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

Deliverable

D2.2 Report on common understanding and GES assessment methodology (both impulsive and continuous noise) and recommendations on the definition of threshold at MED level.

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4	Service Hydrographique et Océanographique de la Marine	SHOM	France
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Abstract
This document is the Deliverable "Report on common understanding and GES assessment methodology (both impulsive and continuous noise) and : recommendations on the definition of threshold at MED level. (31st October 2018)" 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 confidential document reports about different efforts made by some Member States to achieve a definition of thresholds in relation to underwater noise. It is to be considered as a companion of deliverable D2.3 of QUIETMED. This report D2.2 is largely based upon the outcomes of workshops held in 2016 in Hamburg, 2017, in Torrelodones and 2018 within the TGNoise in Bucharest. It also takes into consideration international scientific literature related to noise budgets, noise mapping and species-specific noise thresholds. This document is targeted at a non-technical audience, with the aim of supporting decisions by Public Administrations related to the underwater noise issue.

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Bibliography

Borsani, J.F., Faulkner, R., 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. Cefas - Centre for Environment, Fisheries & Aquaculture Science, UK.

Commission, E. (2008). 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, E. (2016). DG ENV/MSFD Second Cycle/2016. Brussels.

Commission, E. (2016). Gran Agreement No. 11.0661/2016/748066/SUB/ENV.C2. Brussels.

Merchant, N.D., Faulkner, R.C., Martinez, R., 2018. Marine Noise Budgets in Practice. Conservation Letters 11(3), e12420. http://onlinelibrary.wiley.com/doi/10.1111/conl.12420/pdf

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
UPC	Universitat Politècnica de Catalunya

1 Introduction.

The QUITMED Project is funded by 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. The Project has the following specific objectives:

- ✓ 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.
- ✓ 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 its objectives, the project is divided in 5 work packages which relationships are shown in Figure 1.

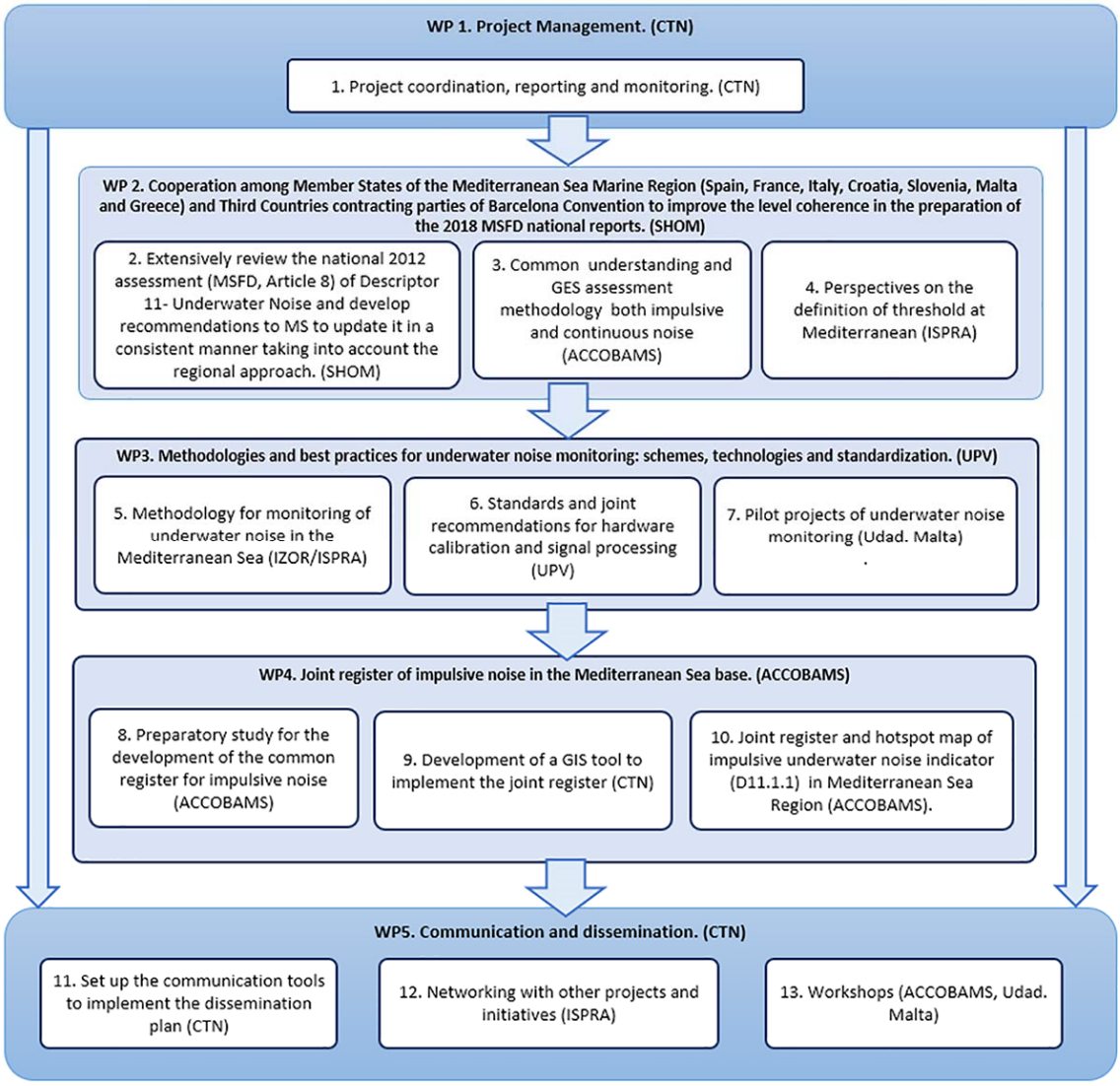

Figure 1. Work Plan Structure

The project is developed by a consortium made up of 10 entities coordinated by CTN and it has a duration of 24 months starting on January 2017.

This document reports about different efforts made by some Member States to achieve a definition of thresholds in relation to underwater noise. It is to be considered as a companion of deliverable D2.3 of QUIETMED. This report D2.2 is largely based upon the outcomes of workshops held in 2016 in Hamburg, 2017, in Torrelodones and 2018 within the TGNoise in Bucharest. It also takes into consideration international scientific literature related to noise

budgets, noise mapping and species-specific noise thresholds. This document is targeted at a non-technical audience, with the aim of supporting decisions by Public Administrations related to the underwater noise issue.

2 Overview of the GES criteria assessment at the Mediterranean basin level. How thresholds have been integrated in the definition of GES.

The Marine Strategy Framework Directive (MSFD) requires European Member States (MS) to achieve or maintain good environmental status (GES) of their national marine waters by 2020.

For descriptor D11, the Commission Decision 2017 requires Member States to establish threshold values to ensure that levels of anthropogenic noise do not exceed levels that adversely affect populations of marine animals. Member States should establish threshold values through cooperation at Union level (taking into account regional or subregional peculiarities).

From the previous assessment of D11 in 2010 emerged that knowledge related to underwater sound was poor and data were generally scarce. The following document is taken into consideration:

In-Depth Assessment of the EU Member States' Submissions for the Marine Strategy Framework Directive under articles 8, 9 and 10. Authors: Andreas Palialexis, Victoria Tornero, Enrico Barbone, Daniel Gonzalez, Georg Hanke, Ana Cristina Cardoso, Nicolas Hoepffner, Stelios Katsanevakis, Francesca Somma, Nikolaos Zampoukas Luxembourg: Publications Office of the European Union 2014 – 149 pp. – 21.0 x 29.7 cm EUR – Scientific and Technical Research series – ISSN 1831-9424 ISBN 978-92-79-35273-7 doi: 10.2788/64014

D11 Art8,9,10 are analysed in depth at pages 138-148. The conclusions herein are:

"Overall the information supplied regarding marine energy and noise was very little as shown by the high percentage of non-reporting on different issues. It can be expected that this situation meanwhile has changed significantly due to the work performed in the Technical group on Noise and the published guidance documents. A quarter of the considered MS did not deliver a GES definition (Art. 9) for Descriptor 11. Baselines or thresholds were almost inexistent. On the other hand, 9 MSs out 20 included other forms of energy in their definitions, but only 2 MS detailed them as light, electromagnetism and changes in temperature. The available information on the Initial Assessment reports (Art. 8) was very limited and mostly focused on lists of potential noises sources. Regarding actual data on underwater noise levels, one Member State claimed to have availability, while 5 MS had some limited data. This fact remarks the non- existence of previous methodological approaches or monitoring programs for the assessment of energy and noise introduction in the marine environment. A total of 7 MS out of 20 did not include Environmental Targets in their reports (Art 10). There was a general lack of baselines and thresholds for the associated indicators. It is clear the difficulty to establish Environmental Targets due to the lack of data and knowledge in the field, as it has been reflected by MS in the definition of GES and the Initial Assessment reports."

3 The definition of thresholds as a challenge. Why and how to integrate thresholds in GES definition.

It is common in European directives to define environmental targets to be achieved. Some of these are put in relation to reference conditions or values. These are often referred to as "natural" or "background" levels. The official documents of the EU suggest that these concepts are applicable to noise as well. However, both for continuous as well as for impulsive noise some issues should be considered.

It is unclear what reference (zero control value) should be used for shipping noise (D11.2): the preindustrial era? Or maybe the state of continuous noise present at the date of coming into force of the MSFD? Some other in-between criterion?

As opposed to continuous noise, for impulsive noise the reference criterion here appears logically quite simple: since impulsive noise as considered in D11.1 is anthropogenic, the reference is simply "zero noise". This means that no impulsive noise generating activities are allowed.

While a solution for finding threshold values for continuous noise seems doable, the "zero" reference for impulsive noise doesn't help further in finding a sustainable-use threshold for D11.1.

The work of the Technical Group on underwater Noise (TG Noise) is relevant in this perspective

(*Management and monitoring of underwater noise in European Seas- Overview of main European-funded projects and other relevant initiatives*. Communication Report. MSFD Common Implementation Strategy Technical Group on Underwater Noise (TG-NOISE). April, 2017) and in the following several approaches shall be presented.

In the CIS Work Programme (2016-2019) TG Noise was tasked to provide further advice to EU Member States on the development of thresholds.

In order to contribute to this process, TG Noise organised a thematic workshop entitled *"Towards thresholds for underwater noise. Common approaches for interpretation of data obtained in (Joint) Monitoring Programmes."* This meeting was hosted by the Spanish Ministry of Agriculture and Fisheries, Food and Environment and took place on 9-10th November in Torrelodones, Spain. The workshop built upon the results of the 2016 Hamburg thematic workshop, where consensus was found on the main directions to better understand the effects of underwater noise and how to develop impact indicators. (*Way forward to define further Indicators for Underwater Noise*. MSFD Common Implementation Strategy - Technical Group on Underwater Noise (TG-NOISE). Thematic Workshop – Final Report , October, 2016.).

3.1 Criteria (framework, process) to take into account for the definition of thresholds.

Different approaches were presented and discussed. Most of them apply to northern European seas with their specific characteristics, the following four are mainly related to impulsive noise.

- **The UK approach based on marine noise budgets**

  N. Merchant (CEFAS) presented a framework based on a recently published paper (Merchant et al., 2018). It combines population or habitat data with data on pressures, within a defined management area, to produce quantified risk maps and exposure curves which can be used as a basis for defining indicators and setting thresholds. This methodology was demonstrated for two case studies in the North Sea (harbour porpoise, spawning herring), based on data from the OSPAR Intermediate Assessment 2017. It is worth noting that, among other, emphasis was put on the fact that indicators need to be designed such that targets/thresholds agreed at appropriate management levels can be implemented by regulators in practice. This will require that indicators are straightforward to communicate to regulators and stakeholders, and that the methodology does not require unrealistic amounts of time or funding to implement. Similarly, the indicators should be aligned with existing and emerging marine management practices, particularly approaches for marine spatial planning and cumulative effects assessment.

- **The Dutch approach using the impulsive noise registry (INR)**

  M. Ainslie (TNO)introduced a methodology to predict the spatial and temporal distribution of the potential for behavioural disturbance. It makes use of the data used in the OSPAR Intermediate Assessment 2017 – the distribution of (loud) sound sources contained in the impulsive noise register (INR). This method has been used by the Dutch government in an assessment of the cumulative effects of the construction of offshore wind farms. The main conclusion of this presentation was that tools are available to produce sound maps using information contained in INR through acoustic modelling. This method naturally combines different source categories (also noise mitigation) into one meaningful map. If an assumption is made on the received level at which a specified effect may occur, e.g. disturbance, it is possible to map the area of potential disturbance. This area of disturbance can then be combined with distribution data of sensitive species. Modelling in a variety of contexts shows that the size of predicted disturbed areas varies greatly, and may be larger or much smaller than the ICES sub-grid cells.

- **The German proposal for an impact indicator based on impulsive noise**

  Liebschner (Bundesamt fuer Naturschutz) introduced a way to define an impact for impulsive noise by quantifying the overlap of a species (e.g. harbour porpoise) and anthropogenic impulsive sounds exceeding specifically defined levels (e.g. Sound

Exposure Level of 140 dB) that disturb/displace individuals of that species, over determined areas within selected periods ('individual-disturbance-days').

An example using grid cells was presented to demonstrate the methodology of the proposed indicator. The logical steps are delimitation of an area (convention area, sub-region, EEZ, national waters, ecological important areas, etc.), selection of a period (e.g. year), determination of number of individuals in the area in the period concerned (e.g. based on existing monitoring data). Next the number of 'individual-days' is calculated; then number of days different parts of the area are impacted by disturbing anthropogenic impulsive noise is calculated, using defined thresholds; in the example these parts of the of the area were grid cells, but they may be other forms/polygons. These figures were combined to first calculate total individual-disturbance-days and then the intensity of impact, i.e. the proportion/percentage of total 'individual-days' that are 'individual-disturbance-days'.

- **A second UK proposal based on the information contained in the noise registry.**
  M. Tasker (Co-Chair TGNoise) suggested to consider the % of unit area affected by an impact with relation to a particular species with known distribution (eg harbour porpoise). The area can be SAC or another unit; based on biological assessment and can involve analysis of persistence.

The above approaches are all based on the principle of overlaying noise registry information in some format with species distribution data, in effect an exposure assessment by comparing the distribution of sounds with that of marine life. The species data could be absolute or relative density, or distribution range with an added measure of habitat importance/quality. In all cases the indicator species considered was the harbour porpoise.

- **France (SHOM) presented an articulated approach to D11C1.**

The assessment of D11C1 is based on a two-step decision three. It uses three indicators: spatial repartition (in ICES rectangles), temporal repartition (in days per period) and source level categories (following categories of TG Noise). Then, **temporal and spatial TVs** have to be defined for each source category.
The first step concerns the temporal extend per ICES rectangle: the number of days of emissions of sources from one category in one ICES rectangle over the period has to be below a **temporal TV** defined for a MRU and constant over the period.
The second step concerns the spatial extends over the MRU (Marine Reporting Unit): the number of ICES rectangle where the **temporal TV** is exceeded has to be below a **spatial TV** defined for a MRU and constant over the period.
To guarantee the assessment of GES regarding D11C1 at the MRU scale, a one-out all-out (OOAO) aggregation is performed over the categories and over the periods.
The considered period to assess the methodology is a trimester, as studies show that seasons may be of a great influence on the ecosystems.
To simplify the methodology, the categories proposed in the TG noise monitoring guidance are merged into two regarding the French GES definition:

- ✓ all the categories: all the emissions are considered in relation to the **risk of a population displacement;**

- ✓ high and very high categories: only the more powerful emissions are considered in relation to the **risk of stranding**.

The decoupling of temporal and spatial distributions is of great importance as the management of these dimensions differs strongly. The spatial displacement of an emission may not be possible whereas temporal planning may be easier to apply.

Continuous noise poses additional challenges, in that it is ubiquitous in European seas, be it as a weak background level, be it as a strong nearby noise from passing ships. How this type of noise interacts with marine life is under investigation, some clear effects (eg masking/loss of communication space) are evident, some others, such as percentual loss of habitat, are less well studied. All information available is that both impulsive noise as well as continuous noise cause some sort of habitat degradation. The challenge is to link the pressure posed by underwater noise to potential population impacts. As the information derived both from impulsive noise registries as well as from monitoring programs will become gradually available, some population impacts will become measurable. It is important that temporal and spatial scales will be taken into account for the assessment of impacts. Also, the choice of indicator species will need to be agreed upon, although at present only very few species were studied (with the harbour porpoise being the flag species in northern Europe), despite repeated EU indications (Borsani et al. , 2015). Since indicator species cannot be avoided, for some areas with high biodiversity (such as the Mediterranean Sea) one should start thinking of defining a “generic receiver”. Potentially, the generic receiver is an organism that is sessile and cannot efficiently escape noise.

Approaches for continuous noise included the following three: two are presented by France (one on behalf of BIAS, the other by SHOM) and one by UPC, Spain.

T. Folegot (QuietOceans) introduced the use of BIAS soundscape tool developed by the EU LIFE project Baltic Sea Information on the Acoustic Soundscape (BIAS) for quantifying the pressure from ship noise in the Baltic Sea. The planning tool can be the basis for study of the impact on marine animals once thresholds for impact are established.

The soundscape tool is based on measured and modelled soundscape data and provides a number of functions to evaluate the spatial and temporal sound characteristics within a user-defined geographical area. The tool is based on several hundred soundscape maps covering different frequencies, depth intervals and exceedance levels, where e.g. 5% exceedance level describes the highest SPL in an area that occurred 5% of the time (this will give the strongest sources in the area) and 90% exceedance level will represent SPL 90% of the time (this level will often represent the background noise level).

Two main assessment methods are implemented in the tool. Both are designed to assess the pressure during a certain time and in a specific area. The data from these assessments can later be used to study the impact on marine life or to establish if a threshold for impact was exceeded or not.

France (SHOM) presented the following approach to D11C2.

The methodology for the assessment of D11C2 for France is made only using modeling of the shipping noise (CABAT model). Opportunistic measurements were used to validate the model. The model uses a statistical approach to reduce the uncertainty on the environment properties and in the AIS data.
Shipping noise levels (SNL) are computed in ICES rectangles for four months representing the seasons, at several depths and for the one-third octave bands. For each ICES rectangle, only the **maximal values per depth and per season** are conserved, leading to **an annual 2 D map of the SNLs**. This is a conservative approach of the pressure. These are computed using Lloyds AIS data, completed by VMS data, for years 2012 and 2016.
The indicator is the **median spatial trend** per MRU between these two years for both one-third octave bands. TVs have then to be defined for both one-third octave bands, and each MRU. An OOAO aggregation method is proposed for the assessment of the GES.

M. André (UPC) This presentation introduced a relatively new bioacoustics-based approach – the Bioacoustics Based indicator (BBI). This method is not species dependent and does not rely on gathering new data on species sensitivity to noise (thresholds) to be implemented. It is global (pan-European) and transversal by combining MSFD D11.1 and MSFD D11.2 objectives to address both impulsive and tonal (continuous) sources. It does not rely on static thresholds but on monitoring trends (changes in the soundscape) that can be assessed on a variety of timescales (hourly/daily/weekly/seasonally/yearly). It provides the MSFD a regional noise budget approach for GES; biological and anthropogenic activities are comparatively assessed, and it can be based on MSFD D11.2 existing/planned monitoring stations.

- **Additional information, BSPII**
  The HOLAS II Workshop on the Baltic Sea Pressure and Impact Indices discussed improvements proposed to the data layer 'Input of continuous anthropogenic sound', which is used in the Baltic Sea Pressure and Impact Indices (BSPII). The workshop noted that the layer would need to be further refined, and recommended that the Secretariat and Sweden work on a proposal, including guidance from EN-Noise.
  Based on the workshop recommendation, Sweden initiated and led a drafting group to elaborate on the issue and provide a proposal on how to define the layer. The drafting group included experts from Denmark, Estonia, Finland, Germany and Sweden, who have been involved in producing the data used in the layer via the BIAS project. In 2018 Sweden presented the following paper:
  Anderson, M., Sigray, P., Lalander, E., Fischer, J., Tougaard, J., Pajala, J., Klauson, A., Laanerau, J.
  2018. Proposal for a continuous anthropogenic sound level layer. HOLAS II BSPI BSII WS 1-2018.
  It provides evidence that an interim layer for the Baltic Sea Pressure index is introduced: "For the Baltic Sea Pressure Index (BSPI), data from the BIAS project (www.bias-project.eu) could be used where measured and modelled acoustic data is provided as Sound Pressure Level (SPL). However, decisions needs to be made for what SPL should

be used for the normalization corresponding to index 0 and 1 levels, as well as what BIAS maps to apply this normalization on. Based on information from HELCOM, the index 0 represent no pressure and index 1 the maximum pressure i.e. maximum value in the map layer.”.

4 An approximation to the definition of thresholds. Basic principles.

As a partial outcome of the documents and literature considered above, some basic considerations emerge with respect to the definition and implementation of threshold values for defining achievement of GES. These are by no means exhaustive and discussions in this regards are ongoing as both science as well as public awareness progress within the EU with the adoption of the Marine Strategy Framework Directive (MSFD).
In particular, when the process of defining threshold values (TVs) is started, it is deemed important that:

a) TVs are both understandable as well as applicable for the Regulator.
b) TVs are defined in a way so that they can be realistically implemented and can be accepted by the stakeholder.
c) TVs are based on solid evidence of impacts upon populations.
d) TVs are based on scientific expert advice.