special significance for the purpose of this report is the Annex attached to Decision 2017/848, laying out an amended version (with respect to repealed 2010/477/EU Commission Decision) of the criteria and methodological standards for good environmental status of marine waters and specifications and standardised methods of monitoring and assessment. This new Decision brings several relevant new concepts that might have a direct influence in the definition of national criteria for the assessment of GES. These are:

- Threshold values should be set on the basis of the precautionary principle, reflecting the potential risks to the marine environment.
- The threshold values to be defined should accommodate the dynamic nature of marine ecosystems and their elements which can change in space and time.
- Member States may also decide, on the basis of the specificities of their marine waters, to consider additional elements not laid down in this Decision (2017/848) and not dealt with at international, regional or sub-regional level.

- Criteria should now follow a primary and secondary level if needed. Primary criteria should be used to ensure consistency across the Union, but flexibility should be granted with regard to secondary criteria. The use of a secondary criterion should be decided by Member States, where necessary, to complement a primary criterion or when, for a particular criterion, the marine environment is at risk of not achieving or not maintaining GES.

Further concepts of this Decision appear worth citing here. Commission Decision 2017/848, Article 2 (*Definitions*):

'threshold value' means a value or range of values that allows for an assessment of the **quality level** achieved for a particular criterion, thereby contributing to the assessment of the extent to which good environmental status is being achieved.

Paragraph 15 (Introductory part):

[…] threshold values […] will be part of the set of characteristics used by Member States in their determination of good environmental status […]. Threshold values do not, by themselves, constitute Member States' determinations of good environmental status.

Paragraph 17 (Introductory part):

Where threshold values […] are not met for a particular criterion, Member States should consider taking appropriate measures or carrying out further research or investigation.

2.1.1 Assessment of impulsive noise regarding the new Commission Decision 2017/848.

As such, the new Decision stipulates that the primary criteria be, "D11C1 — Primary: The spatial distribution, temporal extent, and levels of anthropogenic impulsive sound sources do not exceed levels that adversely affect populations of marine animals. Member States shall establish threshold values for these levels through cooperation at Union level, taking into account regional or sub-regional specificities" and that Member States shall develop such thresholds through cooperation at Union level, while taking into consideration "regional and sub-regional specificities, and should be able to use national threshold values, directional trends or pressure-based threshold values as proxies" (Commission Decision 2017/848, Descriptor 11).

Comparing to Decision 2010/477/EU:

"11.1. Distribution in time and place of loud, low and mid frequency impulsive sounds

— Proportion of days and their distribution within a calendar year over areas of a determined surface, as well as their spatial distribution, in which anthropogenic sound sources exceed levels that are likely to entail significant impact on marine animals measured as Sound Exposure Level (in dB re 1 $\mu Pa^2/s$) or as peak sound pressure level (in dB re 1 µPa peak) at one metre, measured over the frequency band 10 Hz to 10 kHz (11.1.1)" (Decision 2010/477/EU, Descriptor 11). "

The extent to which GES has been attained will be determined based on "the duration per calendar year of impulsive sound sources, their distribution within the year and spatially within

the assessment area, and whether the threshold values set have been achieved." (Commission Decision 2017/848, Descriptor 11).

The new Decision furthermore outlines specifications of standardized monitoring methods:

a) Spatial resolution: geographical locations whose shape and areas are to be determined at regional or sub-regional level, on the basis of, for instance, activities listed in Annex III to Directive 2008/56/EC.

b) Impulsive sound described as monopole energy source level in units of dB re 1 µPa$_2$s or zero to peak monopole source level in units of dB re 1 µPa @ 1 m, both over the frequency band 10 Hz to 10 kHz. Member States may consider other specific sources with higher frequency bands if longer-range effects are considered relevant.

The new Decision also gives the units of measurement for the impulsive noise criteria:

D11C1: Number of days per quarter (or per month if appropriate) with impulsive sound sources; proportion (percentage) of unit areas or extent in square kilometres (km2) of assessment area with impulsive sound sources per year.

2.1.2 Assessment of continuous noise regarding the new Commission Decision 2017/848.

Regarding the GES assessment of continuous noise (D11C2, identified as primary criterion), the Commission Decision 2017/848 primarily focuses on anthropogenic continuous low-frequency sound. As such the agreed primary GES criterion as stipulated by the Decisions is, "**The spatial distribution, temporal extent and levels of anthropogenic continuous low-frequency sound do not exceed levels that adversely affect populations of marine animals**", again calling on Member States to set such threshold values at Union level while taking into consideration other specificities (Commission Decision 2017/848, Descriptor 11).

Comparing to Decision 2010/477/EU:

"11.2. Continuous low frequency sound

— Trends in the ambient noise level within the 1/3 octave bands 63 and 125 Hz (centre frequency) (re 1µPa RMS; average noise level in these octave bands over a year) measured by observation stations and/or with the use of models if appropriate (11.2.1) " (Decision 2010/477/EU, Descriptor 11).

Likewise, the extent to which GES has been achieved will be dependent on, "…the annual average of the sound level, or other suitable temporal metric agreed at regional or sub-regional level, per unit area and its spatial distribution within the assessment area, and the extent (%, km²) of the assessment area over which the threshold values set have been achieved" (Commission Decision 2017/848, Descriptor 11).

The specifications and standardized methods for monitoring and assessment criteria for continuous low-frequency noise are as follows:

- Annual average, or other suitable metric agreed at regional or sub-regional level, of the squared sound pressure in each of two '1/3-octave bands', one centred at 63 Hz and the other at 125 Hz, expressed as a level in decibels in units of dB re 1 µPa, at a suitable spatial resolution in relation to the pressure. This may be measured directly, or inferred from a model used to interpolate between, or extrapolated from, measurements. Member States may also decide at regional or sub-regional level to monitor for additional frequency bands.

Units of measurement for the criteria in relation to continuous low-frequency noise:

D11C2: Annual average (or other temporal metric) of continuous sound level per unit area; proportion (percentage) or extent in square kilometres (km2) of assessment area with sound levels exceeding threshold values.

These definitions for D11C2 introduce the concept of *unit area* in the calculation of average continuous sound levels. This concept is comparable to unit areas used for D11C1 and, as stated in the last available report from WG-GES, it implies the use of an appropriate grid size for aggregating data within the assessment area (Walmsley et al., 2017).

2.2 Environmental assessment methods relevant for the MSFD process

Hereafter are listed and described several project whose scope is relevant for the consistent definition of GES at the regional and sub-regional scales.

- **Development of Innovative Tools for Understanding Marine Biodiversity and assessing Good Environmental Status (DEVOTES)**. Cordinated by AZTI-Tecnalia, Spain. The main objective of the Project was to not only improve our understanding of anthropogenic activities on biodiversity but to also identify the obstacles that still persist in achieving Good Environmental Status (GES). Moreover, the Project was also aimed at developing and testing monitoring tools to improve biodiversity understanding and ecosystem changes. Lastly, DEVOTES also set out to propose integrated ecosystem management strategies which include both industry and other stakeholders (Ibid). As part of its 6.2 Deliverable, DEVOTES proposed a potential definition of GES in 2015. In a collaborative effort, including researchers from the University of Hull, the University of Aarhus as well as other experts, the Project produced a guidance document that not only attempted to conceptualize a definition of GES but furthermore addressed target-setting as a means to quantify GES. Likewise, the Project furthermore proposed a unique status assessment, a process that has been neglected by the MSFD process thus far.
- **Baltic Marine Environment Protection Commission - (HELCOM indicators)**, an intergovernmental organization and governing body of the Convention on the Protection of the Marine Environment of the Baltic Sea Area, HELCOM is not only a policy maker but also a forum that develops and recommends measures aimed at ensuring a healthy and biologically diverse Baltic Sea. A large part of HELCOM's work is to use core indicators with quantitative threshold values to evaluate the progress that has been achieved towards reaching GES (HELCOM, 2017). HELCOM has developed 24

indicators, with associated GES boundaries being developed, that can be used to evaluate individual indicators or be included in thematic assessments to evaluate progress towards GES in the Baltic Sea region. While features of the indicators such as species and habitats may be specific for the Baltic Sea region, the principles of the indicators can explored also for other marine regions.

- **OSPAR 2017 - Intermediate Assessment.** OSPAR is a legislative instrument regulating international cooperation on environmental protection in the North-East Atlantic. An assessment of the quality status of the North-East Atlantic is carried out by the Commission for the Convention for the Protection of the Marine Environment of the North-East Atlantic (OSPAR) since 2000 with a 10-year cycle. So far, two Quality Status Reports have been produced (QSR 2000 and 2010); and an intermediate assessment was issued in 2017. This is the first report from OSPAR explicitly including underwater noise as a descriptor of the marine environment. The assessment method took advantage of the establishment of an international register for impulsive noise sources (INR), developed and maintained by the International Council for the Exploration of the Sea (ICES) for OSPAR. This INR accords with the guidelines from the EU Technical Group on Underwater Noise (adopted by OSPAR in 2014) and allowed using data uploaded by Contracting Parties to OSPAR for 2015 to produce an overview of the distribution of impulsive sound sources in the OSPAR region. Though not exhaustive, the 2017 intermediate report provide the first baseline levels for D11C1 in a regional sea relevant for the MSFD process. However, the report does not give any element about GES, and the main conclusion is that future reporting should results in better assessment of pressure from impulsive sound generation in the area. Finally, this assessment does not inform about continuous noise. Despite the limits described above, the OSPAR 2017 Intermediate Assessment provide useful baseline information to build a common understanding for a maritime region with regards to underwater noise.
- **Achieveing QUieter Oceans by shipping noise footprint reduction (AQUO).** The European AQUO project »Achieve QUieter Oceans by shipping noise footprint reduction« started in October 2012, in the scope of the FP7 European Research Framework, for three years duration. The main objective of the AQUO Project was to measure impact from different vessels connected to AIS information on marine life using an innovative methodology, and to provide practical solutions and tools for the mitigation of the impact on marine life of ship traffic regarding underwater noise. (AQUO European Collaborative Project (Link: http://www.aquo.eu/, Moreno, A. et al. 2015, Audoly, et al., 2016). One of the results of the outcome of the project of interest for the MSFD process appears to be the development of a novel certification standard applicable to commercial vessels. This certification (Underwater Radiated Noise, URN, developed by Bureau Veritas) is aimed at promoting the adoption of measures for reduction of vessel noise introduced into the marine environment (Guidelines for Regulation on UW Noise from Commercial Shipping, 2015), which may be considered as a target in sense of the MSFD process.

- **NOAA Ocean Noise Strategy.** The Ocean Noise Strategy (ONS) outlines a 10 year vision to guide the agency towards more comprehensive and effective understanding and management of ocean noise impacts. The ONS Roadmap was finalized in September, 2016, and in November 2016 NOAA Fisheries approved two directives to incorporate into their Policy Directive System (PDS): the Ocean Noise Policy and an accompanying Ocean Noise Procedure. These directives established NOAA Fisheries' commitment to implementing the Ocean Noise Strategy, and established an initial six-month deadline for contributing to an internal biennial Ocean Noise Work Plan tracking noise related efforts across the agency. This biennial work plan is modeled as a tracking system to outline local and regional to national and international efforts taking place throughout the agency. The workplan is a living document that can be updated continually, streamlines and encourages collaboration among offices and programs, and allows for the leveraging of efforts and resources to strengthen NOAA's ability to achieve the objectives of the Ocean Noise Strategy. While it is still relatively early in the decade long time-frame of the Strategy, and there is considerable work to be done, the effort has demonstrated success on a number of levels so far. To note just a couple of examples from the Science and Monitoring objectives, NOAA has implemented its first ever noise monitoring system (the Noise Reference Station Network) distributed widely throughout US waters. This unique collaborative effort across NOAA line offices (OAR, NMFS, NOS) and the National Park Service currently has 12 established sites where long-term low frequency underwater acoustic data is being collected. This allows characterizing and comparing the acoustic environment across US waters, as well as assessing long-term trends and changes in underwater noise. NOAA is continuing to develop standardized analysis techniques and metrics, as well as output products from the NRS network characterizing the acoustic environment at each of these sites. In addition, by working with NOAA's National Centers for Environmental Information, a Passive Acoustic Data Archive has been established, that provides long-term data storage as well as an online map viewer where the public can view data collection sites and request access to the acoustic data.

3 Consistency and coherence in GES definition and criteria assessment at the Mediterranean basin scale

Deliverable 2.1 "Report on lessons learned of national 2012 assessment and GES definition", developed under QuietMed, provides this key message:

- The review of the first cycle of implementation of the MSFD confirms disparities among Member States' approaches in GES definition. This disparity is on the one hand due to the wide scope of definitions which extend from pressure based to risk-based and response-based definitions. It is also due on the other hand to the lack of scientific knowledge which has lead Member states to stick to the pressure indicators even for more elaborate definitions, which generally makes quite unrealistic to proof the achievement of the GES at risk or response level.

To overcome this disparity, D2.1 propose to find the trade-off in the definition of a risk-based GES. This appears fully coherent with the new Comm. Dec. in that the establishment of threshold values proposed therein could reflect the potential risks to the marine environment.

3.1 A risk-based GES definition

A risk-based GES definition could be the following:

The Good Environmental Status (GES) is defined when communication capabilities of marine life are not degraded, functional ecological zones for sensitive marine wildlife are preserved so that marine animal are not displaced, and noise does not induce excess mortality.

This example addresses three kinds of biological and ecological risks (reduced communication due to masking, displacement, and increased mortality). To improve comparability among MS, a catalogue of risks to be managed (e.g. masking, over mortality, disturbance, harassment, etc.) could be agreed at the Mediterranean level. Each MS could then identify which risks are relevant at the national level regarding its prevailing noise pressures, sensitive species or any other specificities. The definition of GES needs also to be consistent with the biodiversity descriptor (D1) in particular in terms of species and maritime regional unit of assessment. On the other hand, characteristics dealing with management and regulation of drivers, thus far included in GES definition for several Member States (Cf Deliverable 2.1), could be included instead into the environmental target definition and the program of measure (see section 4).

3.2 Assessment of noise criteria for the determination of GES

Considering the previous points and based on the analysis of the new Commission Decision provided in section 2.2 of this document, assessing GES criteria means assessing the quality level achieved for each criterion (D11C1 and D11C2). This quality level (QL) may be set on a reference scale, such as: Good/bad; or High/Acceptable/Poor; or other quality reference scale. Therefore, each level of this reference scale may be attributed a value (threshold) which is based on the associated biological and/or ecological risks.

Sections 3.2.1 and 3.2.2 hereafter describe a possible framework for putting these concepts in practice for each noise criterion.

3.2.1 Assessing D11C1 criterion quality level

For impulsive noise (D11C1), table 1 draws a first proposal of a common framework, based on the units of measurements set by the new Comm. Dec. and reported above.

Table 1. Assessment of the quality level achieved for D11C1 criterion. In bold are proposed disambiguation of new Comm. Dec., based on existing work from TG-Noise.

D11C1				
N	Units of measurement as defined in the new Comm. Dec.	Value scale	Associated risks	QL
1a	Number of days per quarter with impulsive sound sources (**pulse-block days per quarter**)	< xx PBDs Between xx and xx PBDs > xx PBDs	Risk catalogue	Ref scale (e.g. High/Acceptable/Poor)
1b	Number of days per month with impulsive sound sources (**pulse-block days per month**)	< xx PBDs Between xx and xx PBDs > xx PBDs	Risk catalogue	Ref scale (e.g. High/Acceptable/Poor)
2a	Proportion (%) of unit areas (**blocks**) of assessment area with impulsive sound sources per year (**at least 1 pulse-block day**)	< xx% Between xx% and xx% > xx%	Risk catalogue	Ref scale (e.g. High/Acceptable/Poor)
2b	Extent in square kilometres (km2) of assessment area with impulsive sound sources per year (**at least 1 pulse-block day**)	< xx km² Between xx and xx km² > xx km²	Risk catalogue	Ref scale (e.g. High/Acceptable/Poor)

A preliminary consideration is that it appears possible for Member States to select one out of two temporal units of measurement (1a or 1b in table 1) and one out of two spatial units of measurement (2a or 2b). Subsequently, recalling that threshold values will be part of the set of characteristics used by Member States in their determination of good environmental status, and that threshold values do not, by themselves, constitute Member States' determinations of good environmental status, we can draw an example on how the table above may be used for GES determination:

- A Member State may decide to use units 1b and 2a
- Calculation of 1b results in "poor" in the QL scale for a given month, and "acceptable" or "high" for all the other months
- Calculation of 2a results in "acceptable" or "high"
- The Member State may assess overall positive **outcome** of D11C1 assessment and decide to investigate and/or undertake measures to prevent further poor evaluations of 1a with special focus on the month where levels exceeded the acceptable-to-poor threshold

We present an example with a positive **outcome**. However, we contemplate similar situations where the outcome may not be that easy to assess. For example, calculation of 2a may result in a small proportion of blocks per year with impulsive sound sources. However, if that small proportion of blocks is concentrated in an important area for sensitive cetacean species, the outcome may be deemed negative or unacceptable. Similarly, calculation of 1b may result in a single month with a high number of pulse-block days. However, if that particular month is important for critical life functions, such as feeding or breeding, for sensitive cetacean species, the outcome may be deemed negative or unacceptable.

In this regards, it appears that the elements considered for setting the thresholds are crucial.

3.2.2 Assessing D11C2 criterion quality level

For ambient noise (D11C2), table 2 draws a first proposal of a common framework, based on the units of measurements set by the new Comm. Dec. and reported in section 2.2.2 above.

Table 2. Assessment of the quality level achieved for D11C2 criterion.

D11C2				
N	Units of measurement as defined in the new Comm. Dec.	Value scale	Associated risks	QL
3a	Annual average or continuous sound level per unit area	< xx dB Between xx and xx dB > xx dB	Risk catalogue	Ref scale (e.g. High/Acceptable/Poor)
3b	Other temporal metric of continuous sound level per unit area	< xx dB Between xx and xx dB > xx dB	Risk catalogue	Ref scale (e.g. High/Acceptable/Poor)
4a	Proportion (%) of assessment area with sound levels exceeding threshold values	< xx% Between xx and xx% > xx%	Risk catalogue	Ref scale (e.g. High/Acceptable/Poor)
4b	Extent in km² of assessment area with sound levels exceeding threshold values	< xx km² Between xx and xx km² > xx km²	Risk catalogue	Ref scale (e.g. High/Acceptable/Poor)

As previously highlighted, it appears that MS can select one out of two units of measurement expressed in decibels (3a or 3b) and one out of two spatial units (4a or 4b). Subsequently, an example is drawn on how the table above may be used for GES determination, also recalling that threshold values will be part of the set of characteristics used by Member States in their determination of good environmental status, and that threshold values do not, by themselves, constitute Member States' determinations of good environmental status:

- A Member State may decide to use units 3a and 4b

- Calculation of 3a results in some potential biological risk (e.g. masking of biological signals) for a given area. So, the QL is "poor" for that area, and "acceptable" or "high" for all the other areas
- Calculation of 4b results in "acceptable" or "high"
- The Member State may assess overall positive **outcome** of D11C2 assessment and decide to investigate and/or undertake measures to prevent further poor evaluations of 3a with special focus on the causes of the values measured (or inferred) for the area where levels exceeded the acceptable-poor thresholds

As for D11C1, for similar situations the **outcome** may be more difficult to assess. Again, if the small area of poor QL falls in an important area for a particularly sensitive cetacean species, or occurs only during particularly important periods, the outcome may be deemed negative or unacceptable for the whole assessment area. Again, the elements considered for setting the thresholds appear as crucial.

3.3 Principles for considering thresholds in the assessment of the quality level of noise criteria

In 2011, the GES Working Group advised to use existing framework where thresholds where developed for the initial assessment of the MSFD. The **picture hereafter** summaries this proposal (Claussen et al., 2011).

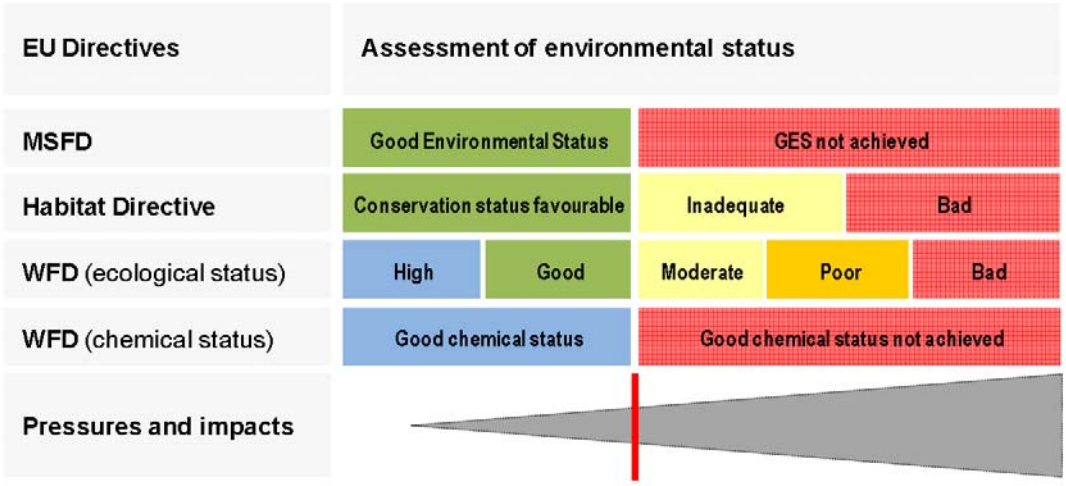

Figure 1. Advice from GES Working Group on the development of thresholds for the MSFD process (source: Claussen et al. 2011). This example is focussed on chemical pollution and should not be considered "as it is", but as a possible basis to develop similar framework for criteria related to D11. (WFD = Water Framework Directive)

However, underwater noise pollution is not included in any EU environmental legislation adopted before the MSFD, and it is still commonly recognised that current level of knowledge on the effects of noise (dose-response, magnitude of effects on populations, etc.) is not sufficient to definitely set science-based thresholds. Related to this, New Comm. Dec. itself states indeed that "Until a sufficient level of knowledge on state and impact is available and thresholds agreed at the EU levels":

[...] precautionary thresholds, baseline levels and trends should be set at the national levels as specified in the revised decision (Comm. Dec. 2017/848).

With this in mind, **two main principles are proposed here for the establishment of threshold**. The first is a recommendation from quietMed Deliverable 2.1, i.e. the establishment of a **catalogue of biological and/ecological risks** that can be associated to the assessed inputs of noise into the environment. The second is the use of biologically and ecologically **important areas and periods as the driver** for setting threshold according to conservation priorities of those conservation areas.

3.3.1 Interim catalogue of risks

Risks should be set according to the two criteria, to account for the different responses potentially observed at the population scale from impulsive and continuous noise. Regarding D11C1, based on TG-Noise guidance on the impulsive noise register, registered sound sources are already considered as potentially entailing impact, where impact is defined as *displacement of a significant proportion of individuals for a relevant time period and at a relevant spatial scale* (Dekeling et al., 2014). So for D11C1, since the MSFD addresses the ecosystem scale, we consider the risks deriving from the cumulative effects of multiple displacements and from multiple impulsive sound sources during the temporal scales assessed (year, quarter, month). This interim list of risks is initially related to marine mammals cetaceans only:

- **Disturbance** (D11C1)
- **Habitat avoidance** (D11C1)
- **Reduction of survival or reproduction** (D11C1)
- **Habitat degradation** (D11C1 and D11C2)
- **Masking** (loss of acoustic space, D11C2)

Such interim list of risks can be related to cetaceans as a single group, or to single species or groups of species, according to priorities identified at different scales. The next section provide proposals to consider species-specific risks through the use of existing areas designated to some extent as important for protection and/or conservation.

3.3.2 Biologically and ecologically important areas

In the Mediterranean Sea there are several areas designated as important for biodiversity under several international fora as well as by the European Union and nationally:

- The maritime NATURA 2000 network, established by EU-Member Statess thanks to the HABITAT (and BIRD) Directive

- The Pelagos Sanctuary, established under the Pelagos Agreement, and also listed as Specially Protected Area of Mediterranean Importance (SPAMI) under the UNEP/MAP-Barcelona Convention.
- The rest of SPAMIs established under the UNEP/MAP-Barcelona Convention.
- Critical Cetacean Habitats (CCH) established by ACCOBAMS (currently under revision)
- Important Marine Mammal Areas established by the IUCN (ongoing definition process)
- Cetacean Migration Corridor in the Mediterranean declared as Marine Protected Area in Spain (in process to be listed as Specially Protected Areas of Mediterranean Importance-SPAMI)[2].

Among these areas, Member States may select those that were established for the conservation of species that are sensitive to noise (cetaceans, fish, turtles, etc.). In this regard, it is relevant to consider the UNEP/MAP strategy on underwater noise monitoring drafted in the framework of the Ecosyste-Approach process (EcAp) by the Joint ACCOBAMS/ASCOBANS/CMS Working Group on Noise in 2014 (ACCOBAMS, 2014). This monitoring strategy was focussed on the potential impact entailed to three cetacean species known to be sensitive to noise: the Cuvier's beaked whale, the sperm whale and the fin whale. The main concerns about these species are:

- Loud mid-frequency **impulsive** sounds with respect to beaked whales. Such sounds have indeed been identified as disrupting diving and feeding behaviour, disorientation, and in some cases they have been correlated to mass strandings (Agardy et al., 2007; Fernandez et al., 2004; Filadelfo et al., 2009; Frantzis, 1998; Martin et al., 2004).
- Loud low-frequency **impulsive** sounds with respect to fin whales, as studies conducted in the Pelagos Sanctuary and in the Western Mediterranean pointed out communication disruption and massive spatial avoidance in fin whales (Borsani et al., 2008; Castellote et al., 2012)
- Low-frequency **continuous** sound, especially caused by navigating ships, identified as a cause of changes in the singing behaviour of fin whales, masking of biological acoustic signals produced by fin whales - whale song notes -, and sperm whales – clicks -, although the concern about masking on sperm whales by shipping noise is supported by much less scientific evidence (André et al. 2017; Clark et al. 2009; Erbe et al. 2016; Okeanos Foundation 2008, Castellote, Clark, and Lammers 2012).

Therefore, thresholds may be set according to species representing conservation priorities/concerns within these areas. Of course, further species may be considered according to national specificities.

[2] Royal Decree 699/2018, of June 29, which declares the Cetacean Migration Corridor in the Mediterranean as a Marine Protected Area, approves a preventive protection regime and proposes its inclusion in the list of Specially Protected Areas of Mediterranean Importance (SPAMI´s List) within the framework of the Barcelona Convention.

4 Next steps for a shared and consistent understanding of targets

We recall here introductory concepts taken from (Claussen et al., 2011) in order to ground the interim proposals expressed further in this section:

1. Environmental targets guide the process towards achieving GES
2. Four types of targets are described in the MSFD text: state-, pressure- and impact-based targets, as well as operational targets. The table presented hereafter, extracted from Claussen and co-authors (2011), shows examples solely for illustration purposes, in order to help understanding the nature of a specific type of target (and its relationship to potential measures).

	State	Pressure	Impact	Operational	Measure
D11	Anthropogenic noise should be at levels which do not significantly affect or interfere with the health of the marine ecosystem.	The proportion of days in which anthropogenic sound sources exceed x dB should not exceed x % in a calendar year or an average of x pulse days per year per block	The cumulative input of noise from peak and continuous noise sources are reduced to levels below which impact on marine cetaceans is measured. (also D1)	All developments generating potentially damaging levels of impulsive sounds to adopt best available technology and best practice in order to minimise risks to marine life Establish a noise registry to record in space and time impulsive sounds by 2020 (or as a measure)	Soft start techniques employed on all developments utilising pile driving

Such examples were in no way intended to be exhaustive or prescriptive. Nonetheless, it is worth noting that the establishment of a noise register was presented as an example of operational target (or as a measure).

3. Targets will be primarily pressure- and impact-based since the reduction in pressures and impacts is the most effective way to achieve or move towards to GES.

Following such concepts, the present deliverable supports, as proposed in quietMed D2.1, the idea that **characteristics dealing with management and regulation**, thus far included in GES definition for several Member States, should be rather included into the environmental targets definition (and the program of measure), and be **more specific and measurable**. Art. 10 MSFD requires indeed that environmental targets be measurable and hence be associated with appropriate indicators; further, it was expected that these indicators were based on those outlined within the EU Comm. Dec. 2010/477/EU (Claussen et al., 2011). Despite the new Comm. Dec. 848/2017 updates, sometimes modifying substantially, the structure outlined in Comm. Dec. 477/2010, the concept that indicators (associated to criteria) should allow measuring the path towards the environmental targets, and hence towards the achievement and maintenance of GES, is still valid.

With this in mind, the general process required to get to setting targets can be resumed in the following steps, where the steps addressed in this part of the document are in bold:

1. Defining GES or updating GES definition
2. Deciding on a baseline/reference (baseline levels)
3. Comparing with current situation (e.g. the initial assessment in 2012) and assess deviation from GES definition
4. Defining targets to achieve (or maintain) GES

We address in the following sections options for baselines values and targets.

4.1 Baselines values

Considering the 2011 report from WG-GES, three main baseline setting approaches may be considered:

1. **Baseline as an unimpacted or pristine state**, with three different options:
    a. Present unimpacted state → depends on the existence of unimpacted areas (and related scientific evidence) in the present times
    b. Historical unimpacted state → as the baseline is set in the past, depends on the existence of reliable historical data
    c. Modelled unimpacted state → this approach is theoretical, and therefore it depends on the quality and quantity of available historical and present data, and on the (generally debatable) scientifc methods employed to derive model-based baselines
2. **Baselines set at some point in the past**, for example the date of the first data point in a time series, provided this is considered the least impacted state (or an acceptable state). The difference from the approach outlined in 1b above is that these baselines are not necessarily considered as describing a pristine or unimpacted state
3. **Current baselines,** set as the date of inception of a particular environmental policy (e.g. the MSFD, the HABITAT Directive and the Water Framework Driective) or the first assessment of state. The intention behind this type of baselines is typically to prevent any further deterioration from the current state.

For D11C1, the current prevailing consideration is the establishment of baseline levels through the impulsive noise register, as set out by TG-Noise (Dekeling et al., 2014), and corresponding to the 3rd approach described above.

Alternatively, or as an interim baseline until national registers (and the regional register) are fully operational in the Mediterranean, the results from the ACCOBAMS work “Overview of the noise hotspots in the ACCOBAMS area, Part 1 – Mediterranean Sea”(Maglio et al., 2016), could be considered.

For D11C2, different options appear workable:

- Selecting the pristine status by taking the values contained in some landmark study on ocean noise such as (Wenz, 1962), which would correspond to approach 1b or 1c described above

- Obtaining reference levels from the current available knowledge on ambient noise characteristics in the Mediterranean Sea (i.e. peer reviewed literature). This would corresponds to the 3rd approach aforementioned

- Taking reference levels obtained from pilot studies of quietMed. However, this would be acceptable after going through a peer-reviewed process to validate the methods and results obtained in these pilot studies. Such option would correspond the the 3rd approach described above, or approach 1a if the measurements of continuous noise are done in areas considered as unimpacted

- Carrying out a literature review to define possible baselines based on best available science (1st and/or 2nd approache described above)

- A combination of the above options

4.2 Targets

Guidance from the different documents established under the MSFD (including the Directive itself and the document from the different expert working groups) defines that targets should be set once baselines are defined. In many countries targets have already been set or the process is ongoing but, as stated in QUIETMED Deliverable 2.1, consistency was lacking among MS and such targets were not enough specific and measurable.

As mentioned before (cf section 3.1), we try to focus here on targets related to management and regulation. The targets themselves are not proposed here, but we outline a (not exhaustive) list of elements that may constitute the common/shared basis for setting such targets.

Table 3. Proposition of the elements that may constitute the common/shared basis for setting environmental targets for both D11C1 and D11C2. The table is not exhaustive and more and/or different combination of elements may be relevant including in this list (e.g. focus on further marine species

Criterion	Target elements	Type	Example
D11C1	Number of mitigation measures and good practice applied, which can be measurable through the noise register	Operational	(1) All high and very high intensity noise events use mitigation measures (2) At least XX% of noise events use mitigation measures
D11C1 and D11C2	Adoption of best technologies	Operational	(1) Marine vibroseis is actively promoted or incentivised as a lower impact instrument to conduct O&G exploration (D11C1) (2) The building of new vessels following IMO noise mitigation measures is actively promoted and incentivised (D11C2)

			(3) The adoption of a "low-noise" label by ships is promoted and incentivised
D11C1	The inclusion of the reporting of data into the impulsive noise register through EIA (or other environmental) procedures	Operational	Reporting data into the register by industry is a condition for complying with national environmental regulation
D11C1	The number and the trend of registered noise events per year, measurable with the noise register	Pressure-based	Less than XX mid-frequency noise events with very high and high source levels in habitats of Cuvier's beaked whales
D11C1	The extent of the area of potential spatial displacement for fin whales in seasonally important areas.	Pressure-based	Less than XX% of the area with very high, high or medium intensity low frequency noise events
D11C2	Value in decibel and trend of average noise in the assessment area	Pressure-based	Threshold levels not exceeded > XX days/year
D11C2	Extent of the area with noise levels adversely affecting marine animals	pressure-based	Area with levels exceeding thresholds does not exceed XX% of the assessment area

5 Approximation to an integrated assessment D11-D1

The assessment of the MSFD is built around a DPSIR approach (Driver-Pressure-State-Impact-Response), Fig. 1 (Art. 8). It provides a causal framework where impacts are defined regarding the combination of pressure descriptors to state descriptors, in order to manage the activities through appropriate policy responses. D11, as pressure descriptor, has to be related to D1, biodiversity, (among other state descriptors) to assess the GES. In particular, criteria D1C2 (population abundance) and D1C4 (distributional range) seem to be relevant to establish a framework for comparison. Other state criteria can be considered as well, depending on the available knowledge, and if a sensitivity to underwater noise is established.

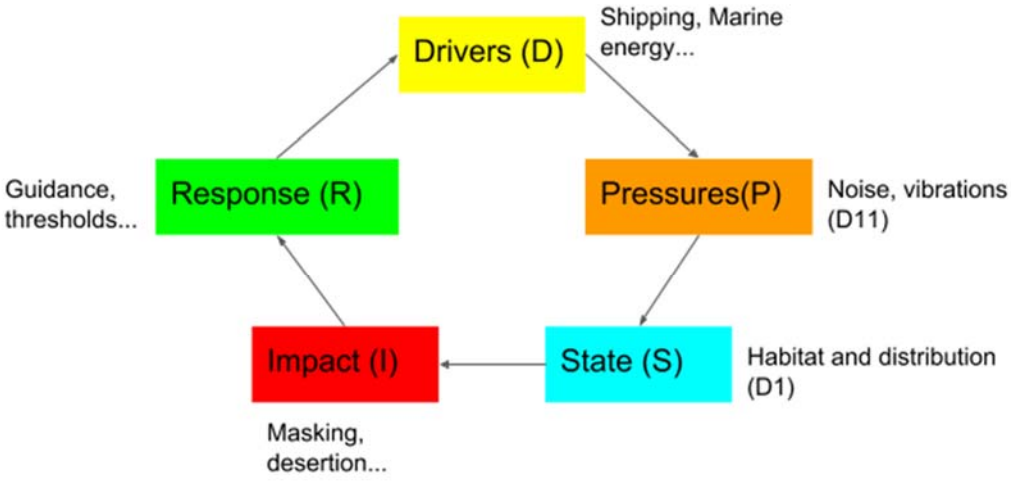

Fig. 1 DPSIR framework

The comparison between D11 and D1 criteria have to be assessed using similar scales in time and space. A coherence have to be established at regional or subregional levels between State and Pressure descriptors.

Usually, D1 is inferred from observation using spatial averaging or habitat modelling. For marine mammals, OBIS-SEAMAP is a portal that gathers many data (campaign, opportunistic or stranding events). For European waters, programs like SCANS (Small Cetaceans in European Atlantic waters and the North Sea, St Andrews University), PELGAS (Pelagique Gascogne, IFREMER), ACCOBAMS Survey Initiative (ACCOBAMS), SAMM (Suivi Aerien de la Megafaune Marine, Plagis and AAMP) can provide sufficient information on marine mammals to have a first assessment of some of the D1 criteria.

Regarding the causal assessment of the DPSIR framework, if state descriptor (D1) are assumed to be in GES, it seems unlikely that pressure (D11) cause impact. On the contrary, if state descriptor does not meet GES, impact have to be investigated using the pressure descriptors. Relevant response will be later proposed on drivers to mitigate the pressure. A complementary approach is to establish targets, as proposed in Sec. 4.2 in this document, particularly when GES is not measurable.

6 Conclusions and perspectives

This report addressesed topics that should support the achievement of a common understanding of criteria for Good Environmental Status, and a shared view of the assessment methodology with respect to both continuous and impulsive noise.

Main elements addressed in this reports are the following:

- ✓ Proposals were developed for a common ground for the definition of GES in the Mediterranean Sea, and for a common basis for the assessment methodology concerning for the determination of the environmental status with regards to noise criteria
- ✓ Methodological standards outlined in the Commission Decision 2017/848 were described and explained, and relationship with previous guidance from TG-Noise is proposed, especially concerning D11C1
- ✓ Recommendations contained in QUIETMED Deliverable 2.1 on "Lessons learned of national 2012 assessment and GES definition" were developed in this document. They deal with how to move towards a more coherent and shared understanding of GES and assessment methods. The principle proposition of this part of the document is the adoption of a risk-based definition of GES, where biological and ecological risks caused by anthropogenic underwater noise are considered in the definition of GES.
- ✓ Principles for considering thresholds were proposed and discussed. In particular, this document supports and develops the concept, proposed in QUIETMED Deliverable 2.1, of a catalogue of biological and ecological risks that should be shared at the regional level, where countries can select the risks that are deemed adapted to their specificities. It is proposed that threshold values be associated to the risks listed in this catalogue.
- ✓ Further, this document discusses the possibility to build the catalogue of risks and the associated thresholds upon the characteristics of areas designated both at the national and international level for the protection of species that are also acknowledged as noise-sensitive.
- ✓ Also, this deliverable addresses the topic of environmental targets. Practical elements for the consideration of baselines, and for the setting the targets are proposed.
- ✓ Finally, a first outline of an integrated assessment of Descriptor 1 (biodiversity) and 11 is presented.

Although considerable work has been done in the last 10 years, since the adoption of the MSFD by the European Parliament, the large number of topics addressed here indicates a need for further effort towards a full and consistent implementation of Descriptot 11 at the national and regional scale.

Current and future challenges are the definition of meaningful thresholds, as required by Commission Decision 2017/848 and the determnation, if considered appropriate, of an integrated assessment of GES relative to Descriptor 1 and 11.