mspmed

Case study between Spain and France: Planning the offshore Gulf of Lion with respect to the ecosystems

D11 – Underwater noise Workshop report

May 10th, 2022
Mediterranean Centre for Marine and Environmental Research (CMIMA, CSIC) – Barcelona (Spain)

ACKNOWLEDGEMENT
The work described in this report was supported by the European Maritime and Fisheries Fund of the European Union- through the Grant Agreement number 887390 - MSPMED - EMFF-MSP-2019, corresponding to the Call for proposal Call EMFF-MSP-2019 (Maritime Spatial Planning) Topic: EMFF-MSP-2019 Type of action: EMFF-AG for Projects on Maritime Spatial Planning (MSP).

Project Full Title	**Towards the operational implementation of MSP in our common Mediterranean Sea**
Project Acronym	**MSP-MED**
Gant Agreement Nr.	**887390**
Project Website	**www.mspmed.eu**

Deliverable Nr.	**D11**
Status (Final/Draft/Revised)	**Final**
Work Package	**WP2 – Setting-up of maritime spatial plans**
Task Number	**Task 2.2 – Sub-task 2.2.3 Spain: Report of stakeholders' underwater noise workshop**
Responsible Institute	**IEO,CSIC**
Author/s	**Mónica Campillos-Llanos, Cristina Cervera-Núñez, Elena Gutiérrez-Ruiz, Manuel Bou-Cabo**
Recommended Citation	**Campillos-Llanos, M., Cervera-Núñez, C., Gutiérrez- Ruiz, E., Bou-Cabo, M. 2022. Underwater noise workshop report. Deliverable nº 11 of the MSPMED Project (887390 – MSPMED – EMFF-MSP-2019). 67pp.**
Dissemination Level (Public/Partnership)	**Public**

Document History			
Version	**Date**	**Modification Introduced**	
		Modification Reason	**Modified by**
1 Draft 0	May 2022	Creation	Mónica Campillos-Llanos (IEO,CSIC)
2 Draft1	June 2022	Revision	IEO,CSIC
3 Final	July 2022	Finalization	Cristina Cervera- Núñez (IEO,CSIC)
4			

INDEX

Co-funded by the European
Maritime and Fisheries Fund

Acronyms

ACCOBAMS	Agreement on the Conservation of Cetaceans of the Black Sea, Mediterranean Sea and contiguous Atlantic Area
AIS	Automatic Information System
ASI	ACCOBAMS Survey Initiative Project
CA	Competent Authority
CCH	Critical Cetacean Habitats
CEA	Cumulative Effects Assessment
CIA	Cumulative Impact Assessment
CEDEX	Center for Studies and Experimentation of Public Works
CIS	Common Implementation Strategy
CNR-ISMAR	National Research Council - Institute of Marine Science (Italy)
CTN	Marine Technology Centre (Spain)
dB	Decibels
DGBBD	General Directorate General of Biodiversity, Forests and Desertification
DGCM	General Directorate of the Coast and the Sea
DG MARE	Directorate-General for Maritime Affairs and Fisheries
DST	Decision Support Tool
ECAP	Ecosystem Approach
EBA	Ecosystem Based Approach
EBSAs	Ecologically or Biologically Significant Marine Areas
EIA	Environmental Impact Assessment
ENL	Excess Noise Level
EU	European Union
GA	Grant Agreement
GES	Good Environmental Status
GFCM	General Fisheries Commission for the Mediterranean
IMMA	Important Marine Mammal Areas
IMO	International Maritime Organization
IMAP	Integrated Monitoring and Assessment Programme

IMP	EU's Integrated Maritime Policy
LSR	Listening Space Reduction
LOSE	Level of Onset of biologically Significant adverse Effects
MS	Member State
MED	Italian National Institute for Environmental Protection and Research Mediterranean
MITERD	Ministry for the Ecological Transition and the Demographic Challenge (Ministerio para la Transición Ecológica y el Reto Demográfico)
MPA	Marine Protected Area
MRU	Marine Reporting Unit
MSFD	Marine Strategy Framework Directive
MSP	Maritime/Marine Spatial Planning
MSPD	Maritime Spatial Planning Directive
OWF	Offshore Wind Farms
PAM	Passive Acoustic Monitoring
POEM	MSP Spanish Plan (Plan de Ordenación del Espacio Marítimo)
PSSA	Particularly Sensitive Sea Area
PU	Planning Units
RSC	Regional Sea Conventions
OWF	Offshore Wind Farms
SEA	Strategic Environmental Assessment
SPL	Sound Pressure Level
SPAMI	Special Protection Areas of Mediterranean Importance
SWOT	Strengths, Weaknesses, Opportunities, and Threats
TG	Technical Group
TL	Noise Transmission Loss
TV	Threshold Value
UK	United Kingdom
UNEP/MAP	United Nations Environment Program/ Mediterranean Action Plan
UPV	Polytechnic University of Valencia
URN	Underwater Radiant Noise

UWN	Underwater Noise
WG	Working Group
WP	Work Package

Co-funded by the European
Maritime and Fisheries Fund

UNDERWATER NOISE WORKSHOP REPORT – Gulf of Lion Case Study

Tuesday, May 10th, 2022 – 9:30 – 17:00

In the framework of the MSPMED project (*Towards the operational implementation of Maritime Spatial Planning in our common Mediterranean Sea*), an underwater noise (UWN) workshop was held on May, 10th 2022, in a hybrid format, to involve underwater noise experts from Spain, France and Italy to share different experiences on how to assess and evaluate underwater noise in the application of the Marine Strategy Framework Directive (MSFD) policy and share initiatives and projects related to this topic.

For this reason, 44 participants from different fields assisted to the event: (1) underwater noise experts, (2) marine mammals' experts, (3) Marine Spatial Planning (MSP) experts and (4) MSP competent authorities.

The workshop was structured in two parts: Part 1 was focused in the presentation by different underwater noise experts, of studies and activities regarding underwater noise, including MSPMED activities related to underwater noise (Gulf of Lion case study) and projects and initiatives developed by Spain, France and Italy in regards to underwater noise (including MSFD). Part 2 of the event was dedicated to underwater bio-acoustic monitoring. For each part, a dialogue among participants was carried out to share their experiences, doubts and thoughts.

1. Context

Underwater noise generated by maritime activities (i.e. maritime traffic) is proven to adversely affect the marine environment producing different types of effects on the pelagic component, especially on cetaceans. During the last decades, several effects of noise on marine organisms such as mortality, hearing impairment, communication masking and behaviour disturbance has been increasing. In this sense, UWN has become a hot topic for environmental managers and regulators in Europe and beyond[1]. Therefore, the Marine Strategy Framework Directive (MSFD[2]) includes it as one of the qualitative descriptors (Descriptor 11) for determining the Good Environmental Status (GES), the introduction of energy, including underwater noise, at levels that do not adversely affect the marine environment.

Underwater noise anthropogenic sources are commonly related to maritime transport, deep-sea mining, fishing, and construction. Some human activities could affect adversely to mobile species, especially cetaceans. One of the activities with higher future prospects is offshore wind energy, which has already been considered in the Integrated Maritime Policy (IMP) and in the objectives of the European Green Deal, as one of the sectors that foresees a big development in the upcoming years. However, the effects of these activities on the marine environment still need to be studied and analysed, including underwater noise pressures that may have a negative impact on the species present in the areas where Offshore Wind Farms (OWF) are planned to be deployed.

To evaluate cumulative effects in the ecosystem, the effects of noise pollution caused by human activities need to be assessed and considered in the corresponding Cumulative Impact Assessment (CIA) and, eventually, in the Environmental Impact Assessment (EIA). The consideration of all the effects generated by an activity is essential for an effective and realistic CIA to inform Maritime Spatial Planning (MSP). Cumulative Effect Assessment (CEA) and CIA assessments in MSP provide a way to ensure that MSP considers all pressures[3] identifying areas of great concentration of pressures and high impacted ecological components, therefore proposing measures to reduce these impacts, reallocating activities and/or proposing specific management measures. Most European countries now have regulatory frameworks to manage noise and tools to integrate underwater noise into Marine Spatial Planning. However, further efforts are needed to put some of these into practice and to fully test their effectiveness[1].

[1] Thomsen, F., Mendes, S., Bertucci, F., Breitzke, M., Ciappi, E., Cresci, A. Debusschere, E., Ducatel, C., Folegot, F., Juretzek, C., Lam, F-P., O'Brien, J., dos Santos, M. E. (2021) Addressing underwater noise in Europe: Current state of knowledge and future priorities.(eds: Kellett, P., van den Brand, R., Alexander, B., Muniz Piniella, A., Rodriguez Perez, A., van Elslander, J., Heymans, J. J.). Ostend, Belgium, European Marine Board, 56pp. (European Marine Board Future Science Brief 7). DOI: 10.5281/zenodo.5534224.

[2] 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).

[3] Maria Luz Fernandes, Lisa P. Sousa, Adriano Quintela, Márcia Marques, Johnny Reis, Ana Paula Simão, Ana T. Castro, José Manuel Marques, Fátima L. Alves, Mapping the future: Pressures and impacts in the Portuguese maritime spatial planning, Science of The Total Environment, Volume 715, 2020, 136863, ISSN 0048-9697, https://doi.org/10.1016/j.scitotenv.2020.136863.

For this purpose, EU MSP transboundary projects are the best opportunity to create a first link among countries at a technical level, which in the long term may lead to real cooperation at joint decision levels and to integrate results (coming from case studies) as recommendations into MSP national processes. The importance of these pilot projects lies in their usefulness as laboratories dedicated to build the necessary technical capacities to ensure the proper implementation of the MSP Directive (MSPD[4]). The results obtained should support and can be implemented in the MSP national process.

2. Case study Spain and France: Gulf of Lion

In the framework of the MSPMED project, a transboundary pilot case study (task 2.2.) is being developed by the Spanish and French partners: Instituto Español de Oceanografía (IEO,CSIC) and Office Français de la Biodiversité (OFB), respectively, in the "Gulf of Lion" area, lying from the south of Barcelona to Marseille, although assessments and reflections could concern the whole West-Med sea basin.

The case study aims at providing a common and updated knowledge about ecological stakes in the Gulf of Lion and their interactions with human activities, concretely with offshore windfarms (OWF). In line with the importance of conducting a coordinated and coherent transboundary MSP process, the Gulf of Lion case study, thus has several objectives:

- Sub-task 2.2.1: To build and promote a global view of ecological stakes and their evaluation in the Gulf of Lion, especially related to cetaceans, sea turtles, seabirds and deep habitats;
- Sub-task 2.2.2: To provide knowledge about interactions between Mediterranean ecosystems and maritime uses, with a specific focus on windfarm development in the Gulf of Lion area;
- Sub-task 2.2.3: To assess the effects of noise pollution caused by intense activities, such as maritime transport and offshore windfarms, on the pelagic component and especially on cetacean species.

The sub-task 2.2.3 aims to analyse underwater noise generated by marine traffic, which is proven to adversely affect the marine environment producing different types of effects on the pelagic component, especially on cetaceans. With this regard, underwater noise has been analysed using Automatic Information System (AIS) data from maritime traffic to generate underwater noise propagation models in the Gulf of Lion. In addition, a tentative assessment on a hypothetical pilot Offshore Windfarm (OWF) has been modelled to evaluate how underwater noise from OWF could also have an effect on the marine environment, in addition to the noise produced by maritime traffic (resulting in Deliverable 9 – soon to be available in https://mspmed.eu/). Next step will be to overlap underwater noise propagation models with cetacean distribution present in the case

[4] Directive 2014/89/EU of the European Parliament and of the Council of 23 July 2014 establishing a framework for maritime spatial planning.

study area to evaluate how underwater noise is affecting these species (resulting in *Deliverable 10: Knowledge synthesis and scenario testing about interaction between noise-causing uses and Mediterranean biodiversity (species)* - planned for June, 2022).

3. Objectives of the workshop

The Marine Strategy Framework Directive includes underwater noise, as one of the qualitative descriptors (Descriptor 11) for determining the Good Environmental Status (GES), the introduction of energy, including underwater noise, at levels that do not adversely affect the marine environment. This means that the evaluation and analysis of cumulative effects from what could have a significant impact on the marine environment is necessary, including the impacts in a transboundary context. The analysis of cumulative effects in the marine environment have a clear connection to MSP. This implies that a better analysis of the impacts of human activities into the marine environment and the application of an ecosystem-based approach (EBA) could help in the development of the spatial and temporal distribution scenarios of human activities at sea and to provide recommendations to be included in the MSP plans.

With this purpose, this technical meeting aimed to value and share underwater noise assessments, methodologies and initiatives. In addition, the case study conducted in a transboundary context could help to (i) assess cumulative impacts in the Gulf of Lion due to maritime traffic and OWF, and to (ii) assess the effects and possible impacts on cetacean species at an appropriate scale.

4. Underwater noise workshop

Welcome and introduction

Mónica Campillos-Llanos (IEO, CSIC) welcomed all participants, both in presence and connected online, in Barcelona. Following, she explained the agenda of the workshop (*annex I*).

Co-funded by the European
Maritime and Fisheries Fund

Part 1 – Studies and activities on underwater noise

MSPMED activities related to underwater noise

MSPMED project and Gulf of Lions Case Study – Mónica Campillos (IEO, CSIC)

Mónica Campillos part of the MSP team at the Spanish Institute of Oceanography, established the context of the workshop through a brief presentation of the MSPMED project (objectives, partners, budged and work packages) and the information of the case study of the Gulf of Lions (objectives, tasks developed and Work Package (WP) in which this workshop is included).

The MSPMED project (*Towards the operational implementation of MSP in our common Mediterranean Sea*) is co-funded by the European Commission – DG for Maritime Affaires and Fisheries (DG MARE). Its two main objectives are:

- To support Member States with the implementation of the MSP Directive (2014/89/EU Directive – Maritime Spatial Planning).
- To promote transboundary cooperation in the establishment of Maritime Spatial Planning (MSP).

The project started in March, 2020 and will finish in October, 2022. The consortium is composed by 11 partners from Spain, Italy, Greece, France, Malta and Slovenia. The budget is 3.135.916,25 € and it is divided in 5 Work Packages (WP):

- WP1: Coordination & Management
- WP2: Setting-up of Maritime Spatial Plans
- WP3: Data use and sharing
- WP4: Cooperation among Member States and Third Countries
- WP5: Communication & Dissemination

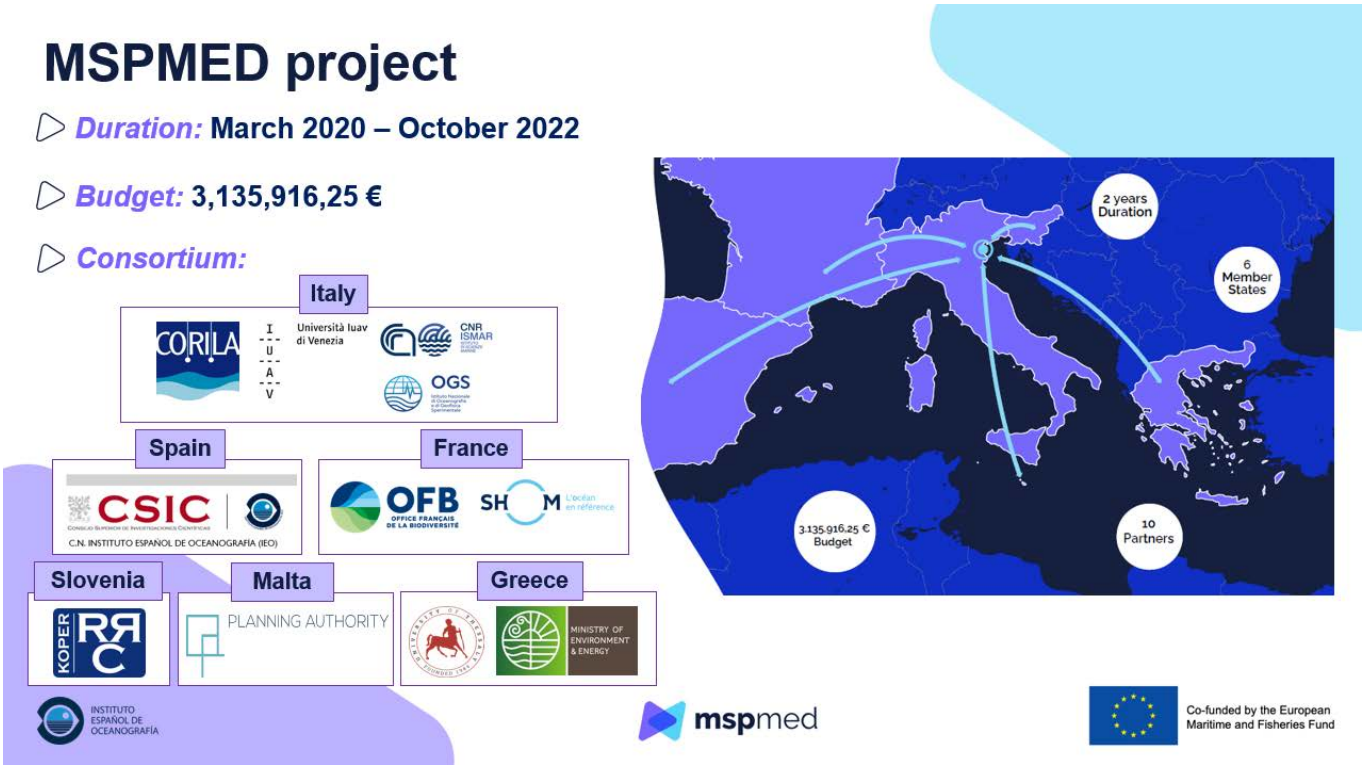


Figure 1. MSPMED project main details. Source: MSPMED project.

To develop the WP2 and support the establishment and implementation of Maritime Spatial Plans, MSPMED develops pilot case studies in different areas of the Mediterranean Sea.

One of these cases studies is the case study between Spain and France developed by IEO(CSIC), OFB and with the support of French Marine Energies (FEM)), for Planning the offshore Gulf of Lion with respect to the ecosystems (WP2 – task 2.2).

Figure 2. Gulf of Lion case study in the context of MSPMED project. Source: Spanish Institute of Oceanography.

The works developed in this case study were focus in:

- The production of a knowledge synthesis about ecological stakes in the Gulf of Lion by OFB and IEO (CSIC) (Subtask 2.2.1).
- The creation of a knowledge synthesis about interactions between offshore windfarms and Mediterranean ecological stakes by OFB, FEM and IEO (CSIC) (Subtask 2.2.2).
- The estimation of noise propagation and noise pollution effects in the pelagic realm by IEO (CSIC) and contributions of SHOM (Subtask 2.2.3) (where the present workshop is included).

QUESTIONS:
There were no questions.

Underwater noise in the Gulf of Lions Case Study – Manuel Bou (IEO, CSIC)

Manuel Bou, expert on underwater noise from IEO(CSIC), presented the work conducted within the MSPMED project regarding underwater noise assessment in the Gulf of Lion. He started by differentiating between impulsive and continuous noise. There are many sources of underwater noise (UWN). Noise can produce potential harm in the marine environment. In the case of the Gulf of Lion, this noise could affect the cetacean-rich transboundary area among France and Spain.

Regarding the methodology followed to analyse ship traffic and windfarm operation, the difference between them is the treatment of the noise coming from the windfarm. The idea is to transfer this information into noise maps.

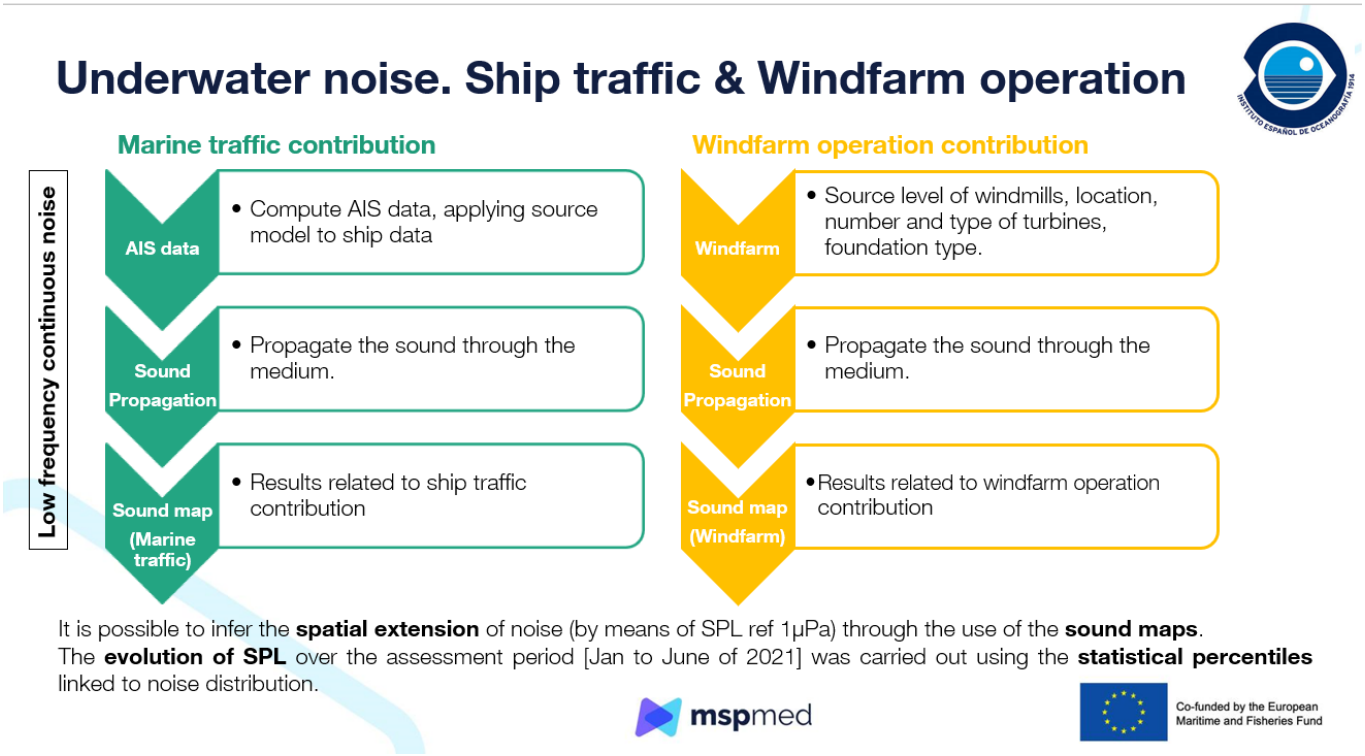


Figure 3. Methodology developed to analyze underwater noise in the Gulf of Lion. Source: Spanish Institute of Oceanography.

In this specific study only anthropic sources were considered, both, sources originated by ship traffic and the one generated by the operation of windfarms. Regarding the methods used to evaluate the contribution of each source to the UWN, it should be noted that the methodology is the same for both, although the source is different. The aim was to obtain a soundmap where the analysis of each effect separately and altogether could be carried out.

Statistical percentiles are used to show the evolution of the noise sources during the assessment period (January to June, 2021), considering frequency bands from 63Hz and 125 Hz, taking snapshots of AIS navigation data each 6h and the time basis of the soundmap is one soundmap/day. Ships as an acoustic source are difficult to study because, apart from the external noises related to the speed, size, etc., there are numerous sources of internal noise, difficult to assess the suitability of the sound propagation models depends on signals, bathymetry, depth frequency, etc. In this case, the propagation model applied considers the seasonally dependence of water column sound velocity. The Sound Pressure Level (SPL) is calculated at each grid cell of the soundmap and the percentage of time that each gridcell is above a given threshold value (from the 70, 90 and 99 percentile) is studied.

Regarding underwater noise analysis made for tentative windfarm operation, there are several studies about the windfarm noise that are anchored but not on the floating windmills. One of this analysis is *Hywind Scotland Pilot Park Project*, which has been use to analyse this underwater noise model. The tentative installation of 8 windmills was simulated assuming a constant radiation during the assessment period. More realistic calculation should consider the dependence of acoustic radiation with respect to the weather conditions (specially with the wind).

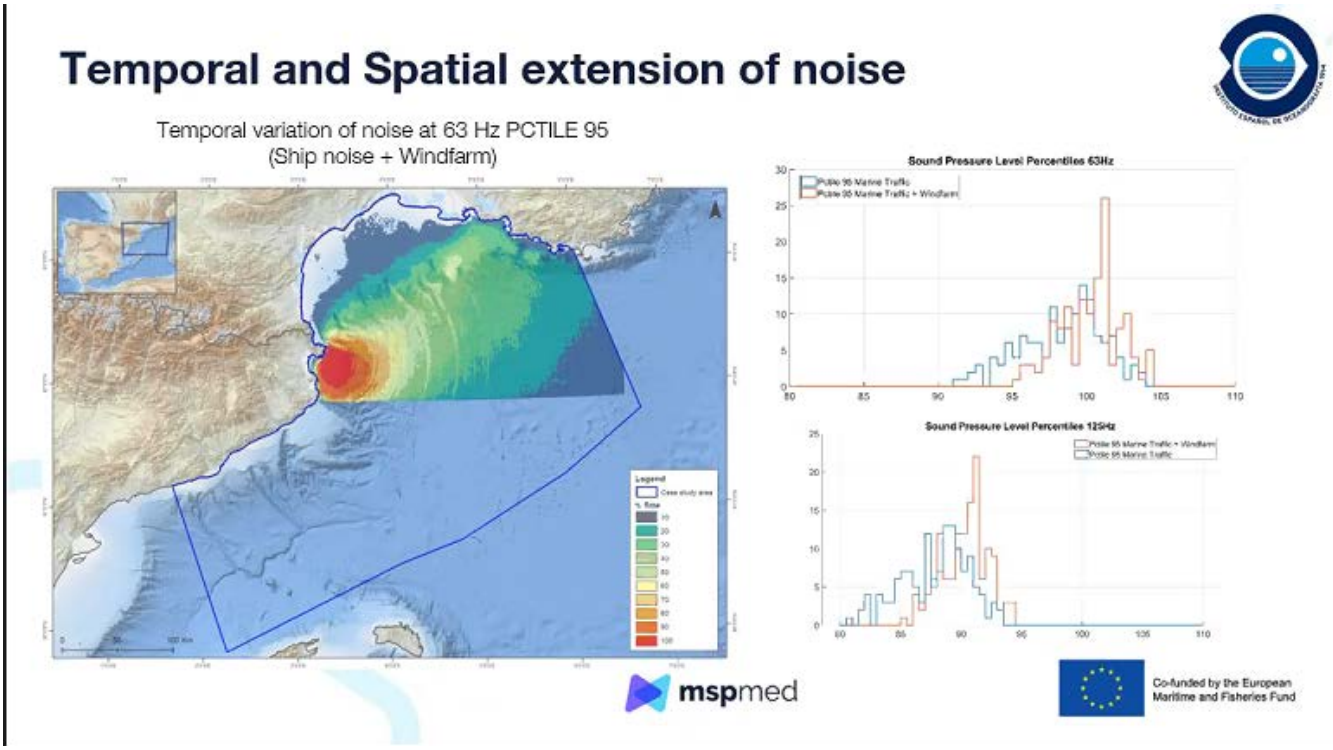


Figure 4. Tentative analysis of underwater noise by OWF in the Gulf of Lion. Source: Spanish Institute of Oceanography.

The ongoing work focuses on applying a risk-based model to study the potential masking over the different species present in the Gulf of Lion. To perform this study, a methodology based on the communication distance reduction[5] will be applied.

This approach considers:

- Selection of Habitat (ASI abundance data will be used).
- Calculation of reference condition (RC).
- Evaluation of Current Condition (CC).
- Adverse effect considered, masking.

[5] Bou-Cabo, M.; Lara, G.; Gutiérrez-Muñoz, P.; Saavedra, C.; Miralles, R.; Espinosa, V. A Risk-Based Model Using Communication Distance Reduction for the Assessment of Underwater Continuous Noise: An Application to the Bottlenose Dolphin (*Tursiops truncatus*) Inhabiting the Spanish North Atlantic Marine Demarcation. *J. Mar. Sci. Eng.* **2022**, *10*, 605. https://doi.org/10.3390/jmse10050605

- Excess level measured by means of percentage of communication distance reduction.

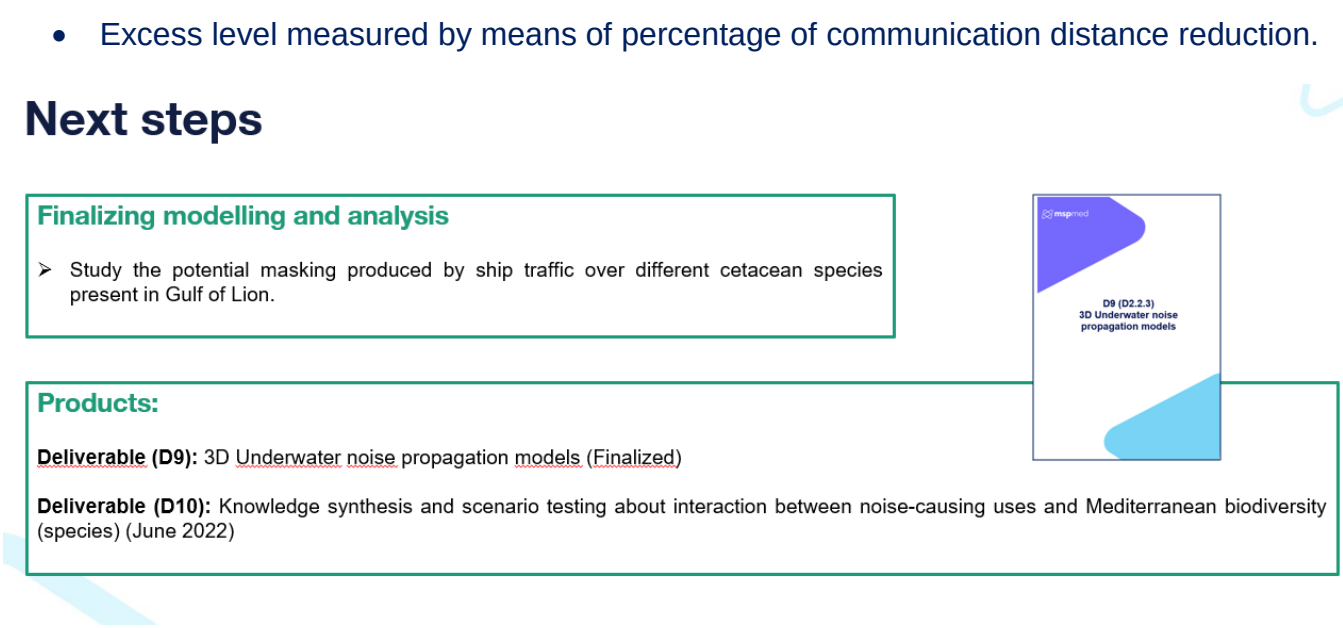


Figure 5. Next steps in the work being carried out in the Gulf of Lion. Source: Spanish Institute of Oceanography.

QUESTIONS:

Federica Pace (Technical Projects Lead Underwater acoustics / Bioacoustics JASCO) considered the work carried out as really interesting. She pointed out that Equinor had just made available a report on the underwater sound levels[6] JASCO Applied Sciences (UK) Ltd measured for the *Hywind Scotland Floating Offshore Wind Farm*, which is the full-scale project.

Maïté Hernández (General Directorate of the Coast and the Sea (DGCM) from the Ministry for the Ecological Transition and the Demographic Challenge (MITERD)) wanted to remark a question because it seemed that the impacts of the windfarms may be higher than the ones from shipping. Manuel Bou (IEO,CSIC) answered that it is difficult to say if the impact of sound is higher or lower, because it is just a simulation. The histograms show that in percentile 95 the sound increases a lot. What it seems to increase a lot is the soundscape in terms of source level emitting in a continuous way, in the same location, but it is difficult to say if there is more affection because we are not considering yet the different factors that could affect (such as the distribution of animals, their habitats, etc.). Probably we will have more sound and the spatial distribution could change with respect to the shipping traffic distribution, but speaking about the impacts is difficult.

Maïté Hernández (DGCM, MITERD): There are still uncertainties about the sound coming from OWF. She had another question; given the aim of the project (MSPMED), she wondered if Manuel

[6] Burns, R.D.J., S.B. Martin, M.A. Wood, C.C. Wilson, C.E. Lumsden, and F. Pace. 2022. Hywind Scotland Floating Offshore Wind Farm: Sound Source Characterisation of Operational Floating Turbines. Document 02521, Version 3.0 FINAL. Technical report by JASCO Applied Sciences for Equinor Energy AS.

is thinking of modelling the small ships, because she does not know how big the fishing impact is, but it is a sector regarding MSP and also, she thinks that a lot of deep diving species live around the canyons of the Gulf of Lion. Would it be interesting to consider the noise coming from small ships? Although it is difficulty without ASI data for small boats. Manuel Bou (IEO,CSIC): When you are modelling any kind of situation, you assume some uncertainties. For example, in the maps presented, noise due to weather conditions has not been considered. We are probably underestimating the noise in some areas, especially in areas where fishing boats are operating. Having VMS and AIS data of every boat would be interesting because these boats contribute to the amount of sound, and models will be probably better.

Projects/initiatives related to underwater noise

H2020 - Saturn project: developing tools to support decision-making on Underwater Radiated Noise (URN) assessment and mitigation – Thomas Folegot (QO) / Fantina Madricardo (CNR-ISMAR)

Thomas presented SATURN project, one of whose work packages (WP) is developing an MSP tool for the prediction and mitigation of underwater noise.

The main objectives of the project are:

- To develop guidelines for an improved MSP process that would consider the underwater sound pressure from a diversity of activities and its effects on the marine fauna.
- To demonstrate the MSP process to assess risks and as a decision-making tool to coordinate maritime activities such as minimizing impacts of sound on marine life.

The methodology to develop it is focused in three main tasks:

- To develop risk and mitigation scenarios in the Northern Adriatic Sea
  - Gathering data layers from Soundscape Adriatic project
  - Gathering new knowledge for other SATURN work packages on ship sound and effects on species
  - Gathering data about existing and future maritime activities
  - Gathering data on species of concern, commercially valuable and charismatic
- To upgrade the Marine Spatial Planning tool
  - To define relevant metrics
  - Technical development to include sound and its effects to marine fauna
  - Tests and validation
- To develop noise policy case studies
  - Full-scale application of the sound-enhanced MSP in the northern Adriatic Sea
  - Evaluation of the tool

The North Adriatic is an interesting place for the project due to its highly vulnerable biodiversity and the number of Natura 2000 sites and protected areas. Human activities are increasing, such tourism and shipping.

The project made over one-year continuous measurements on 9 stations to calibrate statistical sound maps from different layers (surface, deep and entire water column) and maps of natural and shipping sound maps and excess sounds maps (shipping sound above natural sound). All have been populated into a Tools4MSP Geoplatform.

Gathering data for the MSP process has been tricky because everything is linked (*figure 6)*. The sound maps could be divided into categories in order to produce different kind of maps to evaluate the contribution of each category. And then produce a catalogue of sound maps.

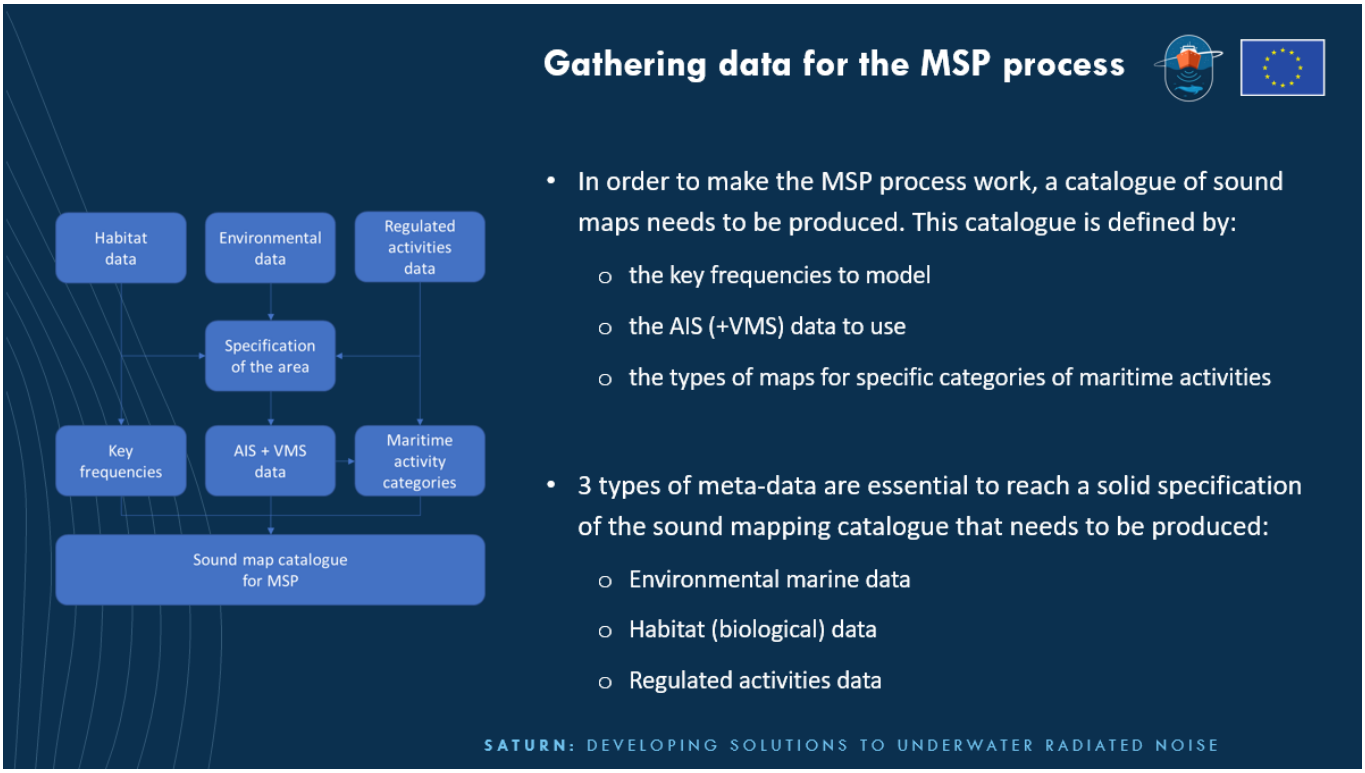


Figure 6. Gathering data for the MSP process. Source: SATURN project.

Sound pressure levels (SPLs) may not be sufficient as an exploitable metric for the MSP process, so a number of candidate metrics are valuable: baseline excess level, activity excess level, pressure index and exposure index.

Within Jonas project methodology to calculate pressure indicators., you could select an area, the key species and the effect you want to study and then select the sound metric, the Onset level and calculate the pressure indicator to calculate the SPL. It is a complex mechanism although it is now totally developed.

Conclusions:

- The SATURN project is going to develop a methodological framework to include the effect of sound into a Marine Spatial Planning process.
- The technical development is based on linking both specialized platforms Quonops© Online Services (Quiet-Oceans) and CEA Tools4MSP (CNR-ISMAR)
- The Northern Adriatic Sea is an ideal area to demonstrate the capabilities for the area hosting increasing pressure from maritime activities and a unique and fragile biodiversity.

QUIETSEAS project and case studies – Maylis Salivas (ACCOBAMS) & Benjamin Olivier (Shom)

Maylis Salivas from ACCOBAMS presented the general context of the Quietseas project.

Quietseas aims to assist regional cooperation for the practical implementation of the MSFD second cycle by providing methods and tools for D11 (D11C1 and D11C2). It is a 2 years project, coordinated by the Marine Technology Centre (CTN) in Spain.

The project is divided into four thematic blocks, subdivided in specific objectives, which are:

- TB1: Indicators and thresholds
  - S01: To identify relevant indicators for criterion D11C2 (Anthropogenic continuous low-frequency sound in water).
  - S02: To promote the consolidation and support the operationalisation of indicators for D11 in close coordination with TG Noise.
  - S03: To promote harmonisation of regional work on threshold values with TG Noise recommendations.
- TB2: Coordinated (sub)regional assessment
  - S04: To develop effective and efficient mechanisms for GES assessment and regional coordination by providing management tools for harmonization, reporting and assessment of D11
- TB3: Measures
  - S05: To demonstrate the potential effectiveness of coordinated mitigation measures to reduce shipping noise.
- TB4: (Sub)regional cooperation
  - S06: To promote (sub)regional cooperation to ensure i) coordination across the region/ subregions ii) the involvement of Competent Authorities iii) long-term dissemination of the results.

9 activities are developed (*figure 7*):

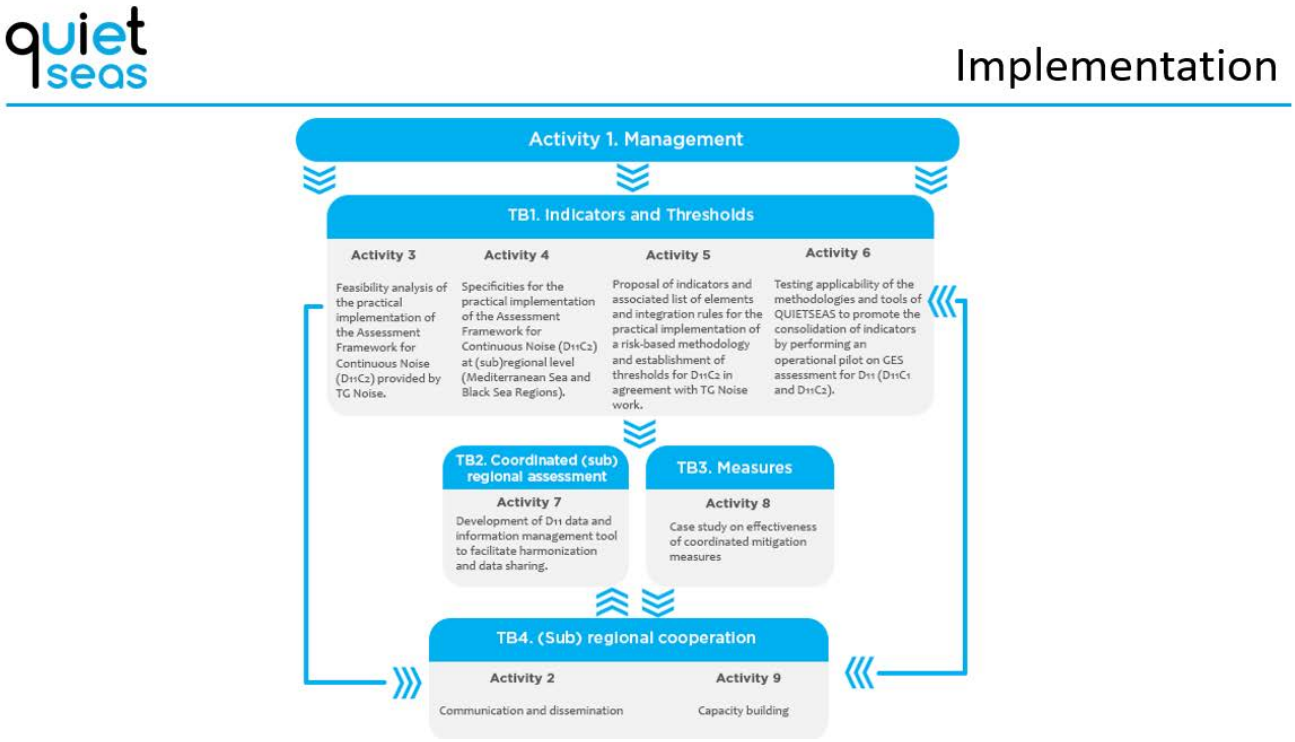


Figure 7. Activities developed in the Quietseas project. Source: Quietseas project.

ACCOBAMS is more involved in the activities related to cooperation and capacity building.

Thanks to the project, there is expected to have the following results:

- Definition of particularities for risk-based GES assessment in the Mediterranean Sea (MED) and Black Sea (BS) regions.
- Recommendations on acoustic propagation modelling for continuous sound assessment in MED and BS regions.
- Proposal of a methodology to establish thresholds values for D11C2 in the MED and BS regions in agreement with TG Noise work
- Management tools for harmonization, reporting and assessment of D11
- Quantification of the effect of potential mitigation measures to reduce shipping noise: vessel speed slowdown and traffic reduction.
- Training session for Competent Authorities and experts from EU and no EU countries

Benjamin Olivier (Shom) presented the technical part of the project and the involvement of SHOM regarding a case study on the efficiency of a speed reduction measure for ambient noise reduction.

To develop shipping noise models, they have combined ship traffic data (AIS data) to estimate the noise of this activity and environmental data (*figure 8*).

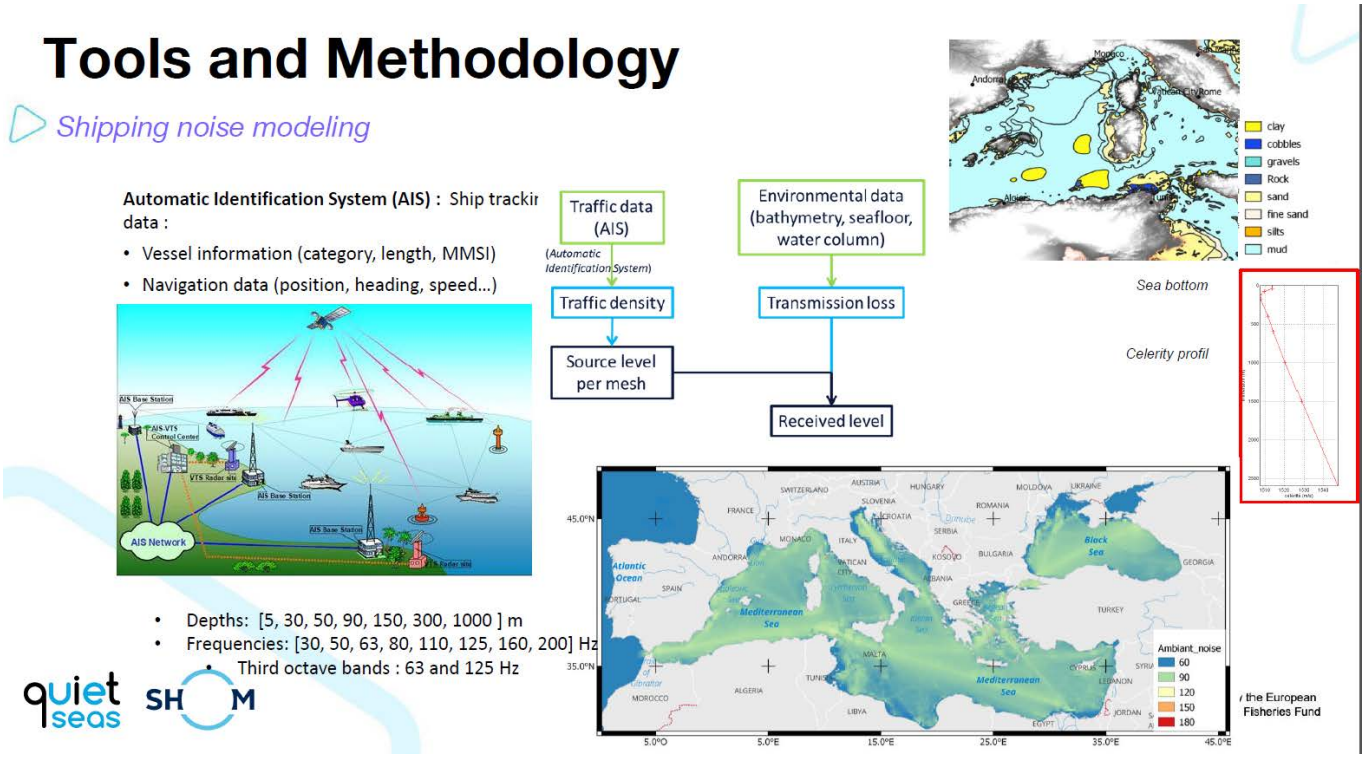


Figure 8. Methodology developed in the Quietseas project. Source: Quietseas project.

They have a model to estimate the noise from ships and it depends mainly of two parameters: the speed of the vessel and the length focusing in radiated noise to evaluate the effect and impact of reducing speed. If we reduce the speed we will reduce the noise but at the end the ship will spend more time in the area so the objective is to analyse what produces the worst effect.

They applied this study in two different areas (*figure 9)*:

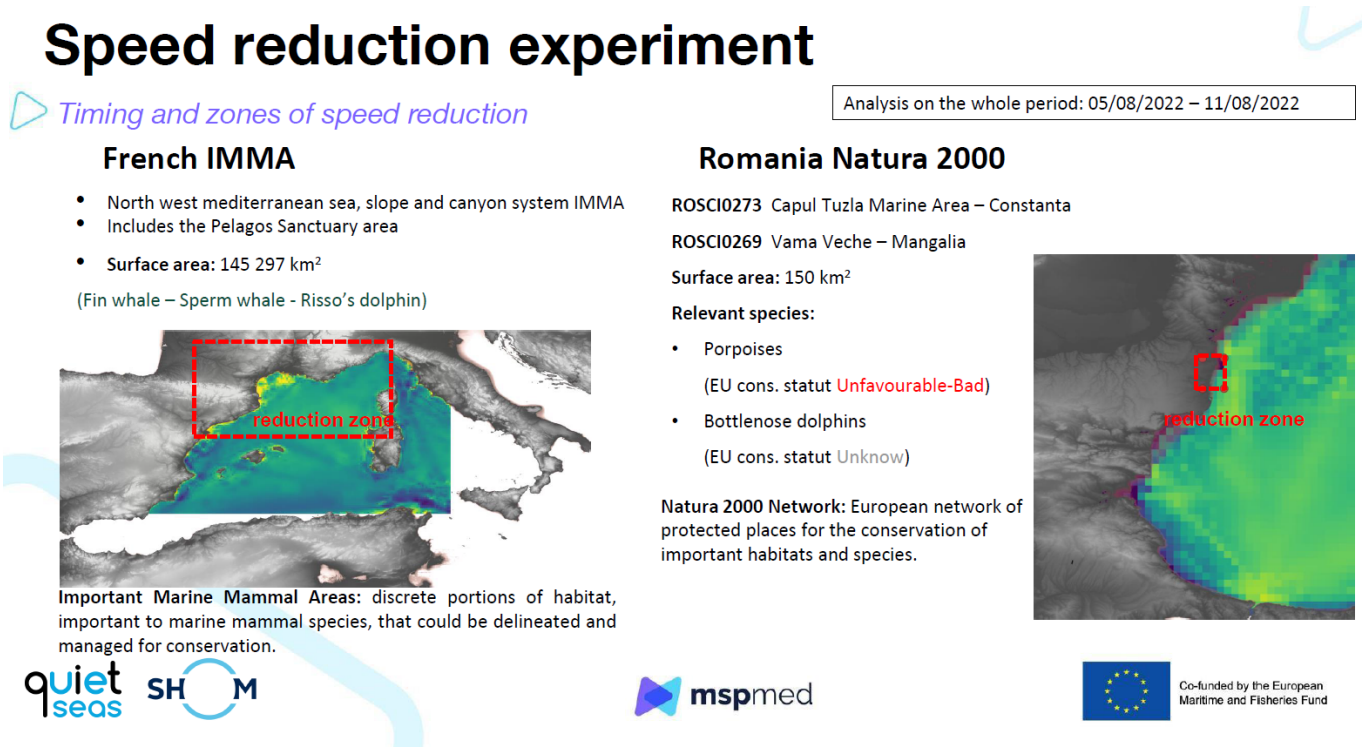


Figure 9. Study areas in the Quietseas project. Source: Quietseas project.

Results show the differences between maps with no speed reduction and speed reduction, in two different frequencies, 63 Hz and 125 Hz, and the areas of harmful noise. There is an important impact of speed reduction of ambient noise, so the measure is efficient but the methodology does not permit to quantify the effect with high levels of certainty. If we reduce the speed of the ship, we can get more vibration that eventually will produce the same harm (*figure 10)*.

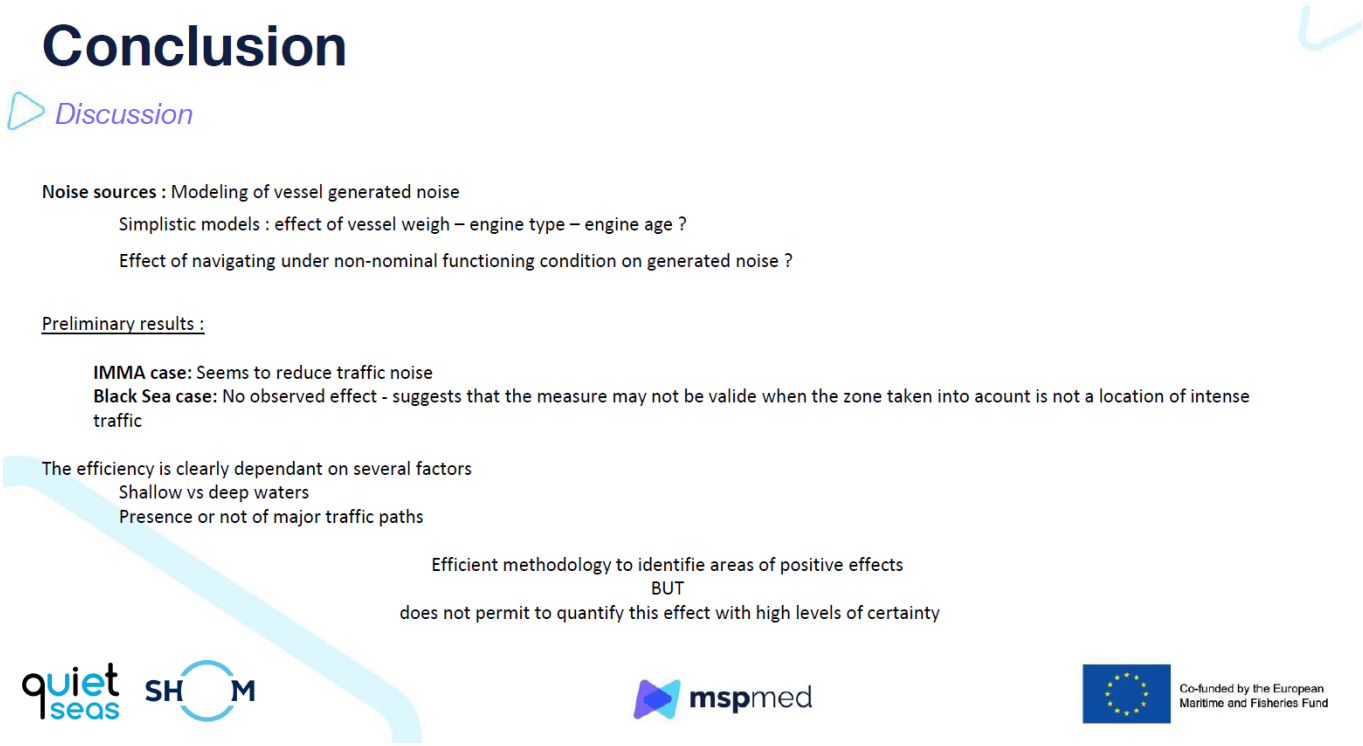


Figure 10. Conclusions. Source: Quietseas project.

The perspective is testing more speed reductions to identify the mitigation of noise, to understand better the temporal variability of the effects (by testing on longer periods), to measure the impact of seasonality and the impact of GES indicators.

Ambient noise due to shipping in French west-med coastal habitat and in the Gulf of Lions – Cedric Gerveaise (CHORUS Acoustics)

Cedric presented the works done by EcoOCEANS regarding ambient noise due to shipping in the French west-med coastal habitats and the Gulf of Lion.

The shipping noise modelling for offshore waters is a mature activity through a sustained research activity for 15 years. To modelized shipping noise they had to define the source level of ships, (the ship distribution AIS), and the need to map the ambient noise from shipping through acoustic propagation models (by parabolic equations-based tools) and they have to identify some indicators of perturbation on marine animals.

Operational tools (soundscape-atlas) are now available at a basin scale and for marine mammals. The soundscape atlas is online and provide measurements and maps of noise levels and ambient noise (high, medium, etc.), masking or noise effect on marine mammals, etc.

Coastal environments provide 41,7% of the ecosystem services and shipping noise may affect marine fauna. But, is AIS always the right tool to describe shipping? They have developed a technology for small boats without AIS with a small camera (PISIGMA) (*figure 11*) to provide AIS like data. The smart camera provides in real time the detection of boats, speed, location, etc. the camera maps the shipping while it is recording noise. The camera has got 4 screens, being one a sound receptor. They implemented artificial intelligence to detect and classify different types of boats (motor boats, sailing boats, etc).

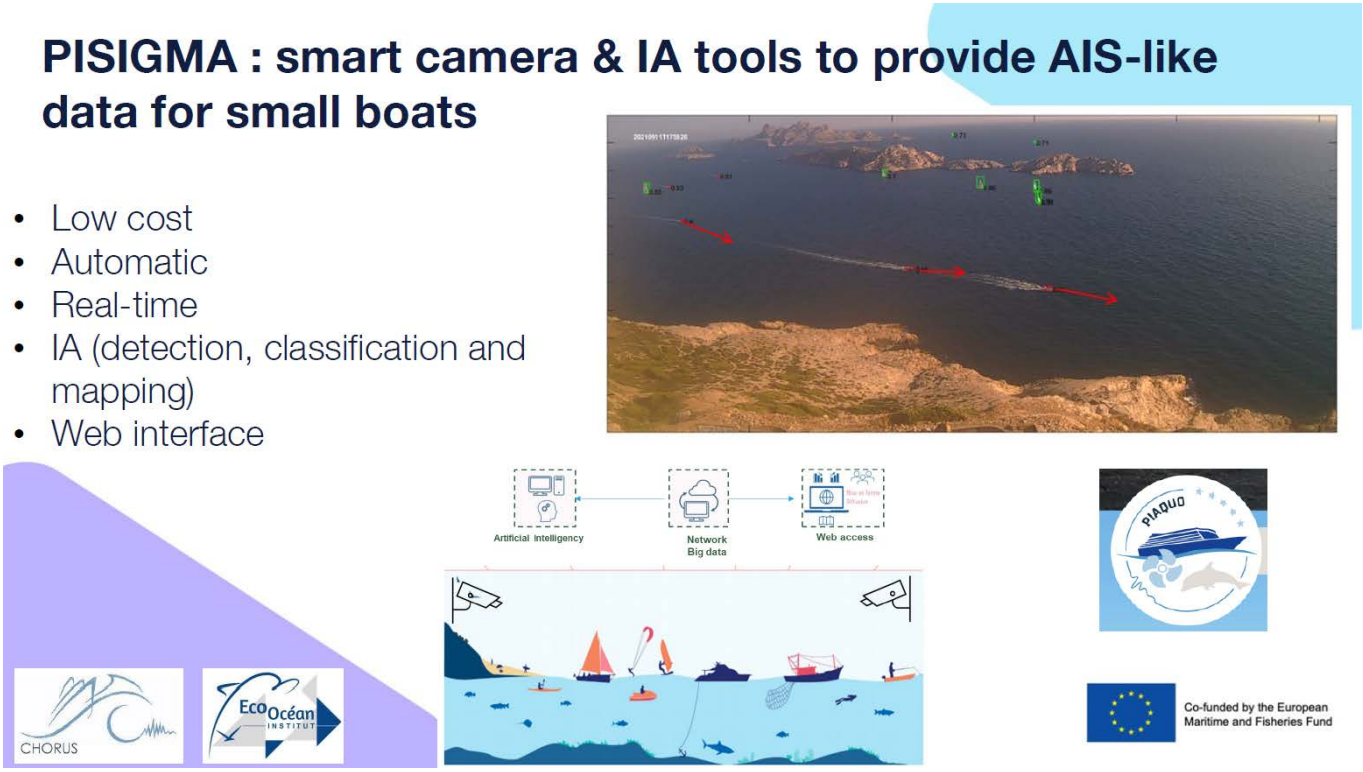


Figure 11. Smart cameras used in the project: Source: EcoOCEANS.

The use of this technology has been used in the Calvi Corsica France case study where more than 550 boats crossing the bay of Calvi per day have been detected. Only 3,7 % of the boats that cross the bay of Calvi have got AIS system. The shipping at daylight creates an increase of noise between 5 to 10 decibels (dB), 80% of the time[7].

They extended the study to the French west-med coast (CALME network), obtaining similar conclusions as the ones of Calvi study.

They wanted to know if these conclusions were also valid for Gulf of Lions coastal ecosystems. In 2021 they mapped the ambient noise in the Gulf of Lions (visual + acoustic monitoring in 121

[7] C. Magnier and C. Gervaise, Acoustic and photographic monitoring of coastal maritime traffic: Influence on the soundscape, (2020) The Journal of the Acoustical Society of America, 147(6), 3749-3757, 2020.

points) to estimate potential impacts of noise in cetaceans, according to D11 and to characterize the acoustic environment of the bottlenose dolphin (*Tursiops truncatus*) in terms of band frequencies suitable for communication signals and for echolocation and hunting clicks. To evaluate the effects of noise on bottlenose dolphins, in terms of reduction of communication space, behavioural disturbance and physiological reactions. And, finally to identify the anthropogenic sources of noise (maritime, other activities) by comparison with received AIS data and visual data on boats (*figure 12)*.

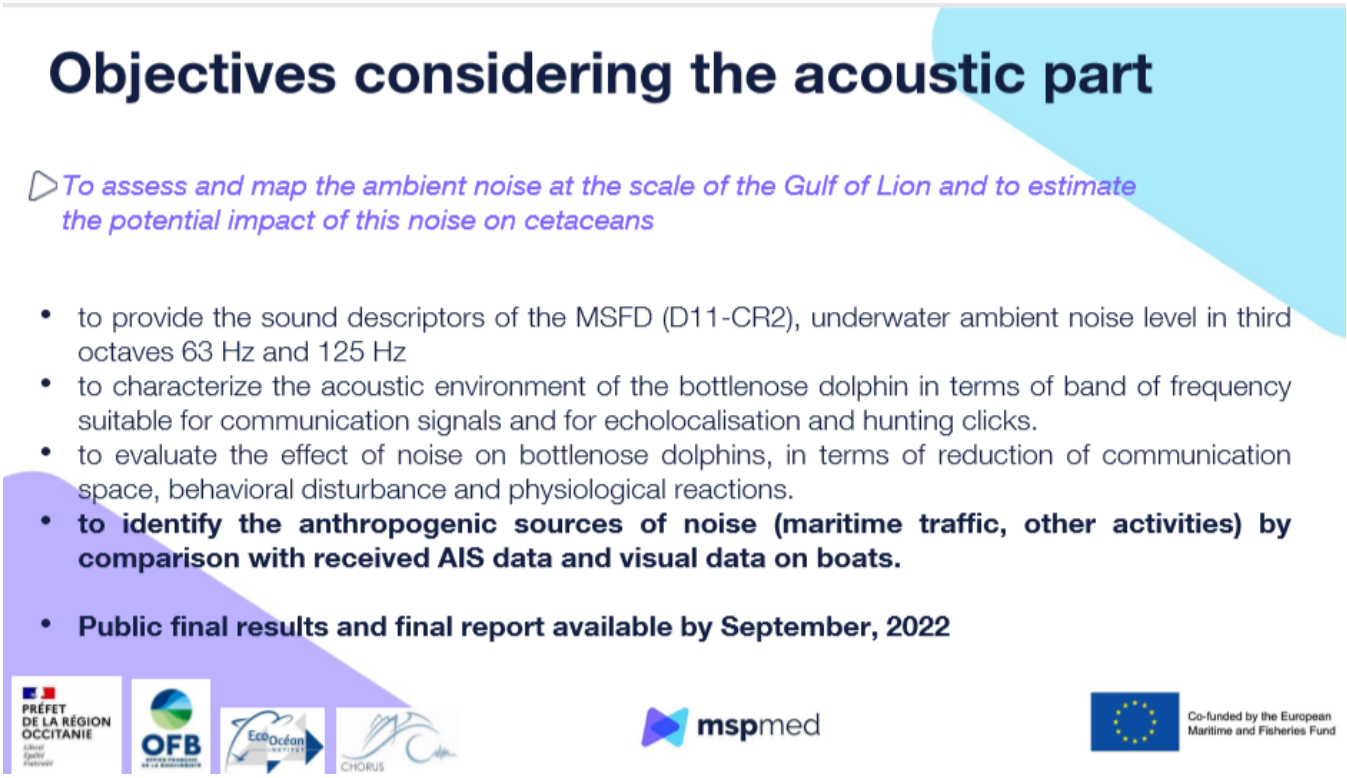


Figure 12. Objectives of the project. Source: EcoOCEANS.

The results will be published by September, 2022.

Are the conclusions from coastal ecosystems valid for the Golfe du Lion ? Characterization of the anthropogenic environment of the bottlenose dolphin in the Gulf of Lion

- Study area : 13,800 km²
- Effort planned : 1,261 km
- visual + acoustic monitoring
- 121 points of acoustic recording
- September 2021

PRÉFET DE LA RÉGION OCCITANIE
Liberté
Égalité
Fraternité

OFB
OFFICE FRANÇAIS DE LA BIODIVERSITÉ

Co-funded by the European Maritime and Fisheries Fund

Figure 13. Conclusions. Source: EcoOceans.

Listening space reduction via excess noise estimation: the Faial-Pico test case - Sergio M. Jesus (Universidade do Algarve)

Sergio Jesus presented the work made under the Jonas project, funded by Interrreg Atlantic Area.

There are several indirect variables to consider the soundscape to be able to calculate the listening space reduction (LSR): sound pressure (SPL) based on sound maps; sound exposure and its variants; excess noise level (ENL); and risk maps (species specific and hard to compare). It requires setting thresholds, often hard to establish. LSR is a direct impact variable that indicates the reduction of the ability of a given species to hear and be heard by co-specifics or to detect predators.

They use several equations to calculate LSR and ENL (the noise that is above the ambient noise).

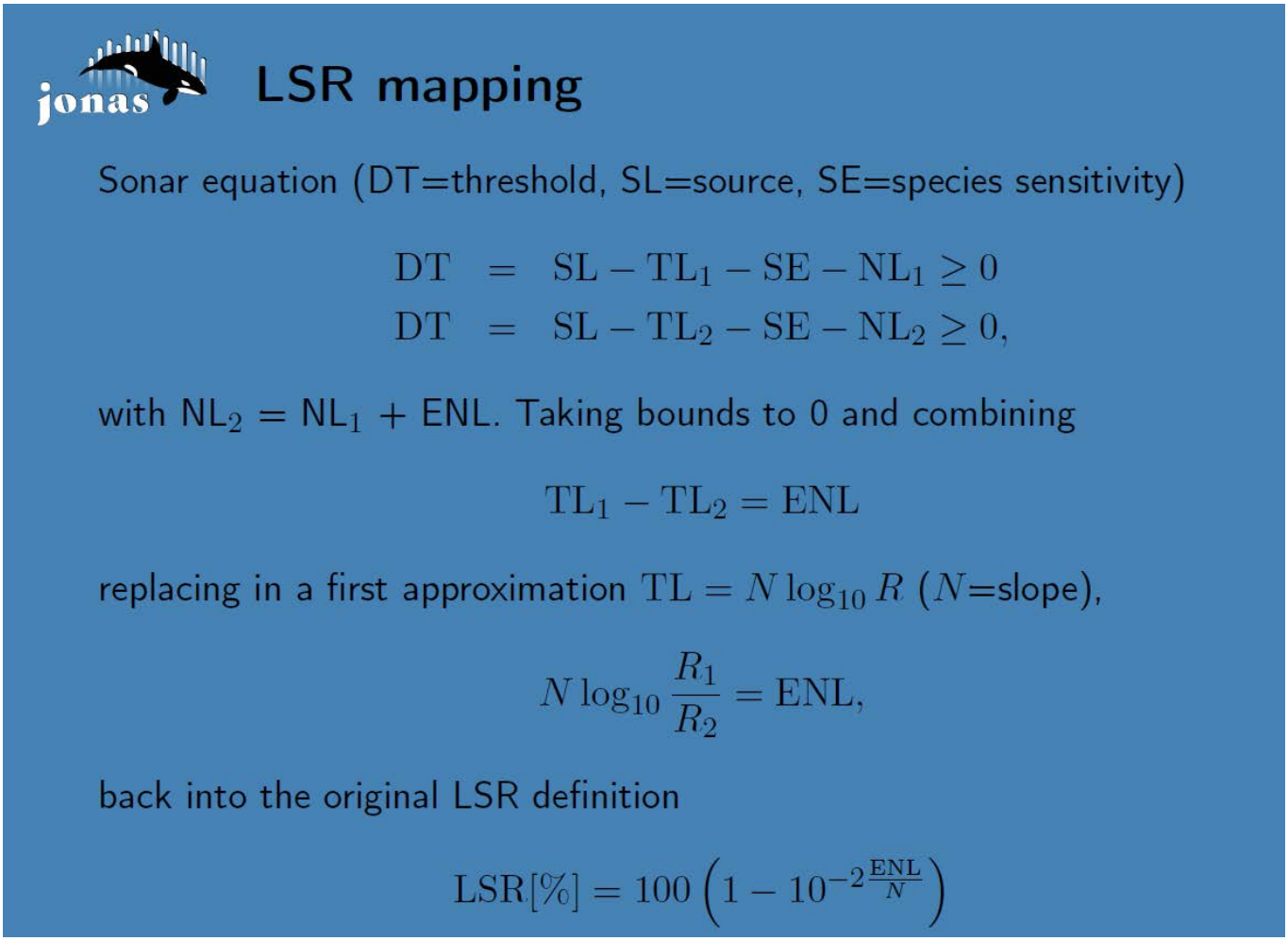


Figure 14. Equations used to calculate LSR mapping. Source: Jonas project.

A test case was made in the Faial-Pico (volcanic islands in the Azores) case study (Azores) from the one there are still only preliminary results. The modelling was made in a 500x500m grid within a 10' interval in a frequency band of 20-1000 Hz (*figure 15*). The maps are showing the results of the ENL in June, 2018. In the channel between the two islands, the number of boats is the highest and/or it is ENL, these high levels also due to the number of the ferries that cross the channel.

Co-funded by the European
Maritime and Fisheries Fund

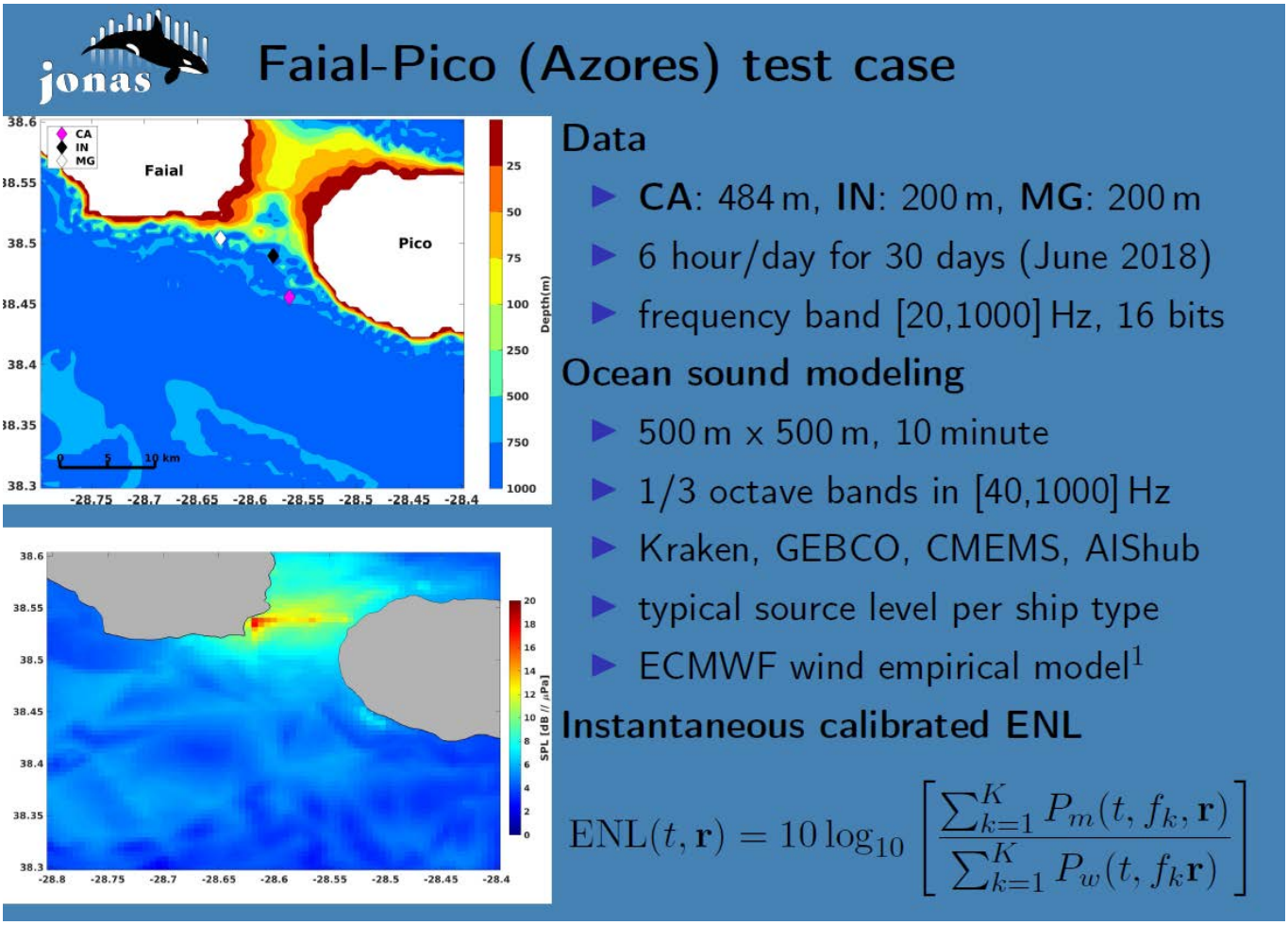


Figure 15. Faial-Pico test case. Source: Jonas project.

Different band frequencies (10 – 120 Hz) were used to calculate the noise transmission loss (TL) for target marine mammal species present in the area, which increases almost to the 100% with the increase of the ENL as it shows in *figure 16*.

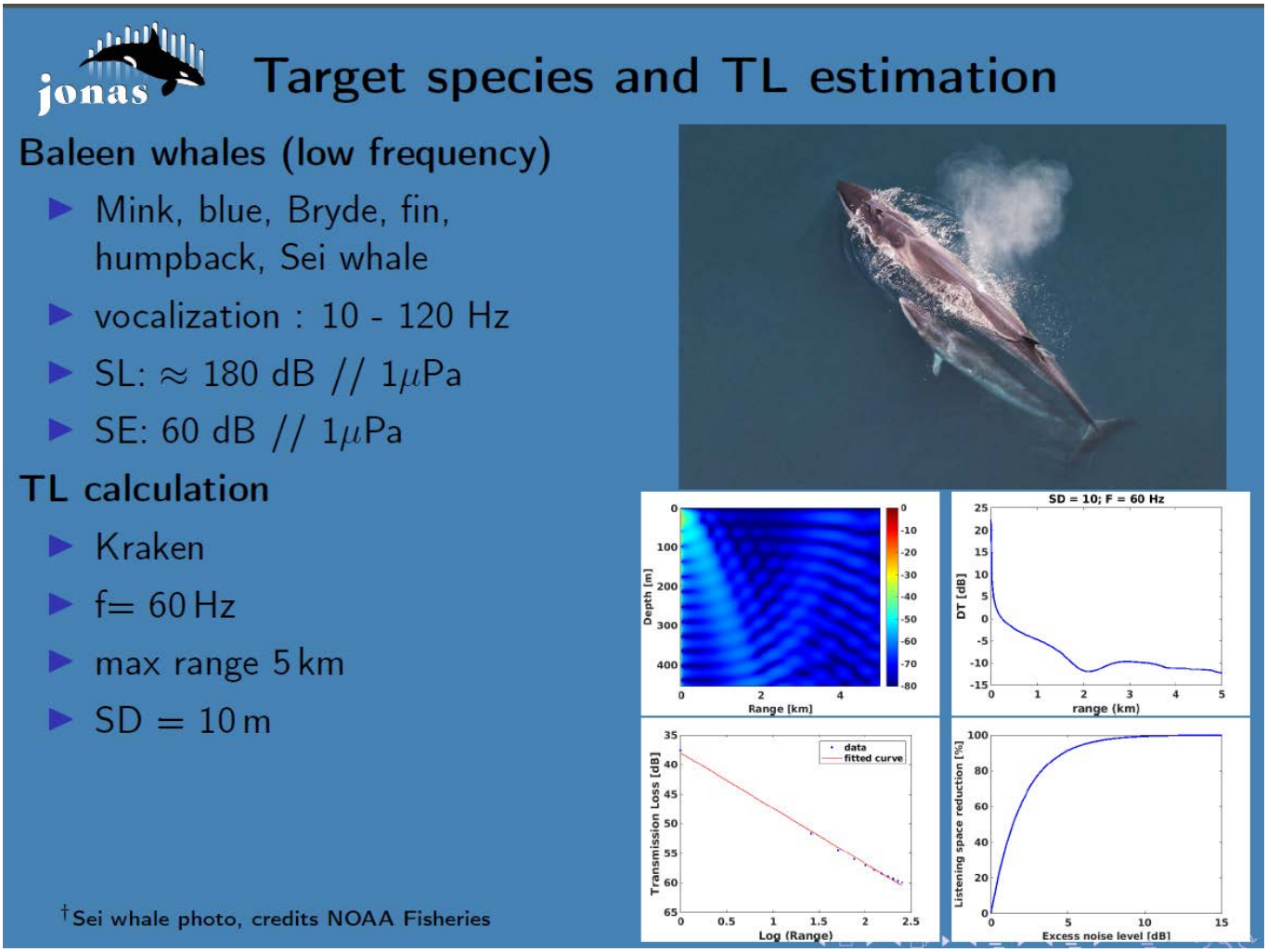


Figure 16. Target species and TL estimation. Source: Jonas project.

Going back to the study area, Copernicus data were used to made a grid where the sound speed profile was determined for every cell. They obtained the TL from this data.

Final results indicate that based on a mean over the month, there are areas of a high LSR %. Which it is surprising is that these areas with the highest level of LSR that are mostly concentrated on the south of the island of Faial do not coincide with the areas of the highest ENL (that are located between the two islands, as we can observe in *figure 17*.

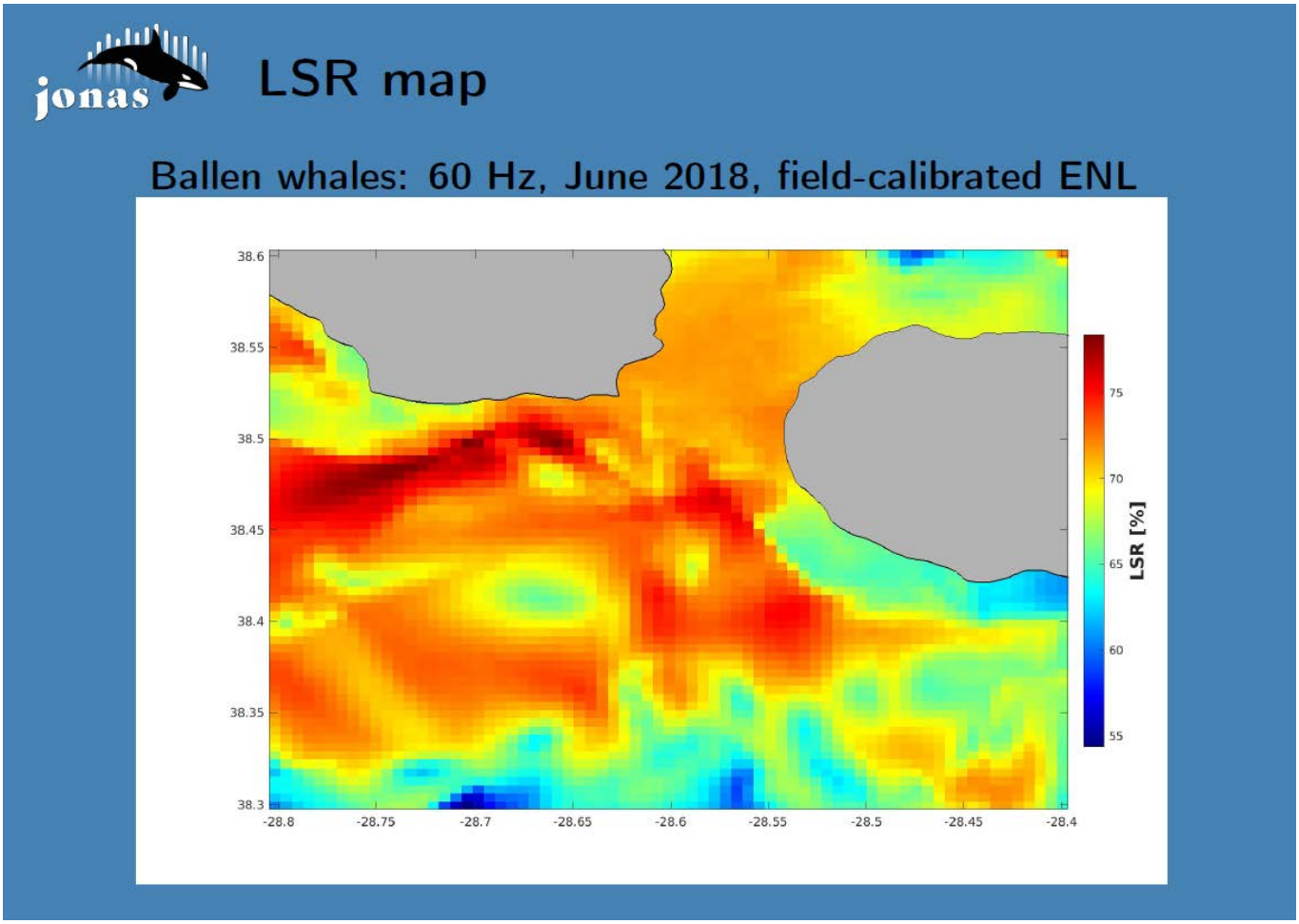


Figure 17. LSR map for Baleen whales. Source: Jonas project.

Summary:

So far

- LSR offers a species selective direct impact parameter
- LSR mapping via a two-step procedure: ENL + LSR
- ENL may (or may not) be field-calibrated, thus also LSR
- LSR and ENL show two different perspectives of the same area, considering local propagation conditions

Next moves

- To target individual species and narrow in a day by day evolution for each area
- global time x space risk indicators are possible

Questions and answers for the projects/initiatives related to underwater noise presented:

Maria Gómez (IEO,CSIC) to Thomas Folegot (QuietOceans): Are you going to take noise measures in three levels around 9 points of the Adriatic Sea? Thomas Folegot (QuietOceans) responded that they will use 1 hydrophone for each position, to calibrate the model and then use it for different layers (the recording is one-year duration). Maria Gomez (IEO,CSIC) asked another question to see if they have more case study areas where they are using the same methodology and measurements of noise and modelling. Thomas Folegot (QuietOceans) stated that they have used in another project and CNR-ISMAR has used as well.

Cristina Cervera (IEO,CSIC) to Benjamin Olivier (Shom) and all: She commented that the following day there was going to be a presentation regarding the Particular Sensitive Sea Area (PSSA) in the Gulf of Lion so she wanted to know if the studies regarding the speed reduction of vessels, are supporting the proposal? Maylis Salivas (ACCOBAMS) confirmed that these studies were used during the elaboration of the proposal. Benjamin Olivier (Shom) also indicated that this kind of speed reduction study is also thought to reduce the pollution and the collisions and considers that there are more positive effects so they should research further than the noise. Thomas Folegot (QuietOceans) had a question related to the previous question wondering if that reduction of speed was a recommendation for the study area or could be used for different vessels and areas? Benjamin Olivier (Shom) replied that they apply it on all ships, independently from the category of the ships. They try to reply what it has been done in the “Ecoprogram”, which is a big project in Canada, if they reduce the speed they pay less taxes to cross the area so that is what they want to establish. Cristina Cervera (IEO,CSIC) Cristina Cervera asked whether the reduction of speed implies a reduction in air pollution. Benjamin Olivier (Shom) answered that it has been proved that it is like that, in general terms.

Léa David (ACCOBAMS) added that the discussion is about the amount of sound added to the environment. It should be considered the impact not mainly caused by the dB, but also due to the vibrations. They have seen that delphinids avoid areas with high vibrations. They should consider vibration impacts on the species.

Cristina Cervera (IEO,CSIC) asked about when do you consider noise as a pollution? Thomas Folegot (QuietOceans) indicated that if you talk about pollution, you are talking about a policy concept, not a scientific one. As a scientist, I prefer to use the word “sound”, which definition is settled in a new ISO vocabulary standardization, as more suitable for what we are talking about. The word “noise” is more a definition for the concept (the signal). There are 2 types of acoustics: sound pressure level (SPL) and particle velocity. There new methods that appearing to measure the sound.

Cristina Cervera (IEO,CSIC) to Cedric Gervaise (Chorus Acoustics) asked regarding the methodology used to have the data from small ships, is it a model or is a direct measure? Cedric Gervaise (Chorus Acoustics) indicated that in the case study of Calvi they counted the small

boats, and to measure the noise, so it was a measure to correlate the number of boats and the increase of noise level. But it is important to consider that if we want to model noise created by small boats, we cannot rely upon AIS data. Preliminary results in the Gulf of Lion demonstrate that there is a large number of boats that do not have AIS data. In any case, they are carrying out an evaluation of the data to have final results in September 2022.

Armelle Sommier (Shom) to Cedric Gervaise (Chorus Acoustics) queried if there is any difference between recreational boats and small fishing boats to be able to know which type is being recorded. Cedric Gervaise (Chorus Acoustics) indicated that thanks to the acoustic recorder of the smart camera, they are able to record the source level of different kind of small. They could define a source level per day, that it can be an input for modelling but we are not able to distinguish among the type of boat in terms of their acoustics.

Léa David (ACCOBAMS) added that there are several issues that need to be considered. It would be relevant to measure in different days, seasons and times of the day for different species and behaviours and/or type and actions of the boats. For example, it is not the same if a boat is chasing an animal that if it just passes by; then, sound is not the only variable to be measured. She wanted to make a recommendation enouncing that it would be preferable to illustrate the examples and to use the images of the marine mammal species that could be encountered in a certain area instead of using species that, although could be beautiful they do not represent the ecosystems that we are focus on. To finish, she added that, in addition, considering the projects presented today, there is a lot of information coming from different projects/initiatives and tools to reduce the speed, or for decision making, etc. regarding underwater noise, that could be used for MSP.

Cristina Cervera (IEO,CSIC) commented that this is precisely one of the topics planned to be answered the following day (in the Trilateral workshop); to discuss how all these initiatives and projects could work together, help each other or how could be shared in order to take advantage of valuable studies and information already performed.

Underwater noise in MSFD

Underwater noise in the IMAP of the Barcelona Convention – Maylis Salivas (ACCOBAMS)

Maylis presented the Integrated Monitoring and Assessment Programme (IMAP) of the Mediterranean Sea and Coast of the Barcelona Convention regarding underwater noise issue in the Ecosystem Approach (EcAp) process.

The EcAP Initiative is a process developed within The Barcelona Convention, applying the EU Directives and regional agreements as ACCOBAMS that is in charge of developing the Guidance to implement the ecological objective 11 of noise at a regional level.

The objective is to manage human activities that may affect the Mediterranean marine and coastal environment. There are 11 Ecological Objectives whose achievement should help attaining a GES of the Mediterranean Sea and Coast. The Ecological Objective 11 concerns the energy inputs into the marine environment, especially noise from human activities that needs to be minimised *(Figure 18)*.

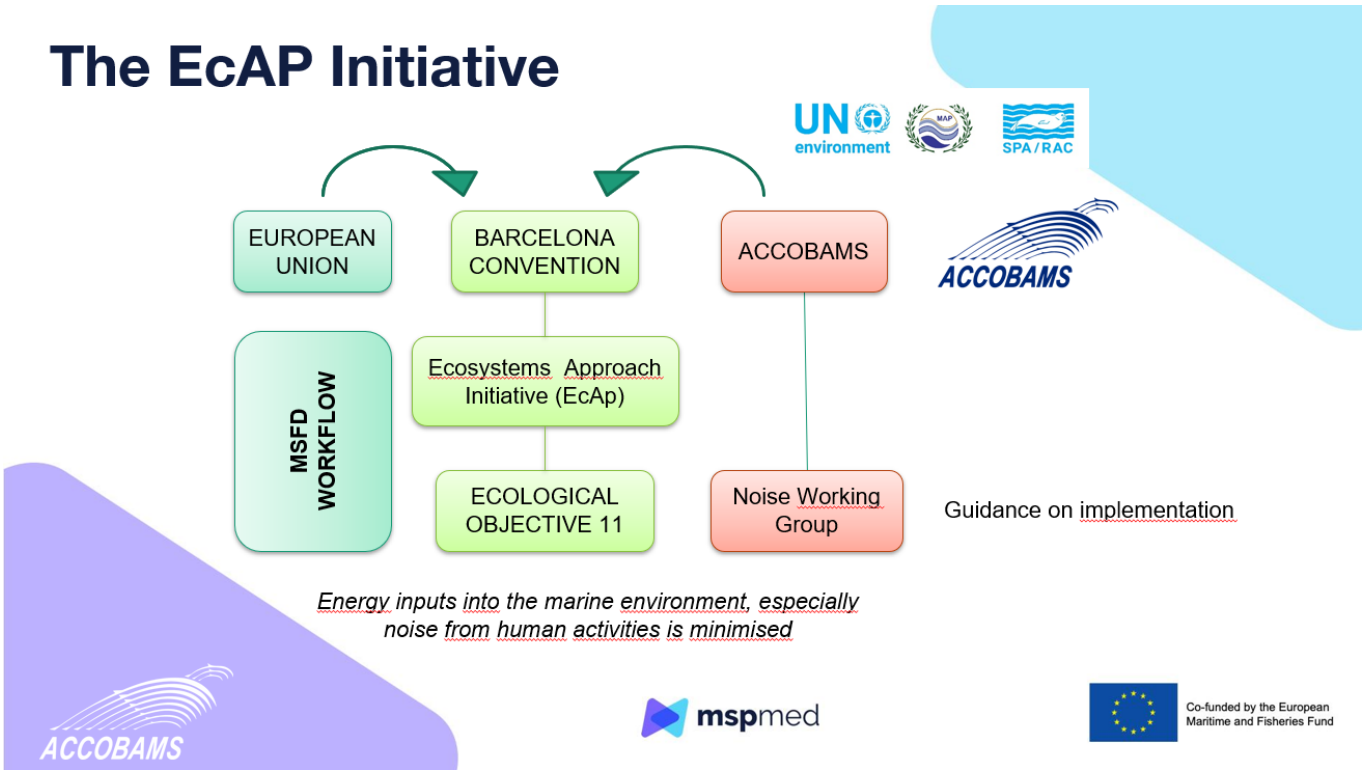


Figure 18. The ACCOBAMS EcAp initiative. Source: ACCOBAMS.

In 2014 parties from Barcelona Convection agreed on two possible candidate Indicators:

- Candidate Indicator 26: Proportion of days and geographical distribution where loud, low, and mid-frequency impulsive sounds exceed levels that are likely to entail significant impact on marine animals.
- Candidate Indicator 27: Levels of continuous low frequency sounds with the use of models as appropriate.

In 2017 there was an IMAP decision, with further development of candidate indicators related to noise, needed to be carried out in close cooperation between United Nations Environment Program /Mediterranean Action Program (UNEP/MAP) and ACCOBAMS, considering that ACCOBAMS is undertaking the identification of noise hot spots in the Mediterranean.

There were important progresses and implementation of the ecological objective 11 by EU projects (QuietMed, QuietMed2 and QuietSeas), to elaborate a Guidance Factsheets prepared by ACCOBAMS (*figure 19*).

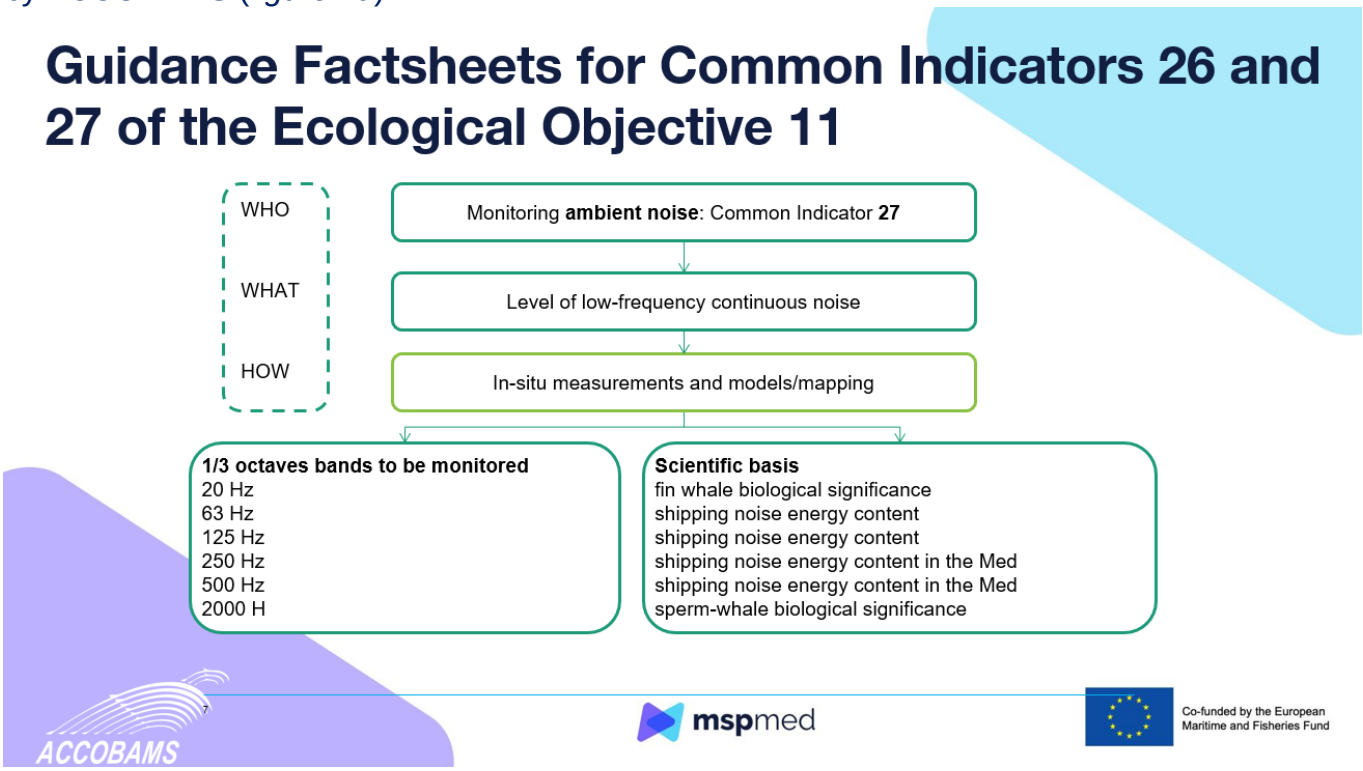


Figure 19. Guidance factsheets for common indicators of the ecological objective 11. Source: ACCOBAMS.

Next steps will focus on:

- Training and Capacity building to promote regional cooperation to ensure coordination across the region & the involvement of Competent Authorities.
- Inclusion of underwater noise in the next Quality Status Report of the Mediterranean Sea.
- To include the 2 Candidate indicators in the IMAP to become indicators at the Med level in the Mediterranean Convection.

Technical Group (TG)-Noise - Junio Fabrizio Borsani, ISPRA & Co-Chair of TG Noise

Fabrizio explained the paper of TGNoise summarizing the workplan and the state of the art.

He pointed out that sound is sound and noise is a sound that may cause harm to animals.

There is a difference in the definition of the descriptor D11 since the Commission Decision 2017/848 was adopted: D11 criteria 1 and 2: the spatial distribution, temporal extent, and levels of anthropogenic (D11.c1) and continuous low-frequency sound (D11.c2) sources do not exceed levels that adversely affect populations of marine animals.

TG noise is a technical group dedicated to the common implementation of the D11 of the MSFD What these 4 technical groups (litter, noise, data, and seabed) advice, is then received by the Marine Directors and office member states and then eventually taken into the national legislation of the Member States (*figure 20)*.

Technical Group on Underwater Noise

Towards a coordinated implementation of D11

Expert group of the common implementation strategy (CIS) for MSFD Descriptor 11

SVE, FR, IT chairmanship since January 2020.

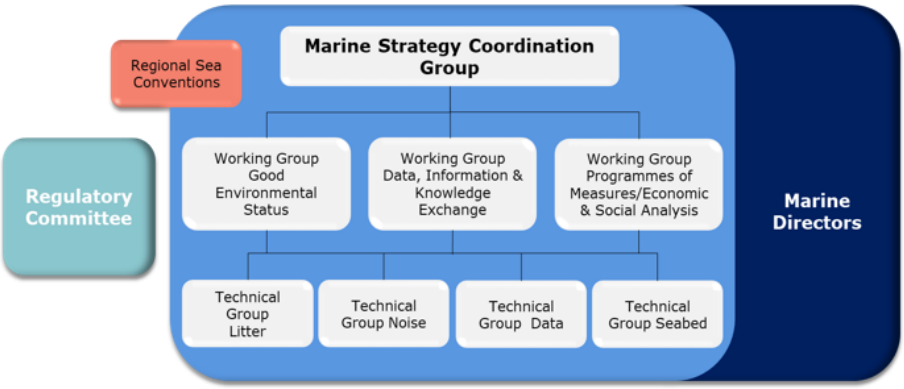


Figure 20. Structure of the Technical group on Underwater noise. Source: TGNoise.

Tasks and/or priorities of TG-Noise could be observed in figure 21.

TG Noise priorities

- Support MS and RSC in implementing operational monitoring.
  - Ensure regional coherence and complementarity through active coordination.
  - Define EU threshold values for underwater noise :
    - *Common methodologies and recommendations adopted in 2021.*
    - *Ongoing work to define options for EU threshold values by 2022 (= objective of the Zero Pollution action plan under the European Green Deal).*
    - *Cooperation with regional seas conventions.*

Figure 21. TGnoise priorities under MSFD. Source: TGNoise.

Co-funded by the European Maritime and Fisheries Fund

They are now at the stage of envisaging threshold for UWN. What it is new, it is that they put together an expert group ("Drafting Group") of the deliverable 4 (DL4) which is "Options for EU threshold values for continuous noise".

The assessment framework is conformed by 8 steps: 3 steps are dedicated to species (species and habitats; the second step is focus on defining the "Level of Onset of biologically Significant adverse Effects" (LOSE) and the third step is to determine the Time period of the assessment); 2 steps regarding pressures and the last 3 steps dedicated to management (*figure 22*).

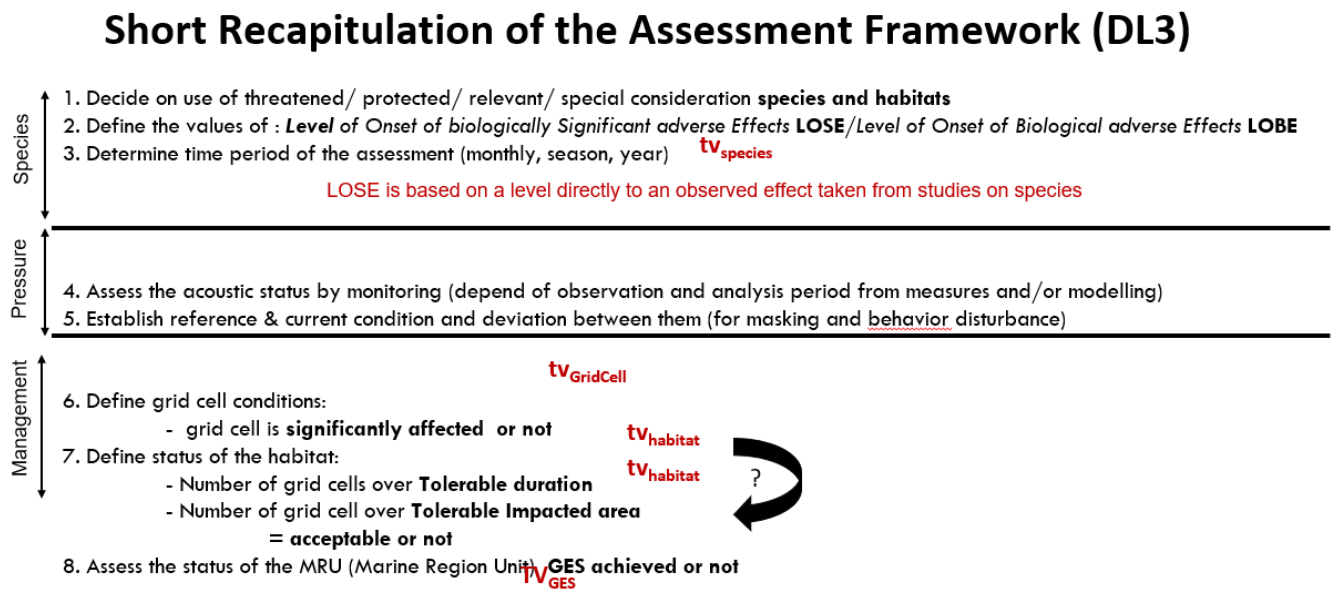


Figure 22. Assessment framework (DL3) under the TGnoise. Source: TGNoise.

The main problem that TG-noise is dealing with is unifying the concept of gridcell, which is the basic building block. They are working in the normalization of the grid cell in each Member State, in terms of comparation models (to achieve the same basic block for all EU waters).

The ongoing work on D11-C2 is about the pressure level and excess level; they are investigating how to set LOBE, tolerable duration, tolerable impact area and options to aggregate several habitats in each Marine Reporting Unit (MRU).

They are producing test cases for different areas in order to see if they can use the gridcell as a reporting unit equal for everybody. They are considering the gridcell is an acceptable condition or not, if the habitat level considered is tolerable o no, and if the GES is achieved or not.

There are several obstacles to be resolved for setting threshold values (TVs) (*figure 23*):

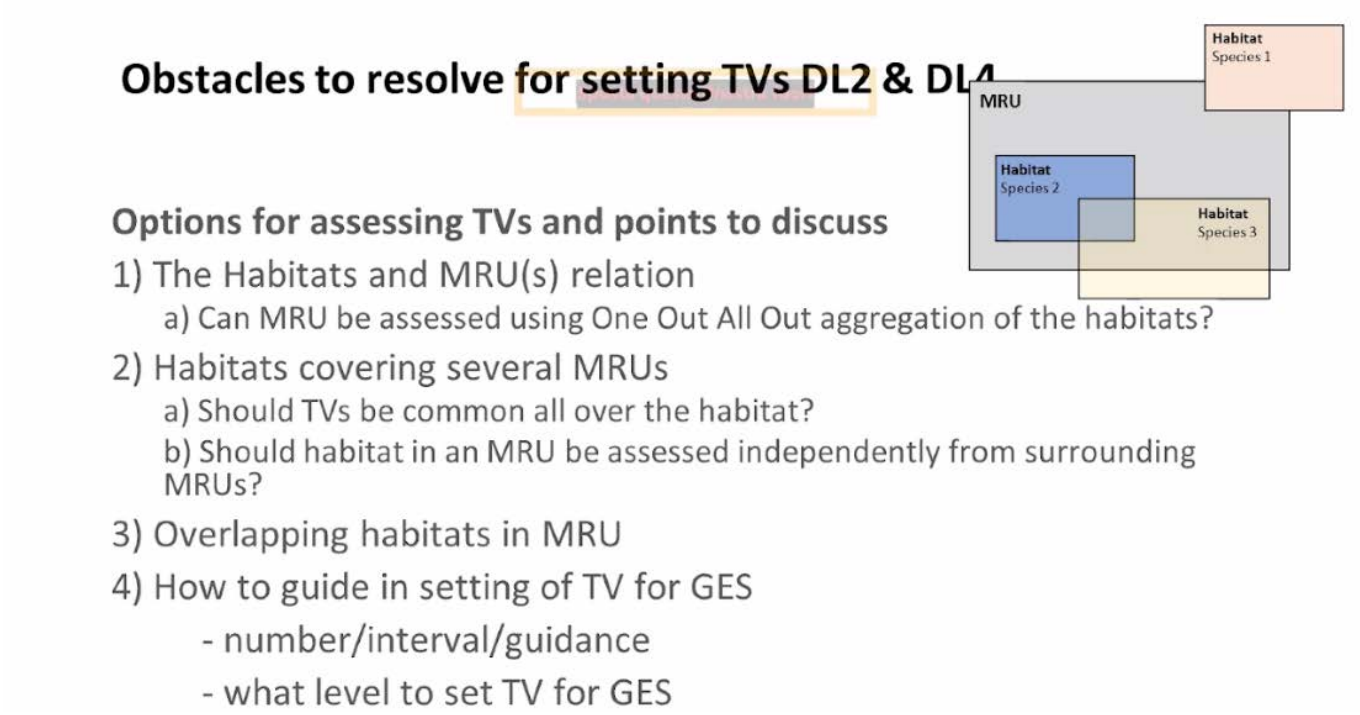


Figure 23. Obstacles encountered among Member States in TGnoise. Source: TGNoise.

In summary, work is progressing. They meet twice a week and they hope to be able to release a draft guidance on pressure values for Member States before summer, 2022.

MSFD Descriptor 11 in Italy - Junio Fabrizio Borsani (ISPRA)

Fabrizio presented the D11 status in Italy, neither from a technical perspective and nor from a scientific perspective. This is a presentation given to the ministry of environment whom want to have solutions, with ease to be implemented. This presentation is called "*D11: a proposed Italian approach to the use of the national noise registry as a management tool for criteria D11.c1 and D11.c2"*.

They merged the interface of the Italian noise registry (D11.c1) with information from EMODNET human activities (grid cell selected "tile"). After merging this information, they know the content of every gridcell (bathymetry, sound profile and the sound propagation, flora and fauna, etc.) and from EModNet they are able to know the number of ships per class per a given period or time (the most suitable time resolution). When the number of ships excess a certain limit (tolerable condition), the gridcell turns red and that means that there is an excess of ships (= noise) in that area (*figure 24)*. The threshold value is the number of red tiles; so, if there is an area with red tiles in coincidence with shipping lanes, this information could be used to illustrate the situation for policy makers.

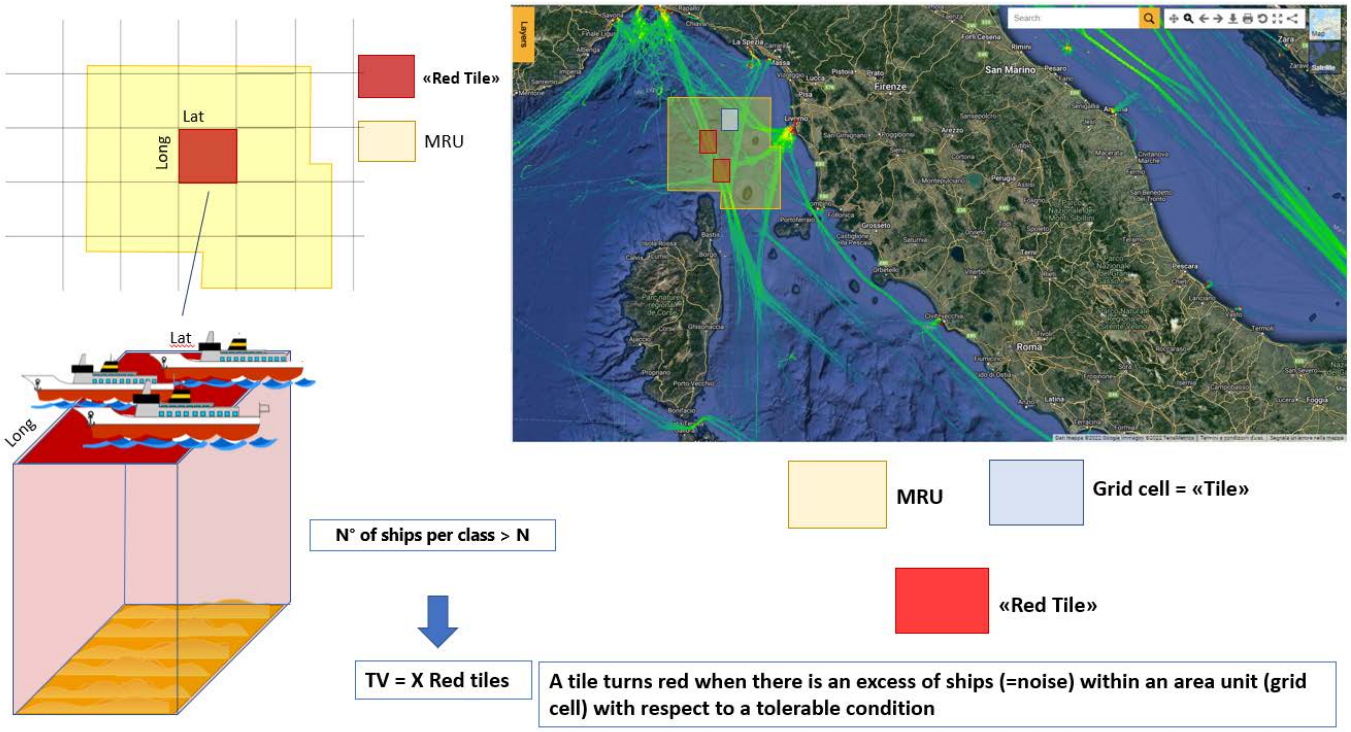


Figure 24. Italian noise registry (D11.c1) under MSFD. Source: ISPRA.

MSFD Descriptor 11 in Spain - Manuel Bou (IEO, CSIC)

Manuel presented the tasks and activities that are being developed in Spain to implement the D11 of the MSFD, which is a tool to reach and maintain the GES in the marine environment. GES is a dynamic concept that must be evaluated periodically.

The IEO activities started in 2019. The main goal was starting with the monitoring activities for the 5 Spanish marine demarcations through:

- In-situ measurements using PAM devices at different locations.
- Simulations of sound present in marine environment due to ship traffic (using AIS data).

As a reference, they used TG-Noise Monitoring Guidance (2014) as a reference: Considering 1/3 Octave Band 63Hz & 125Hz; and achieve the technical advices on Self noise, calibration & sensitivity, dynamic range, etc.

The measurements using PAM devices, have been made by a PAM prototype called “SAMARUC” (*figure 25*).

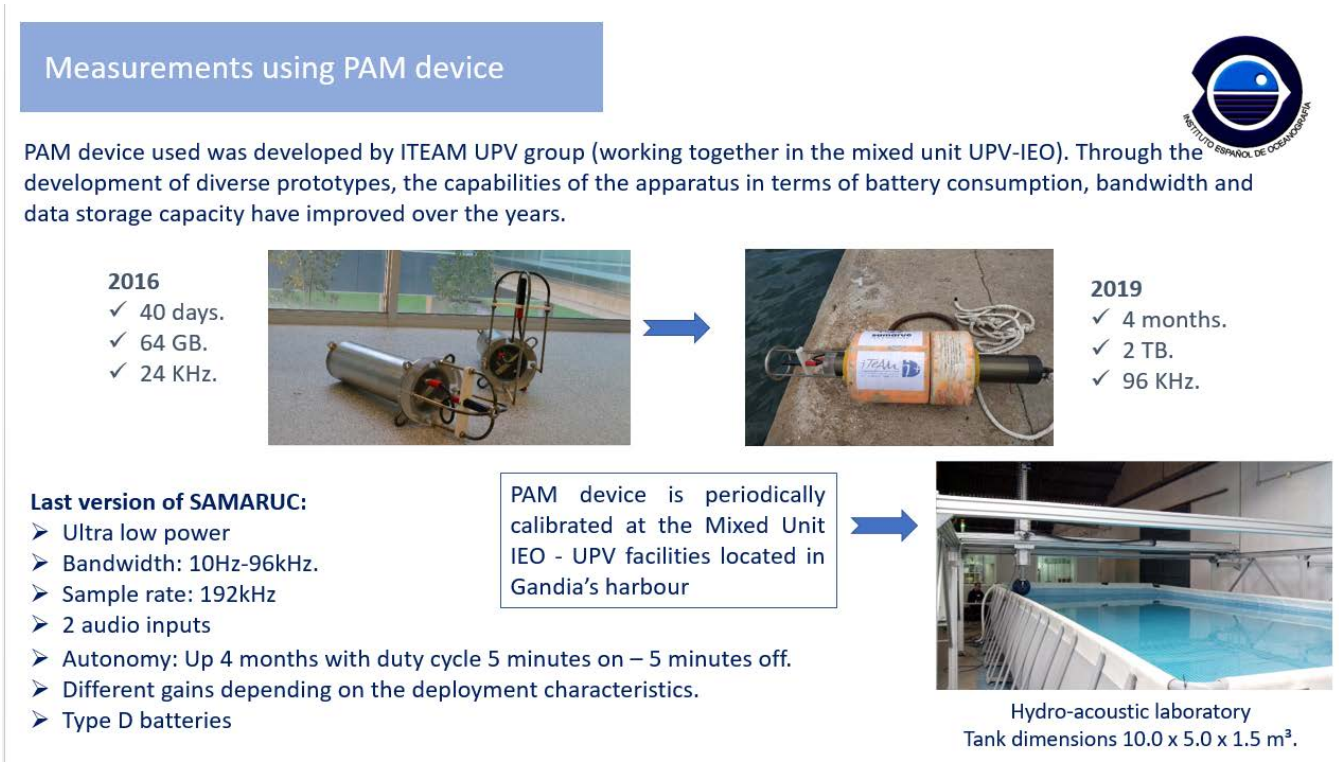


Figure 25. PAM devices used for D11 monitoring in Spain. Source: Spanish Institute of Oceanography.

In the process between the deployment and the recovery of the apparatus, the apparatus is calibrated periodically, in order to be sure that the proper calibration (sound pressure level) is considered.

Currently, the work has been made in 4 marine demarcations, all except for the Canary Islands marine demarcation, where it is planned to be deployed in November, 2022. Annually, different locations are trying to be covered, the range of the depth where the apparatus is deployed goes from80m to 500m, depending on the location.

As an example of data obtained in the south-Atlantic marine demarcation in 2021 (*figure 26)*. The acoustic data is normally computed by obtaining the mean value, the median, etc. and trying to obtain the most valuable metrics and statistical data in order to have a complete picture of the experimental data.

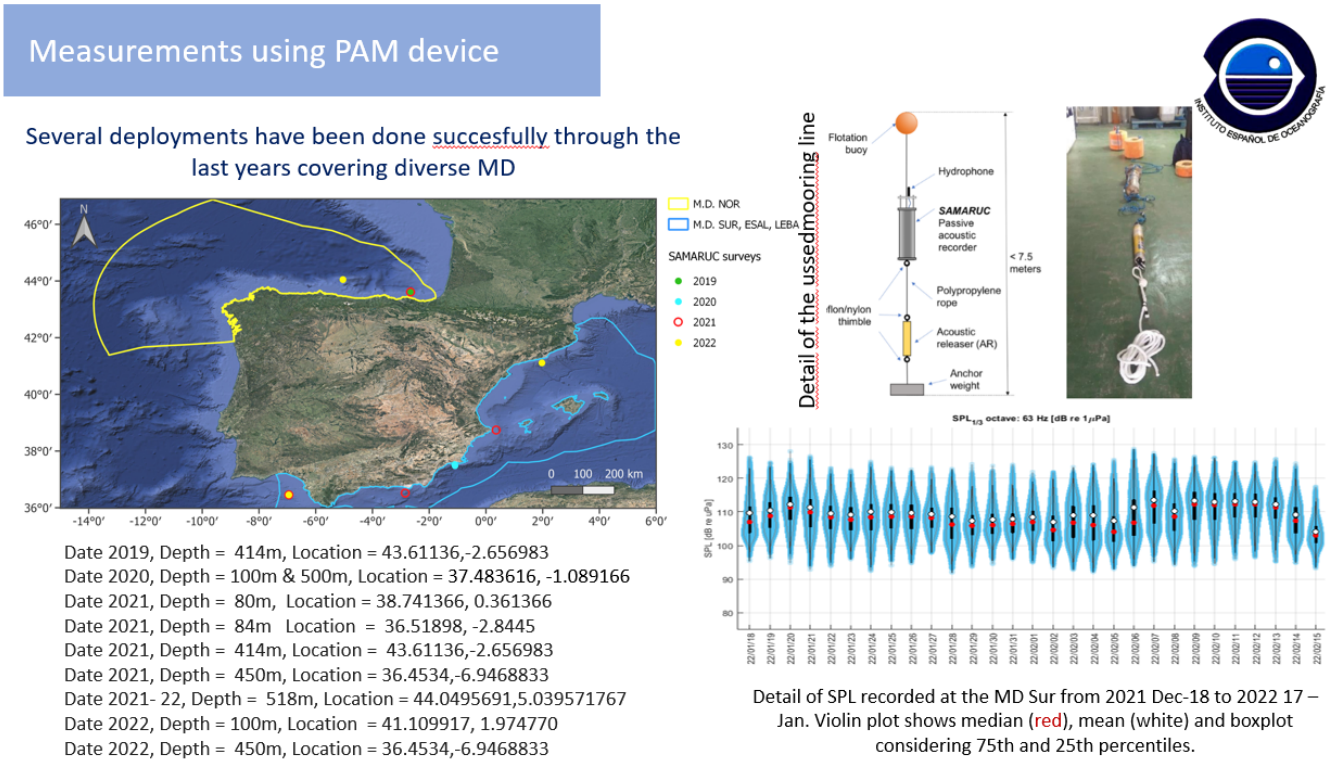


Figure 26. Measurements using PAM devices. Source: Spanish Institute of Oceanography.

With respect to the theoretical simulations, another input of monitoring activities, the workflow is similar to the work done in the case study of the Gulf of Lion, within the MSPMED project, using navigation data, considering environmental conditions to obtain finally a sound map. Some theoretical simulations can be observed in *figure 27*, to see how the noise changes in time.

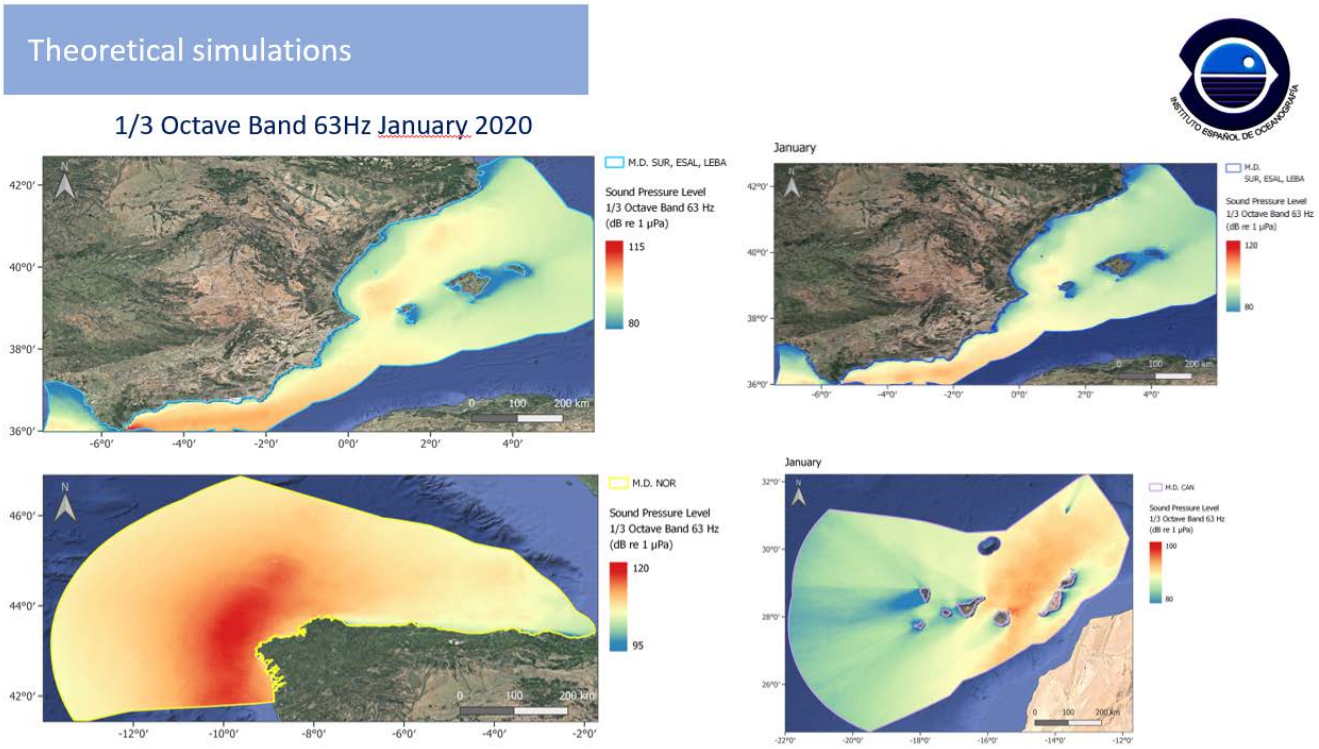


Figure 27. Theoretical simulations made in 4 of the 5 marine demarcations. Source: Spanish Institute of Oceanography.

Next steps are oriented to keep collecting experimental data and studying new simulations and modelling. Moreover, there are also other steps to follow to achieve a GES such as to define indicator species and their habitats, to define the reference conditions, to define the current condition and to determine the level of onset of biologically significant adverse effects; and to determine if each MRU is on a GES or not. In the end, the main goal is to define the GES. In addition, there is a need to obtain cetacean data; in the case of the IEO(CSIC) in the north-Atlantic marine demarcation, this data has been gathering to know the animals' distribution. The idea is to use this biological data to create based-risk models to evaluate the masking effect on certain marine-mammal species due to anthropogenic marine traffic (*figure 28*). The challenge is to make this type of results compatible with the establishment of threshold values from which determining the GES in a certain area.

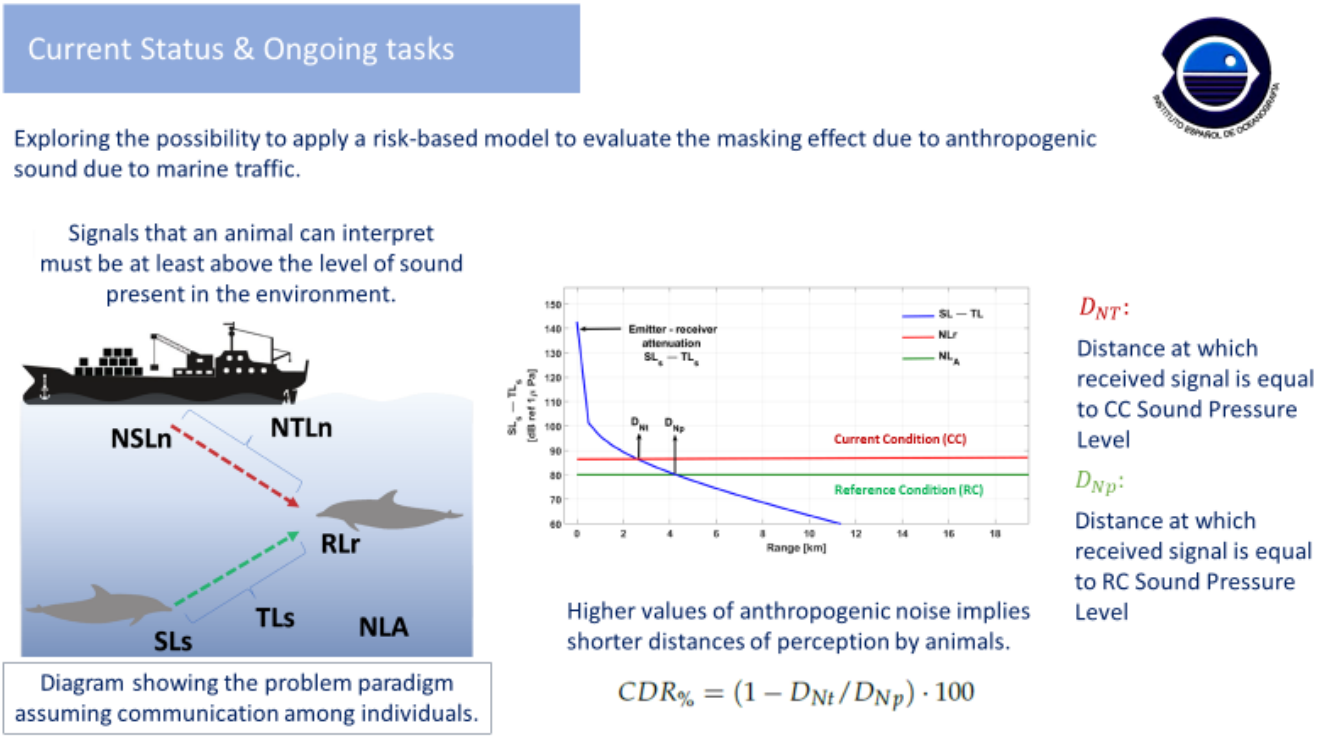


Figure 28. Current status and ongoing tasks for D11 monitoring in Spain. Source: Spanish Institute of Oceanography.

Conclusions:

- Monitoring tasks are a fundamental tool to know the relationship between Sound Pressure Level and anthropogenic activities (i.e. ship traffic).
- It is necessary to evaluate through experimental measurements (in specific locations with low human presence) or theoretical models (e.g. considering weather conditions) the reference conditions from which to measure the excess of sound pressure level.
- The GES will be linked to a specific marine habitat. So, the definition of target species and tasks related to gathering biological available data is essential to continue with the implementation of D11.C2.

MSFD Descriptor 11 in France – Benjamin Olivier (Shom)

France has made an effort to study continuous noise rather than to study impulsive noise.

To model the ambient noise, the French marine waters are divided into different meshes and the noise is measure in each mesh (*figure 29*).

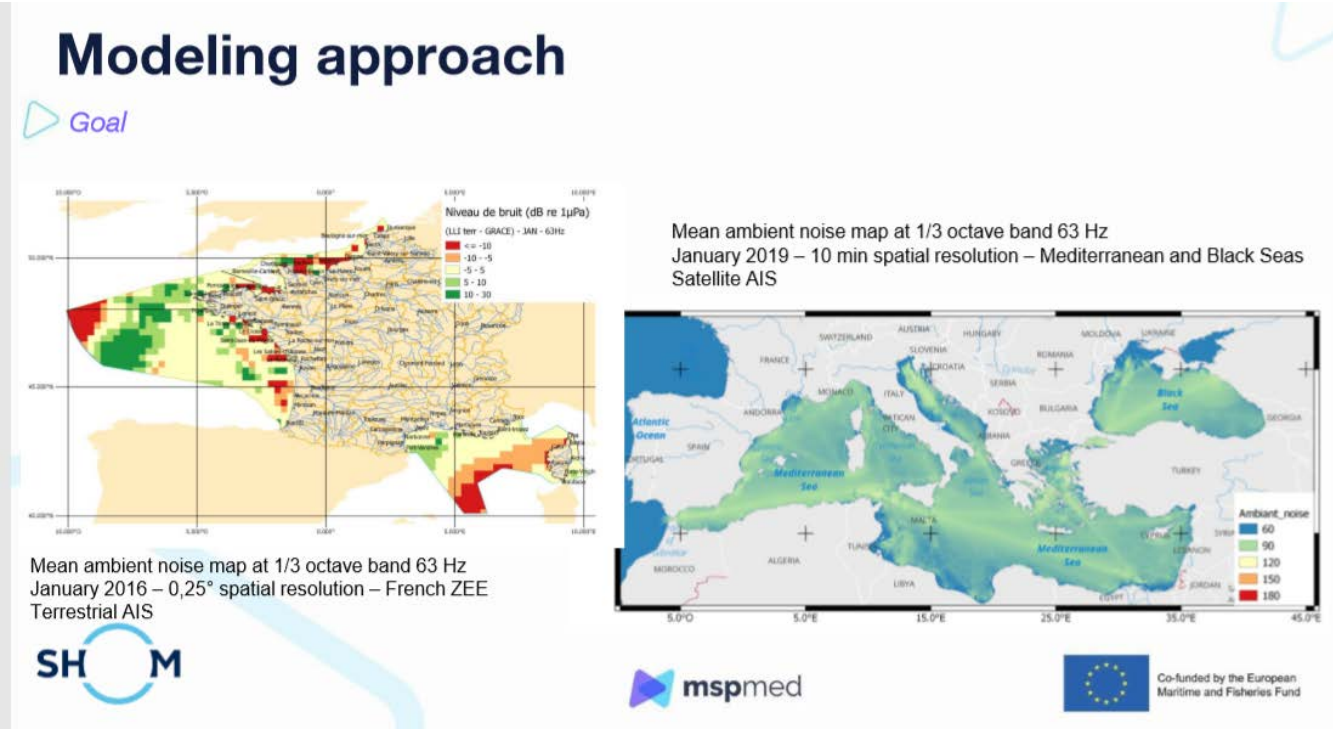


Figure 29. Underwater noise modelling approach for D11 monitoring in France. Source: Shom.

AIS data are used to obtain the traffic density data (ship ID, length, position, speed, etc.) to obtain source level per mesh. On the other side environmental data (bathymetry, seafloor, water column) are analysed to obtain the transmission loss. Once joining these results, the received level can be calculated.

Received level = source level – transmission loss

In order to obtain the most possible accurate traffic data from AIS, different sources are used. Besides land-based stations, to cover the offshore areas, satellite AIS are needed and the routes of the ships with the port of departure and the port of arrival to develop shipping density maps are used. Additionally, other providers as Lloyds and GRACE are utilized for the modelling, to obtain the most comprehensive AIS data sets possible.

They deployed 11 recording stations in different zones of the French seas, both, in the Mediterranean and the Atlantic oceans, where there are hydrophones at different depths for a long-term acoustic measurement (*figure 30)*.

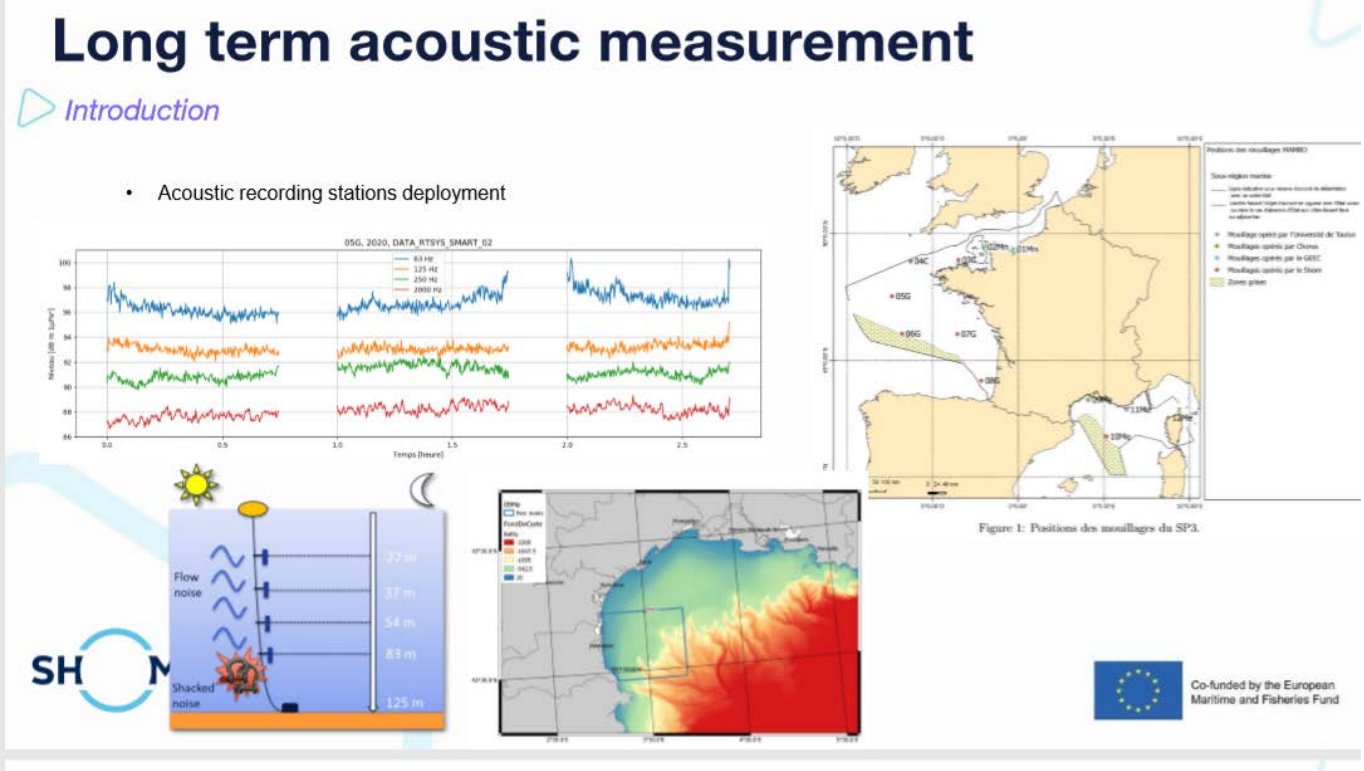


Figure 30. Long term acoustic measurement in France. Source: Shom.

The objective is to extract the ambient noise which is not easy because they have the complete soundscape but this raw data needs to be treated and to extract the different components of the sound.

In summary, to obtain the long-term acoustic measurement, the following steps are to be followed:

1. Extraction of ambient noise level;
2. Comparison with ambient noise modelling;
3. Assessing confidence of UWN maps;
4. To manage the station network to measure the descriptor.

As a conclusion, for the modelling approach they assumed some uncertainties and to obtain the long-term acoustic measurement, to compare and calibrate the model is necessary.

Panel discussion and questions and answers for the underwater noise in MSFD presentations

Cristina Cervera (IEO,CSIC) asked the participants if all of them were aware about what the others are doing and if they were able to identify the main similarities and differences among the methodologies. Benjamin Olivier (Shom) said that what all of them are doing is to compare acoustic measurements and modelling. He stated that it is important to always calibrate the models and to work together and share the different approaches. Manuel Bou (IEO,CSIC) identified that they use more or less the same information although following different technical. But the workflow is the same. The results could change but they would be able to identify the differences and be aware of these differences in methodologies, results and technical data used. Fabrizio Borsani (ISPRA) commented than from the TG-noise they were updating the monitoring guidance process; it is important to keep in touch in the EU to link the different modelling and methodologies at a European level, because a lot of effort has been done in the EU to find, for example, the best model for the transmission loss.

Cristina Cervera (IEO, CSIC) related the previous question to MSP and the need for transboundary collaboration, which is especially relevant for the effect of UWN from maritime traffic on species like cetaceans that are moving species. So, in this given transboundary situation, how is it possible to compare and make compatible the different analysis and models developed in the different countries and results obtained? She added that this is probably related to ACCOBAMS guidance factsheets for common indicators for monitoring the ambient noise, because collaboration is needed.

Cristina Cervera (IEO,CSIC) asked another question regarding OWF, wondering if is there any other country studying this topic in relation to UWN? Benjamin Olivier (Shom) said that in France, they are considering the anthropogenic inputs for the UWN but no specifically OWF. Fabrizio Borsani (ISPRA) said that Italy is passing 41 application for OWF through the national commission of impact assessment, taking into consideration the UWN, trying to harmonize the noise registries. He added that, in Italy, they are merging impulsive and continuous noise.

Maylis Salivas (ACCOBAMS) asked Fabrizio when Italy is including the data into the ACCOBAMS register. Fabrizio Borsani (ISPRA) said that they will include the data as soon as they have them. They hope by 2022 but he is not sure about which information could be published because some information will be confidential, for example, the commercial sensitive data. He believes that they will be able to merge the information at the metadata level.

Cristina Cervera (IEO, CSIC) queried the panel about how are the different countries going to consider the effects of small ships lacking location systems, if they are working on it or, at least, they will try to? Benjamin Olivier (Shom) said that currently, they are not considering it. They do not have that information. He said that they are starting to work with radar observations so, maybe, that could contribute to give some information about the maritime traffic coming from boats without AIS, but with this data, they will not know the length, spped and other aspects, so it will not be possible to integrate that information into the models.

Fabrizio Borsani (ISPRA) commented that in Italy, these data are recording through a system called “VTS”, which is for smaller ships and through the coastguard that, at least in summer, they are recording the activity of recreational vessels. He also wanted to mention two relevant things in his opinion. First, for the noise measuring recordings of environmental sounds across the Italian seas, they have an agreement with the Italian navy submarine department to calibrate some of the hydrophones from their vessels and making a procedure for them to record and to analyse the date; so they are providing non-sensitive information, like positions and dates, but they provide the sound levels so that is a great way of taking advantage of the data that the navy is already recording. Manuel Bou (IEO,CSIC) declared that he is trying to contact with people of IEO that work with VMS data to do a pilot study for small fishing vessels with VMS but, at the moment, it is not easy to establish a correlation between the characteristics of the ship and the source level, because VMS and AIS provide different data. Despite of the difficulties they will continue trying to find a proper solution. and the characteristics of the vessels. Benjamin Olivier (Shom) observed that the situation is the same for France.

Cristina Cervera (IEO,CSIC) added that there is something else that must need to be considered; which is that some ships lack of both systems. Fabrizio Borsani (ISPRA) pointed out that the General Fisheries Commission for the Mediterranean (GFCM) has appointed JASCO S.L, which is a worldwide company that does acoustics at sea, with the study on an MPA in Croatia and the study of the impact of the fishing vessels. As soon as this document is published, the project could be replicated in other places of the Mediterranean for Marine Protected Areas (MPA), because it is very interesting and accurate. and it could be a very good step forward if MPA could motivate the fishermen to collaborate in this kind of issues, for both, for fishermen to fish better and more and for the MPAs to be more effective.
Federica Pace (JASCO) corroborated that the document was not published yet but they are aiming to make the report public, although they do not know which information will be published. Fabrizio Borsani (ISPRA) pointed out that previously that day, there was an indication of floating platform study from JASCO that it is available to be downloaded at https://www.jasco.com/public-reports,, which it is full of interesting technical information for the evaluation of OWF.

Part 2 – Underwater bio-acoustic monitoring

Underwater bio-acoustic projects/initiatives

Bio-acoutics in Cabo Rorcual project – Eduardo Belda (Polytechnic University of Valencia ((UPV))

Fin whales (*Balaenoptera physalus*) have been seen recently really close to Alicante's coast, but these sightings have not always been usual. The data used by Cabo Rorcual project come mainly from satellite tracking. These data show that fin whales use Ligurian sea and gulf of Lions as feeding grounds in summer and then they migrate southwards towards the Sicilia channel. The animals found within this area belongs mainly from the Mediterranean subpopulation of fin whales. It its suggested that there are two subpopulations of fin whales in the Mediterranean, which usually do not breed inter-population, at least not frequently. One of the subpopulations is formed by the natives' Mediterranean fin whales, which stay in the Mediterranean the whole year round, and the other migrate to the Atlantic. In *figure 31* it can be observed from satellite tracking data that some fin whales that feed in the Ligurian sea, migrate to the Atlantic Ocean.

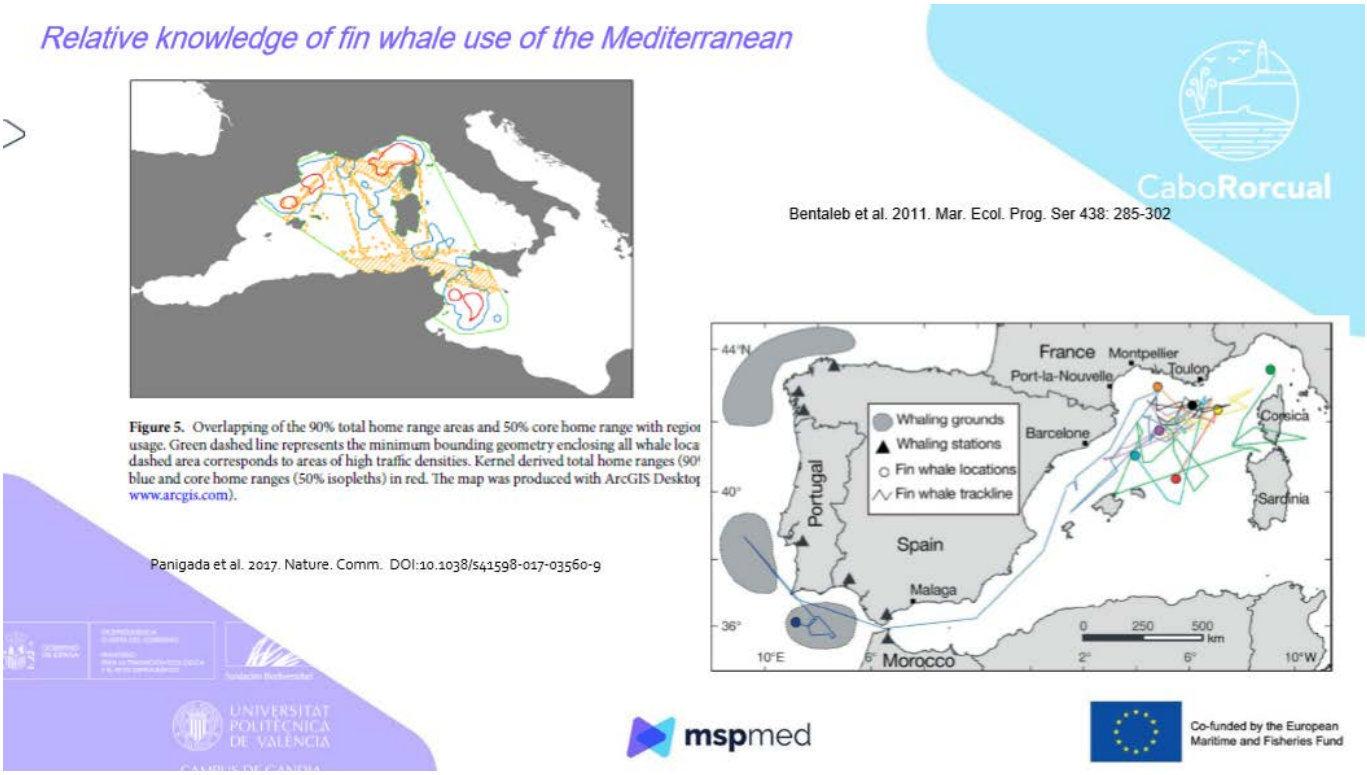


Figure 31. Knowledge of fin whales in the western Mediterranean. Source: Cabo Rorcual Project.

There is relative knowledge on the fin whales use of the Mediterranean. There are several research groups studying them. For example, it is though that there is a spring feeding area close to Barcelona's coast but further studies need to be performed.

Passive Acoustic Monitoring (PAM) is one of the desirable methods to study the possible fin whale migration near the Mediterranean coasts. The general idea that researchers have is that the Atlantic population enters the Mediterranean and feed close to Spanish coasts up to the Ligurian Sea and in the early summer they return. PAM shows that these two subpopulations might be differentiated by their distinct vocalization characteristics.

The UPV, through Cabo Rorcual project, started a study in La Nao Cape thought an area which treasures several MPA and that coincide with the start of "The Mediterranean Cetacean Corridor" MPA that continues until the offshore areas of Girona's coast. Visual and acoustic methods are combined to study this migration. PAM is performed through "SAMARUC" PAM device, suitable for studying fin whales and most of the cetacean Mediterranean species. For fin whales vocalizations, 20 Hz pulses is the frequency usually study, which is mainly produced by males related to reproductive behaviour. There are other sounds recorded like upsweeps (135 Hz) and down sweeps (high and low frequency).

To carry out the study, several PAMs where settled through the study area. There were a lot of sightings whit a clear migration pattern. Acoustic registers by SAMARUC are difficult to analyse due to the background noise, due to marine traffic. Therefore, the results showed no detection of fin whales. Background noise prevents the use of automatic detectors.

Due to the availability of visual detections, they were able to combine this visual observation at specific times with the information of the PAM devices; so specific detectors for the vocalization sounds were designed, based on the spectrogram and they calibrated the machines to eliminate the background noise and obtain the detection data of the fin whales. There are differences in the sound patterns through the different seasons. For example, in summer the pattern is not clear (maybe because of the additional noise coming from recreational boats), but in autumn it is much clearer.

The second objective is to establish a long-term monitoring in a widespread area, to record and try to know the species present during all the seasons and where the fin whales are through the year. Collaboration with other institutions is one the most positive issues which could lead to further and deeper studies. For instance, some of the settled devices are used to monitor underwater noise by IEO(CSIC).

KM3NeT Observatory. Bio-acoustic activities – Guillermo Lara (IEO, CSIC)

KM3NeT is a neutrino particles telescope, located in the deepest seas of the Mediterranean to contribute to research of the properties of the neutrino particles, through the arrays of thousands of optical sensors that detect the faint light from charged particles originated from the collisions of the neutrinos in the Earth. The use of the KM3NeT Infrastructure is a unique opportunity to monitor bioacoustics activities in the ocean through its hydrophone.

KM3NeT has two sites:

- ARCA: Astronomy Research with Cosmics in the Abyss
- ORCA: Oscillations Research with Cosmics in the Abyss, located in the Gulf of Lions, which is the one we will be focus on.

For the bio-acoustic analysis, in relation to marine mammals, common signals are used to monitor presence/absence of individuals can be divided in Echolocation clicks and pulses and wide band whistles: Wide band whistles have been selected to study the acoustics because they are omnidirectional. If we were using the Echolocation clicks and pulses, the sounds would only be detected if they are directed/looking straight to the hydrophone.

In *figure 32*, it is shown there are with the highest delphinids presence. Most of the delphinids species produce similar whistles in terms of frequency, being the long-finned pilot whale (*Globicephala melas*) the only species easy to identify.

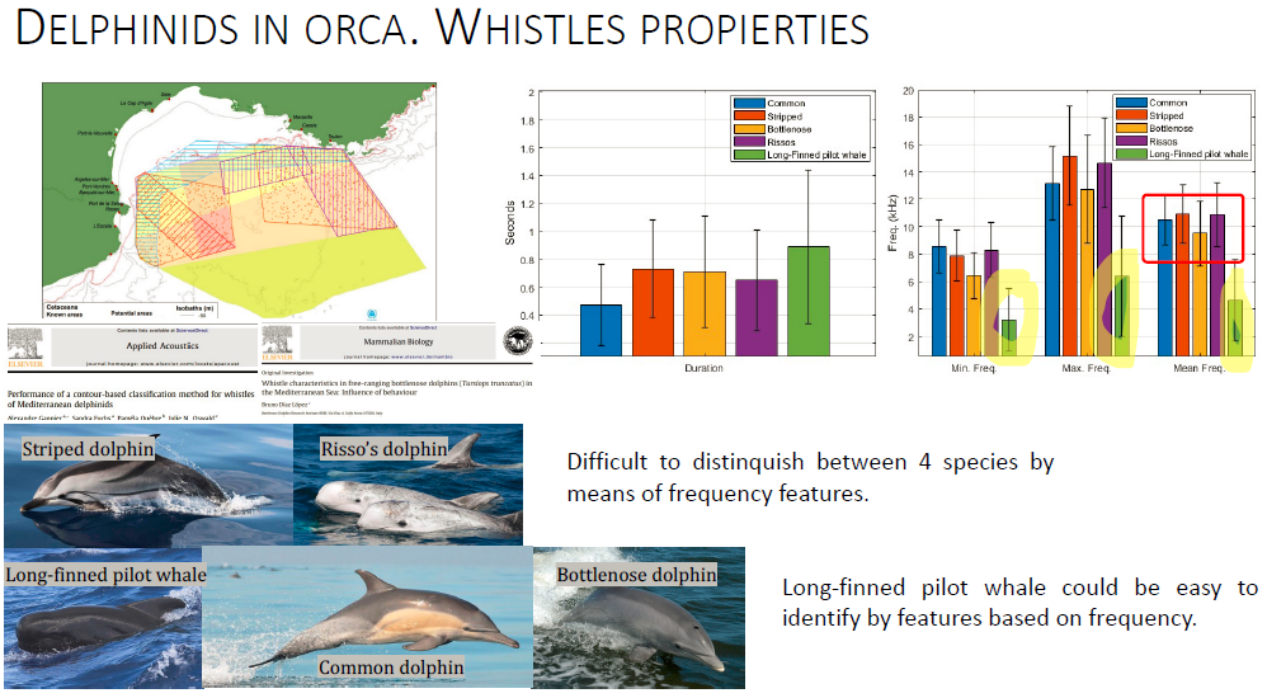


Figure 32. Whistles properties of the delphinids in ORCA. Source: KM3NeT.

Co-funded by the European
Maritime and Fisheries Fund

An automatic whistle detector has been implemented to perform long term monitoring of delphinids, based on the most used frequency range of delphinid whistles (4 kHz – 23 KHz). The results show that there are variations of the number of whistles in different years and different times of the year (*figure 33)*, and the most frequency detected is between 7 and 13 kHz.

Results of whistle detector

The analysis carried out shows information about the use of habitat of delphinids in different seasons:

- Number of whistle events heatmap (time basis 1h).

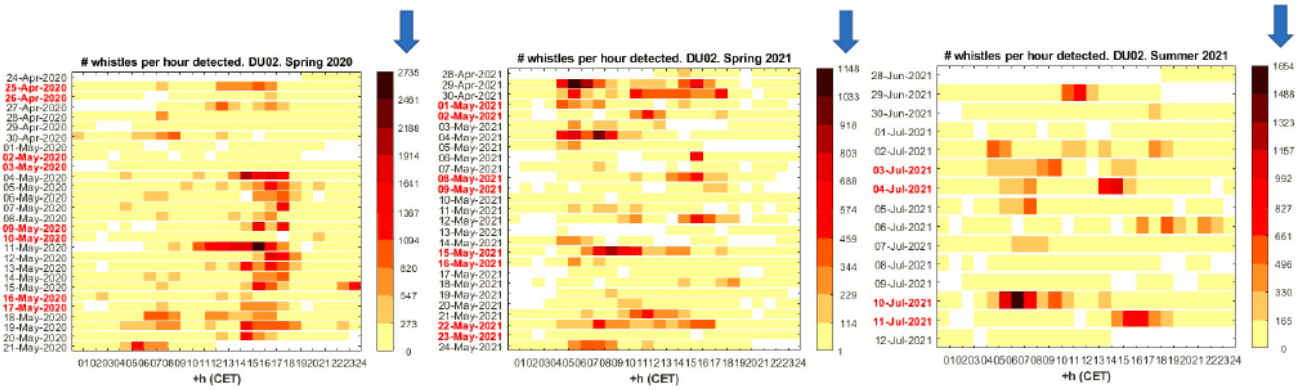


Figure 33. Whistles detector results. Source: KM3NeT.

When plotting this information, it could also be observed (*figure 34*) the circadian patterns that vary every season and throughout the years.

Co-funded by the European
Maritime and Fisheries Fund

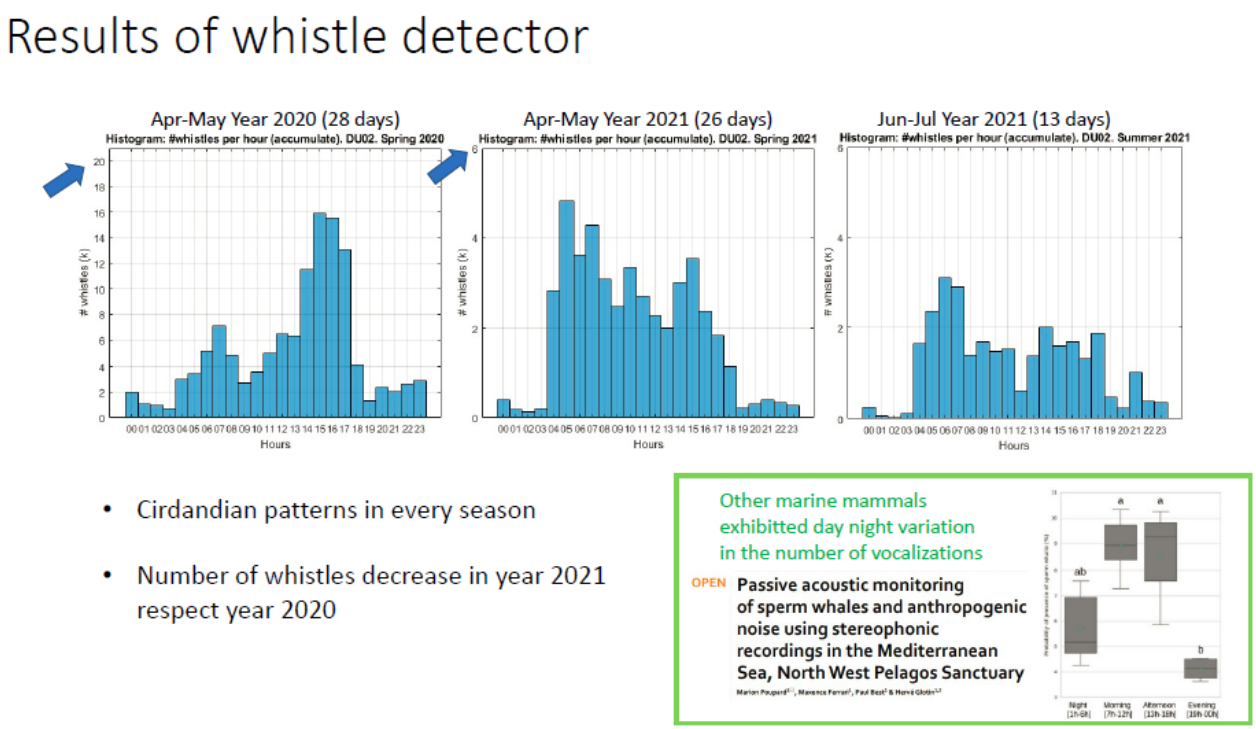


Figure 34. Whistles detector results. Source: KM3NeT.

As a conclusion, KM3Net – ORCA is ideal to do long-term studies about animal habitat and a long-term acoustic monitoring and it is relevant that median SPL per hour increases in year 2021, in comparison to 2020 in low frequency bands, maybe due to the Covid19 pandemic and, therefore, the diminution of maritime traffic during that period of time.

New algorithms are being design to detect and the presence and be able to study other marine mammals (like fin whales) and it is being studying a source location using the 3 hydrophones available in ORCA site.

Analysis tools applied on bioacoustics signals – Ramón Miralles (iTEAM-UPV)

There are different available tools to work with bioacoustics signals, that are provided with different features like Pamguard, Triton, TheCornellLab and SAMARUC. SAMARUC refers to both, the software and the PAM acoustic device, which other participants mentioned before. In this case, Ramón Miralles talked about the software.

They wanted a system that works well when analysing very long recordings (even several months). They wanted to add several plugins or detectors that they can program themselves. SAMARUC has a powerful graphical representation preserving seasonal structures. There is the

possibility of creating neural networks for detection and classification of acoustic events and to classify the different sounds of different species in distinct categories, as well as to transform the sounds into images.

The aim is to be able use the BIG DATA graphical representations to query the database of recordings. The main goal is to detect automatically detect the characteristic sounds of each species.

Neural Networks and their recent advances could be used for the detection and for the classification of acoustic events (*figure 35*).

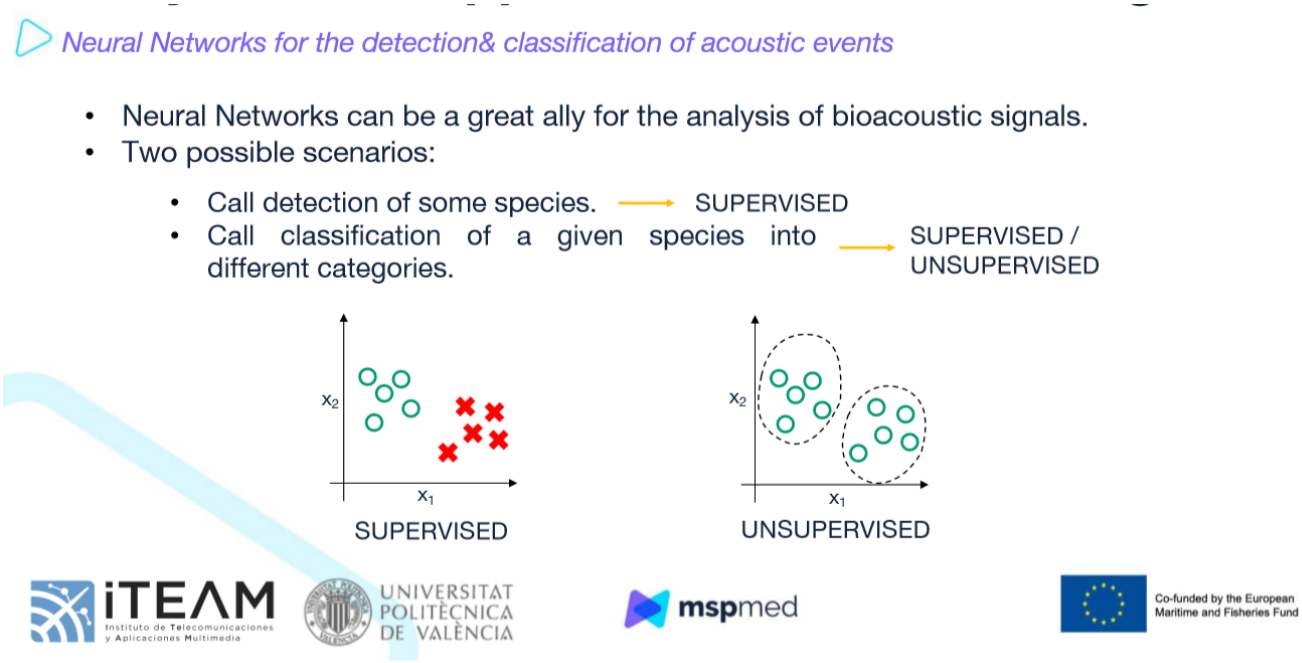


Figure 35. Neuronal networks for the detection and classification of acoustic events. Source: iTEAM-UPV.

We can create a spectrogram to transform the sounds into images, through neural networks. For call detection of some species sounds as fin whales. To do that, they have a training set with different sounds of the animals where we are trying to detect and also with some sounds that look like the ones that interest us but that are not them. Therefore, with the spectrogram of these sounds, they try neural networks and they evaluate how accurate their neural network is working with a different test set of sounds (*figure 36*) to be able to detect the false positives.

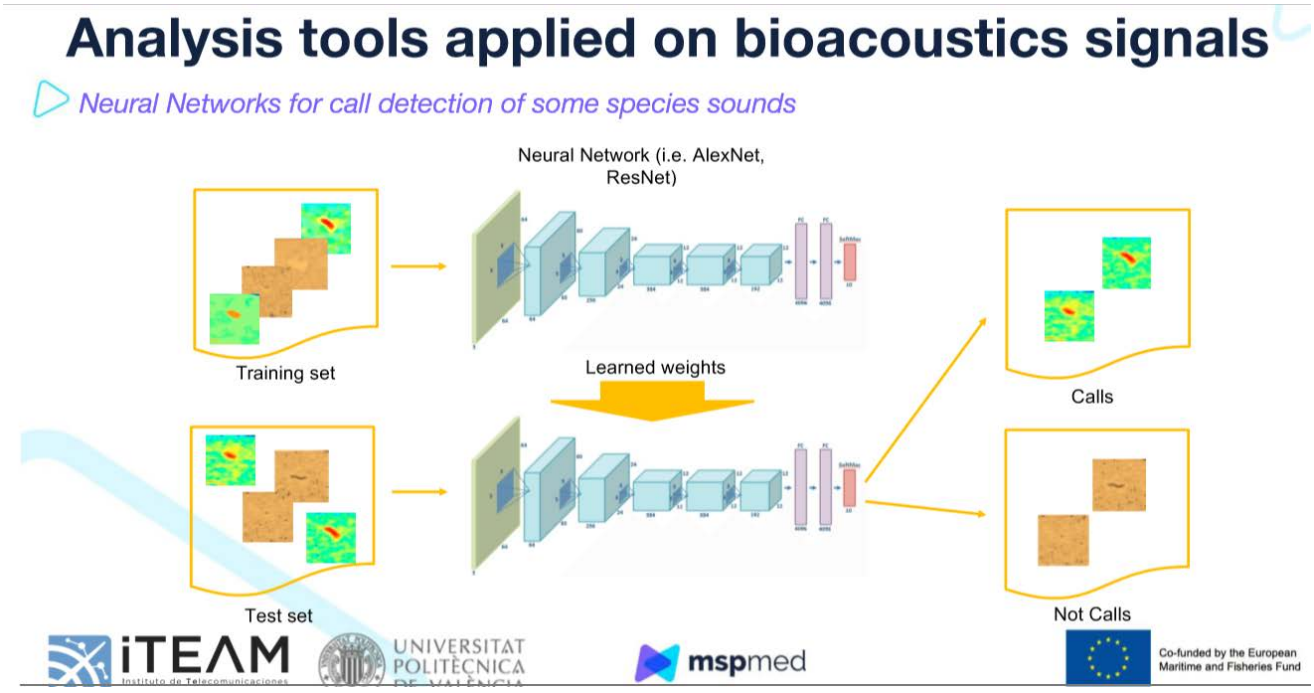


Figure 36. Analysis tools applied on bio-acoustics signals. Source: iTEAM-UPV.

As a conclusion, neural networks to classify the sounds are an easy and fast way, in contrast to the manual data extraction.

To finish, in *figure 37* we can observe an example for the classification of fin whale calls.

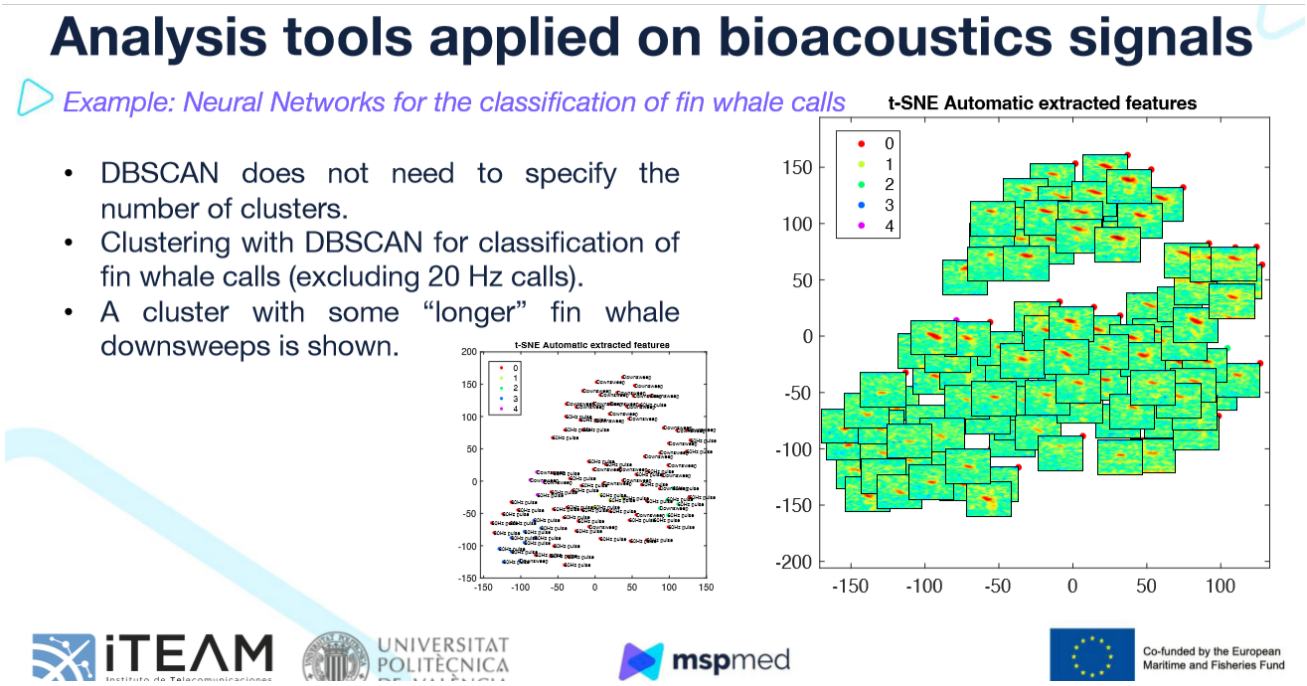


Figure 37. Analysis tools applied on bio-acoustics signals. Source: iTEAM-UPV.

Acoustic monitoring for precision aquaculture: acoustic observation network in Mediterranean marine farms (ACUPREC) - Víctor Espinosa (UPV)

This presentation is about ACUPREC new project for acoustic monitoring dedicated to precision aquaculture.

This a Project within the "Thinking blue", which is a joint Strategy for Research and Development in Marine Sciences, through the Recovery, Transformation and Resilience UE funds, that counts on 40 million of Euros just for Spain. The Regional Government of Valencia is going to dedicate roughly 10 million euros to research precision aquaculture.

This project has two focus:

- Real time biomass monitoring and control in floating cages using active acoustics (echosounders)
- Recording and characterisation of soundscape in marine farms, and the relationship between anthropogenic and natural sources with farmed fish behaviour.

They want to find a relationship between the sources of sound with the welfare of the farm.

The first idea to make biomass estimations through ultrasonic transducers at surface or at the bottom to monitor the whole column. Ventral perspective gives a more accurate picture with less bias, to estimate the fish density.

They also use the concept Target strength (TS); Strength is like the signal or the sign of every fish. As a principle, a higher TS indicates a bigger fish. The total backscattered energy is the sum of every fish contribution.

There are differences over time, because at night they tend to be calm, and more disperse and during the day, they tend to be together and more stress. So, at nigh it is the moment of calculating the total volume of the school of fish. The aim of the new project is to go into a whole production cycle with different species.

Also, they have different approaches based on the temporal characteristics of the echo of a fish for measuring the acoustical "hate" of the fish, having the distances between the echoes in the flesh-water interface and the swim bladder, method by which in the past they obtained very good results for estimating the size and weight of the fish. So, the biomass could be investigated this way. I can also be used to control the moment where the fish stop eating, by detecting the pellet falling. Therefore, we can detect when the fish stop eating, and stop the food supply. Thus, reducing pollution of organic pollutants and reducing economic losses. This method can be applied for several sizes of the pellets (*figure 38)*.

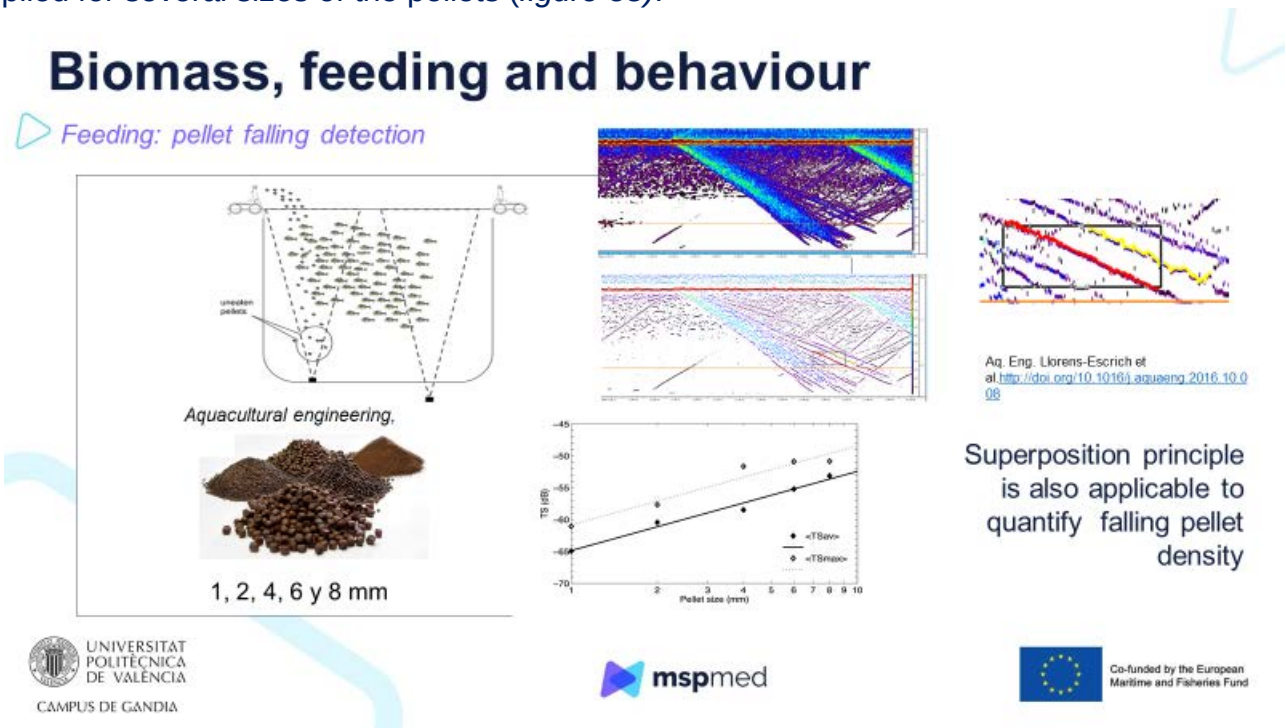


Figure 38. Biomass, feeding and behavior of aquaculture fisheries. Source: ACUPREC project.

This method could be combined with an echosounder, located in a cage, to monitor the vertical displacements of the fish. So, when the fish are starting to lose interest in the food, they start to go down, so the feeding should stop.

Thus, the best approach would be to combine both methods: pellet detection and behaviour.

In relation to welfare and intersection, there are evidences of the reactions of caged fish to underwater noise but there is still a lack of studies to understand the effects. For instances, everyday when the feeding boat is going close to the cages, fish go down until the feeding starts so they start to go up (studies made with caged TUNA[8]).

They also want to research other interactions of farmed fish with other issues. For instance, *Tursiop truncatus* have interactions with farming cages. It is thought that they even use the cages to fish their preys outside easily as an aggregation point.

They are also trying to create a monitoring network (there are already several points in our coasts) and their intention is to install, at least one system in one cage of every farm, with permanent communication to study the UWN with SAMARUC (PAM) with continuous communication.

Questions and answers for the underwater bio-acoustic projects/initiatives presentations:

Cristina Cervera (IEO, CSIC) said that it was spoken of different approaches of underwater noise: as a pollutant, soundscape, as a tool, etc. She informed that the following day we were going to talk about how to use this information for policy-making. Léa David (ACCOBAMS) commented that there was a lot of work carried out with different tools in the Gulf of Lion fin whales, close to the Spanish and French coasts during spring. She thinks it could be interesting to fill the information gaps by installing other hydrophones in other areas and it would be useful to have map to know where the hydrophones are in the water, depths, frequencies obtained by them, etc. to try to gather all the information for people to be able to contact each other and try to make a big picture of UWN.

Folco Soffietti (IUAV) commented by saying that being MSP a horizontal or transversal issue, it would be interesting to find practical ways to use the records and asking how could sound or UWN be useful for MSP.

Eduardo Belda (UPV) said that the idea of having all the information of where we have PAM devices, depths, etc. is very important, to know the noise propagation. People could know where the information is and here is the contact for that information, Maybe creating a portal with all this information would be useful for MSP and the rest of projects, for the general networking.

[8] de la Gándara, Fernando & Puig, Vicent & Soliveres, Ester & Perez-Arjona, Isabel & Espinosa, Víctor & Poveda Martínez, Pedro & Soriano, Jaime & Ordóñez, Patricia & Bou-Cabo, Manuel & Cort, José & Santaella, Eladio. (2021). Monitoring of Caged Bluefin Tuna Reactions to Ship and Offshore Wind Farm Operational Noises. Sensors. 21. 10.3390/s21216998.

Cristina Cervera (IEO,CSIC) to Manuel Bou (IEO,CSIC): You talked about the neutrino telescope. What is the scientific base of the neutrino particles?

Manuel Bou (IEO,CSIC) commented that, because there are a lot of particles from the universe and the eutrines do not interact with the matter so they offer a lot of information because they are not affected by deflection, electromagnetic fields, etc. The issue is that you need a lot of matter to maximise the detection because they are not easy to study. Neutrinos are detected in upward direction, so when they interact with the core of the Earth and release particles as a cascade, as "newtons" travel faster than light in water and when that happens and release a certain kind of blue light.

Léa David (ACCOBAMS) to Víctor Espinosa (UPV) said that the TUNA might react to the feeding boat because they know that food is coming.

Víctor Espinosa (UPV) said that there are evidences that it is because of that but they are still researching. The idea is to study the reactions of the caged fish to the different sounds.

End of the event

Cristina Cervera (IEO,CSIC) thanked everyone for attending in person and online, thanked again the speakers who presented the interesting initiatives and projects in relation to underwater noise and for the dialogue throughout the event. In addition, he invited to participate in the event to be held the following day in regards to the Trilateral meeting between Spain, Italy and France - Underwater noise assessment for decision support in MSP and related policies.

ANNEX I: Workshop agenda

Programme	
10th May- Underwater noise technical meeting	
9:30 - 9:45	**Welcome and introduction**
PART 1 – Studies and activities on underwater noise	
9:45 - 10:15	**MSPMED activities related to underwater noise:** - MSPMED project and Gulf of Lions Case Study (5') – *Mónica Campillos (IEO, CSIC)* - Underwater noise in the Gulf of Lions Case Study (15') – *Manuel Bou (IEO, CSIC)* - Q&A (10')
10:15 - 11:30	**Projects/initiatives related to underwater noise:** - H2020 - Saturn project: developing tools to support decision-making on URN assessment and mitigation (10') – *Thomas Folegot (QO) / Fantina Madricardo (CNR-ISMAR)* -ON LINE - QUIETSEAS project and case studies (10') – *Maylis Salivas (ACCOBAMS) & Benjamin Olivier (Shom)* - Ambient noise in the Gulf of Lions – *Cedric Gerveaise (CHORUS Acoustics)* (10') – ON LINE - Listening space reduction and excess noise estimation: the Faial-Pico test case - *Sergio M. Jesus (Universidade do Algarve)* (10') – ON LINE - Q&A (35')
11:30 – 12:00	**COFFEE BREAK**
12:00 - 13:05	**Underwater noise in MSFD:** - Underwater noise in the IMAP of the Barcelona Convention (10') – *Maylis Salivas (ACCOBAMS)* - TG-Noise (10') - *Junio Fabrizio Borsani, ISPRA & Co-Chair of TG Noise* - MSFD Descriptor 11 in Italy (15') - *Junio Fabrizio Borsani (ISPRA)* – ON LINE - MSFD Descriptor 11 in Spain (15') - *Manuel Bou (IEO, CSIC)* - MSFD Descriptor 11 in France (15') – *Benjamin Olivier (Shom)*
13:05: - 13:45	**Panel discussion + Q&A**
13:45 – 15:00	**LUNCH**
PART 2 – Underwater bio-acoustic monitoring	

15:00 - 16:00	**Underwater bio-acoustic projects/initiatives:** - Bio-acoutics in Cabo Rorcual project (15') – *Eduardo Belda (UPV)* - KM3NeT. Bio-acoustic activities (15') – *Guillermo Lara (IEO, CSIC)* – ON LINE - Analysis tools applied on bioacoustics signals (15') – *Ramón Miralles* - Acoustic monitoring for precision aquaculture: acoustic observation network in Mediterranean marine farms (ACUPREC) (15') - *Víctor Espinosa (UPV)*
16:00 - 17:00	**Q&A + Panel discussion**
PART 3 – RESULTS AND CONCLUSIONS	
17:00	**Conclusions and farewell**

Co-funded by the European
Maritime and Fisheries Fund

ANNEX II: Participants

Nombre	Institución
Aggelos Tsaligopoulos	Panteion University / University of the Aegean
Andrea Barbanti	CNR-ISMAR
Antonio Petrizzo	CNR-ISMAR
Armelle Sommier	Shom
Aurora Mesa Fraile	MITERD
Aurore Morin	IFAW France
Benjamin Olivier	SHOM
Blanca Feliu	UPV
Cedric Gervaise	Chorus Acoustics
Clement Graffard	CHORUS Research Institute
Eduardo Belda	UPV
Eric Delry	PLOCAN
Fabio Carella	IUAV
Fantina Medricardo	CNR-ISMAR
Federica Pace	JASCO
Folco Soffietti	IUAV
Francesco Musco	IUAV
Guillermo Lara	IEO, CSIC
Gulio Farella	CNR-ISMAR
Isabel Pérez Arjona	UPV
Julie Lossent	CHORUS Research Institute
Junio Fabrizio Borsani	Institute for Environmental Protection and Research (ISPRA)
Léa David	ACCOBAMS
Maite Hernández	MITERD
María Ceraulo	Institute for Environmental Protection and Research (ISPRA)
Marine Magnin	Chorus Acoustics

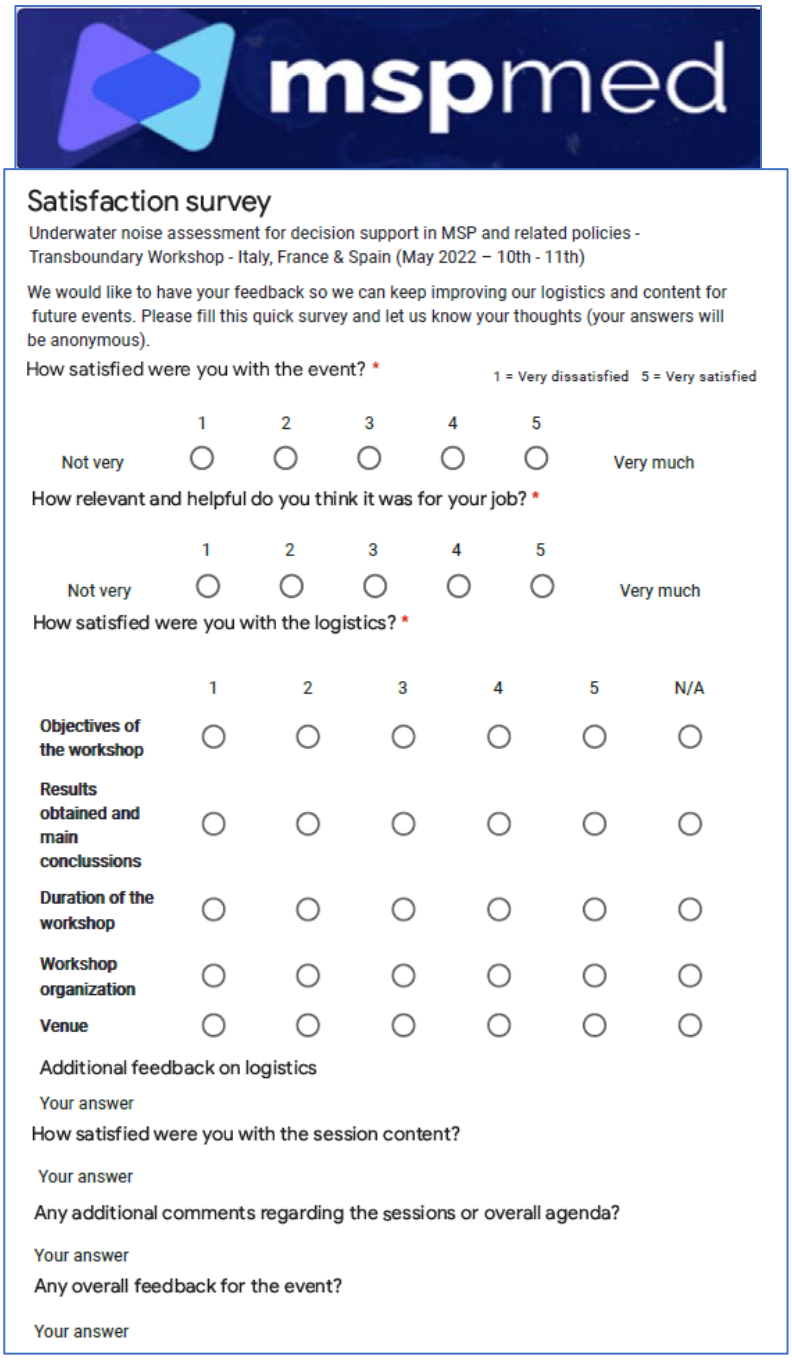
Marta Picciulin	CNR-ISMAR
Maylis Salivas	ACCOBAMS
Noé Swynghedauw	IFAW France
Noemí Vidal Martí	Tragsatec
Noémie Duron	Ministry of France
Ramón Mirallés	UPV
Sergio M. Jesús	Universidade do Algarve
Sofía Bosi	CNR-ISMAR
Soledad Manzanares	MITERD
Stefano Menegon	CNR-ISMAR
Susana Llorens	IEO, CSIC
Thomas Folegot	Quiet-Oceans
Víctor Espinosa	UPV
*Maria Gómez Ballesteros	IEO,CSIC
*Manuel Bou Cabo	IEO,CSIC
*Elena Gutiérrez Ruiz	IEO,CSIC
*Monica Campillos Llanos	IEO,CSIC
*Cristina Cervera Núñez	IEO,CSIC

* Organization MSPMED team from IEO(CSIC)

ANNEX III: Satisfaction survey

After the Underwater noise workshop and the Trilateral meeting between Spain, Italy and France, a satisfaction survey was sent to evaluate the degree of satisfaction of the events held.

The following are the questions asked to the participants:



Satisfaction survey

Underwater noise assessment for decision support in MSP and related policies - Transboundary Workshop - Italy, France & Spain (May 2022 – 10th - 11th)

We would like to have your feedback so we can keep improving our logistics and content for future events. Please fill this quick survey and let us know your thoughts (your answers will be anonymous).

How satisfied were you with the event? *

1 = Very dissatisfied 5 = Very satisfied

	1	2	3	4	5	
Not very	○	○	○	○	○	Very much

How relevant and helpful do you think it was for your job? *

	1	2	3	4	5	
Not very	○	○	○	○	○	Very much

How satisfied were you with the logistics? *

	1	2	3	4	5	N/A
Objectives of the workshop	○	○	○	○	○	○
Results obtained and main conclussions	○	○	○	○	○	○
Duration of the workshop	○	○	○	○	○	○
Workshop organization	○	○	○	○	○	○
Venue	○	○	○	○	○	○

Additional feedback on logistics

Your answer

How satisfied were you with the session content?

Your answer

Any additional comments regarding the sessions or overall agenda?

Your answer

Any overall feedback for the event?

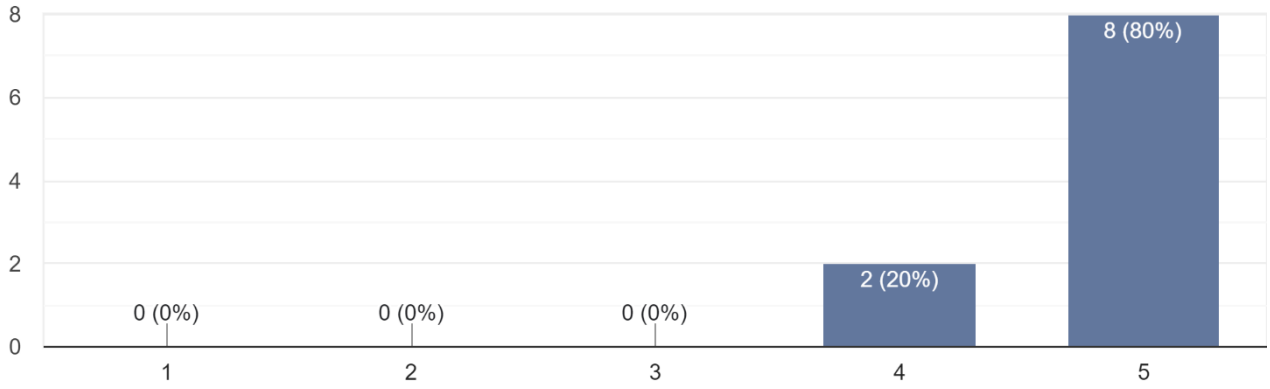
Your answer

Co-funded by the European
Maritime and Fisheries Fund

In total, 10 responses were received:

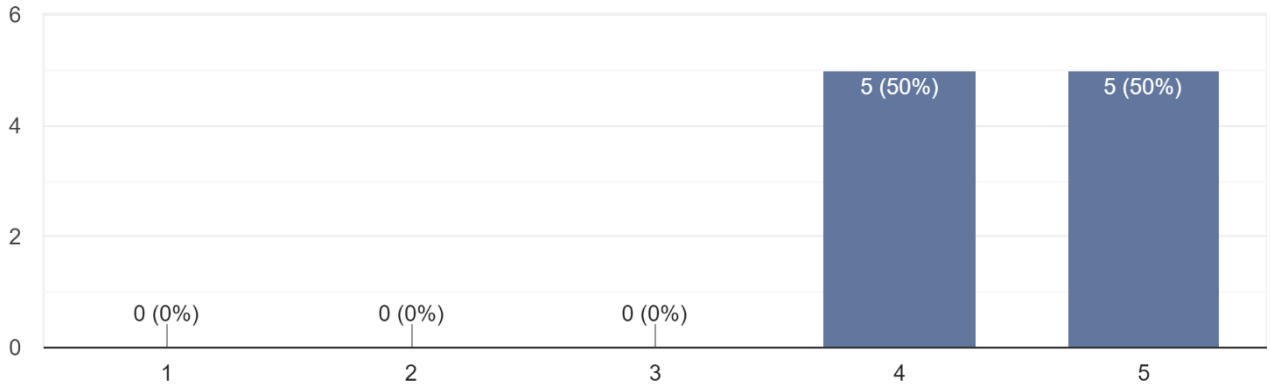
How satisfied were you with the event?

10 responses

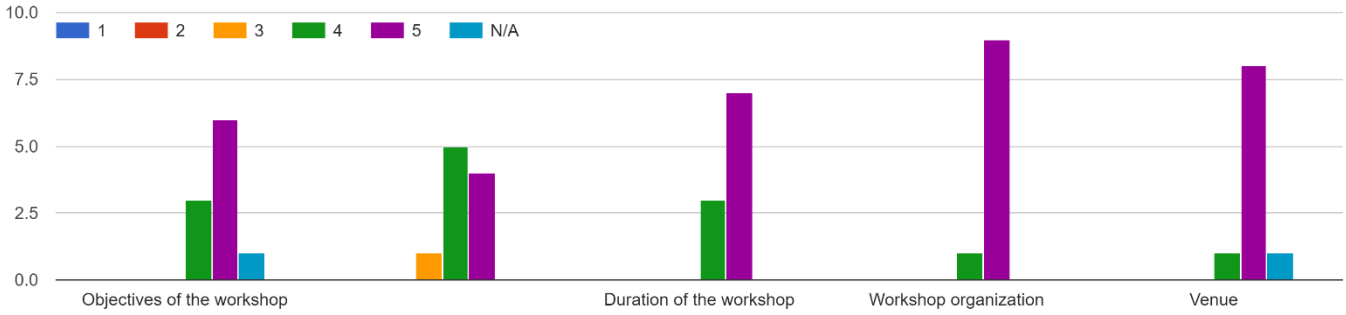


How relevant and helpful do you think it was for your job?

10 responses

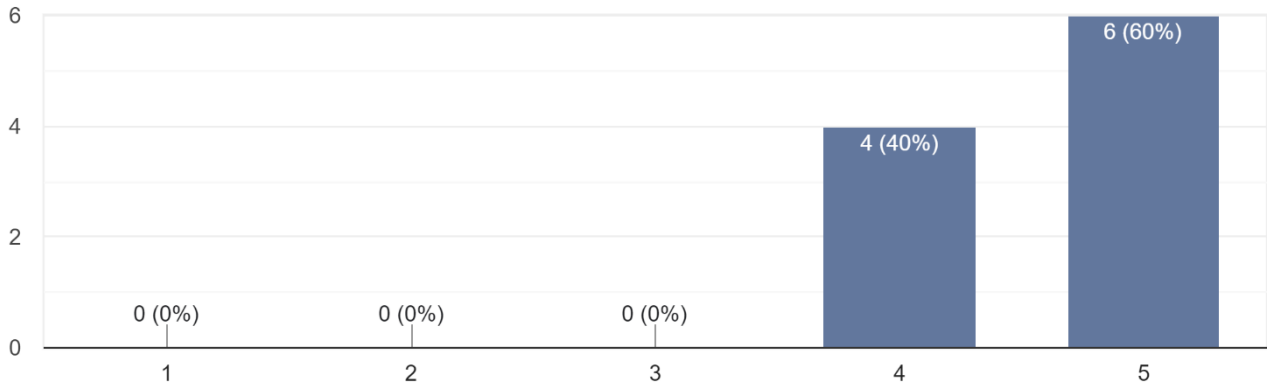


How satisfied were you with the logistics?



How satisfied were you with the session content?

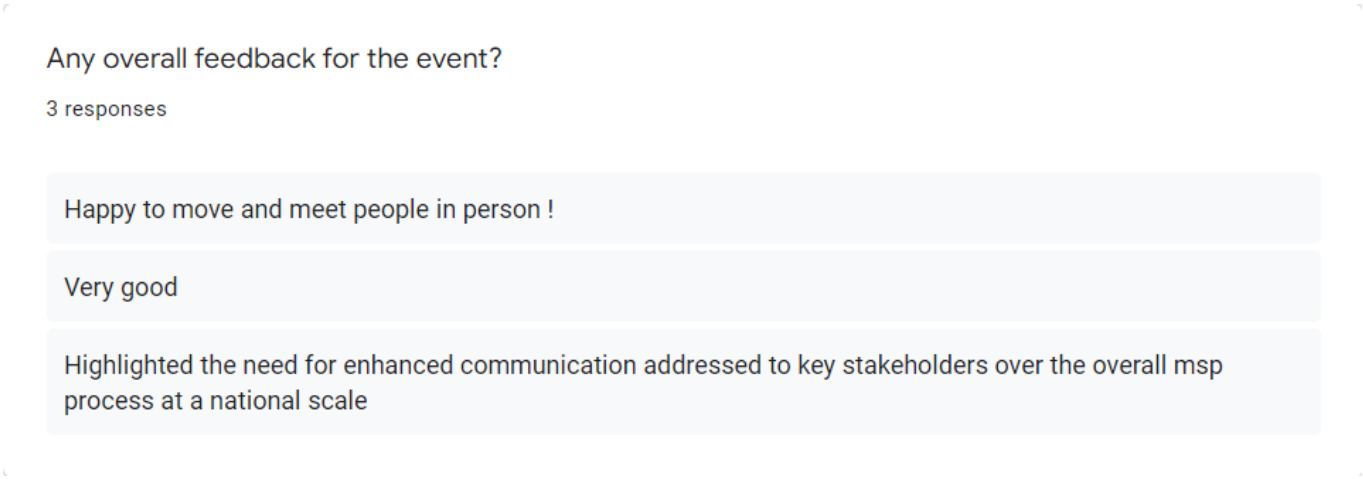
10 responses



Any additional comments regarding the sessions or overall agenda?

1 response

One thing I do for "my" workshop is that I send questions they have to think about before the workshop, even ask all people presenting their work to add a slide where they present some ideas on the subject (here it could have been : which synergy you imagine between your project and other existing project or new ones)....so they are more involve and already have thought on the main points...



IEO(CSIC) MSP team is taking into account this information obtained from the survey to improve future events.