

**MSFD Common Implementation Strategy
Technical Group on Underwater Noise
TG-NOISE**

**Providing research and scientific support to the
implementation of the Marine Strategy Framework Directive**

**Management and monitoring
of underwater noise in European Seas**

**Overview of main European-funded projects
and other relevant initiatives**

2nd Communication Report

December 2019

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1. Introduction & Context

1.1 Marine Strategy and TG Noise

The Marine Strategy Framework Directive (MSFD, 2008/56/EC) requires European Member States (MS) to develop marine strategies to achieve or maintain ‘good environmental status’ of EU marine waters by 2020. The Directive defines good environmental status (GES) as:

“The environmental status of marine waters where these provide ecologically diverse and dynamic oceans and seas which are clean, healthy and productive” (Article 3-5). GES means that the various uses of the marine resources are made at a sustainable level, ensuring their preservation for future generations.

The Marine Directive contains 5 main elements: the initial assessment; determination of good environmental status; establishment of environmental targets; monitoring programme (enabling the state of the marine waters concerned to be assessed on a regular basis); and the programme of measures to maintain and/or improve environmental status.

For determining good environmental status, 11 qualitative descriptors were defined, with descriptor 11 focusing on introduction of energy, including underwater noise. Underwater noise was formally defined as a pollutant in art 3(8) of the Directive. Member States are required to work together at European and regional levels to ensure a coherent implementation of the Directive.

To define and set up good environmental status, Member States are required to work with criteria and methodological standards for each descriptor in their marine strategies. In this regard, Commission Decision 2010/477/EU¹, adopted in accordance with MSFD Article 9(3), provided criteria and methodological standards to ensure consistency in the determinations of GES, and to allow for comparison between marine regions or subregions of the extent to which GES is being achieved. The 2010 Commission Decision was reviewed, and a new Commission Decision (EU)2017/848² was published in 2017, following the Commission’s assessment of the marine strategies’ first elements, as reported by Member States.

In the 2017 Decision, for Descriptor 11 two criteria are defined:

- The first criterion (D11C1) concerns anthropogenic impulsive sound in water and is described as follows:

The spatial distribution, temporal extent and levels of anthropogenic impulsive sound sources do not exceed levels that adversely affect population of marine animals.

¹ 2010/477/EU: Commission Decision of 1 September 2010 on criteria and methodological standards on good environmental status of marine waters (notified under document C(2010) 5956)

² Commission Decision (EU) 2017/848 of 17 May 2017 laying down criteria and methodological standards on good environmental status of marine waters and specifications and standardised methods for monitoring and assessment and repealing Decision 2010/477/EU.

- The second criterion (D11C2) concerns anthropogenic continuous low-frequency sound in water and is described as follows:

The spatial distribution, temporal extent and levels of anthropogenic continuous low-frequency sound sources do not exceed levels that adversely affect population of marine animals.

For descriptor 11, a technical group³ was formed (initially called TSG Noise, later TG Noise) in 2010, that consisted of nationally-nominated experts with experience in different regions and relevant scientific expertise. Back then, anthropogenic underwater sound was an emerging topic, and little was known about the levels and effects of underwater sound and advice was needed to develop monitoring of underwater noise descriptors, as defined in the 2010 Commission Decision. In particular, proposals for methodological standards for monitoring both types of underwater noise were needed. The technical group could also provide a common platform on how to develop objectives (characteristics of GES), environmental targets and associated indicators. In 2014, the EU Technical Group on Underwater Noise (TG Noise) delivered the guidance document: *Monitoring Guidance for Underwater Noise in European Seas*⁴.

Following this guidance, EU-funded projects and other scientific work in the field of underwater sound were implemented, and TG Noise compiled a paper of outcomes of relevant ongoing and future projects in 2017.

This 2nd communication report builds upon this 2017 compilation providing new information and updates regarding the main European-funded project and other relevant initiatives since then. This aims to be useful to experts, policy makers, and to those supporting Member States authorities in implementing the MSFD. In particular, for monitoring measures regarding underwater sound.

³ Technical groups have been assigned on technical tasks for specific emerging issues, under the common implementation strategy of MSFD, established by Member States and the European Commission.

⁴ Dekeling R.P.A., Tasker M.L., Van der Graaf A.J., Ainslie M.A, Andersson M.H., André M., Borsani J.F., Brensing K., Castellote M., Cronin D., Dalen J., Folegot T., Leaper R., Pajala J., Redman P., Robinson S.P., Sigray P., Sutton G., Thomsen F., Werner S., Wittekind D., Young J.V.: Monitoring Guidance for Underwater Noise in European Seas, Part II: Monitoring Guidance Specifications. JRC Scientific and Policy Report EUR 26557 EN, Publications Office of the European Union, Luxemburg,), doi: 10.2788/27158, 2014b. <http://mcc.jrc.ec.europa.eu/documents/201406241443.pdf>

1.2 Monitoring of underwater sound

Sound or Noise?

In this communication report the term “noise” is used when discussing sound that has the potential to cause negative impacts on marine life.

The more neutral term “sound” is used to refer to the acoustic energy radiated from a vibrating object, with no particular reference for its function or potential effect.

“Sounds” include both meaningful signals and “noise” which may have either no particular impact or may have a range of adverse effects.

Ambient noise, continuous sound

At the time the Commission Decision of 2010 was written, the international discussion on terminology to be used to describe underwater sound was not well-developed. By now, there is an ISO standard to describe terminology (ISO 18405:2017(E)); the Commission Decision therefore uses the term continuous sound and no longer terms like ambient noise, to be consistent with the ISO standard.

Impulsive Sound

Regarding high intensity, low and mid-frequency impulsive sounds, monitoring is being done in the form of a register of activities that generate such sounds. As most of these activities are regulated in some form, much of the information on the sound sources is available with regulators or parties responsible for generating sounds. The register will also bring together the information of all these (national) sources of information. Seismic surveys, pile-driving, explosives, sonars working at relevant frequencies and some acoustic deterrent devices are the most important sound-sources to be considered for inclusion in the register. In the Baltic Sea and North-East Atlantic Ocean regions, a joint register for impulsive sound is now available and hosted at the International Council for the Exploration of the Sea (ICES). In the Mediterranean and Black Seas, efforts are also being made to establish a register for impulsive sound.

Continuous Sound

Before the MSFD required EU Member States to address underwater noise, sound levels in European marine waters and their impact on the ecosystem were not monitored so historical levels and trends are not known. Continuous sound is caused by both natural and anthropogenic sources. The most ubiquitous source of anthropogenic continuous sound is commercial shipping, but in some regions seismic surveys can be a notable contributor too. In areas of intensive human activity, these anthropogenic sound sources tend to dominate natural sound sources at the low frequencies. At higher frequencies, natural sounds tend to dominate. In the 2014 Monitoring Guidance TG Noise advised MS to work together in a sub-region to set up monitoring. This report describes how, in sub-regional monitoring, continuous sound has now started in joint monitoring programmes from the onset, as well as new project initiatives being developed at a regional or sub-regional scale.

1.3 The role of Regional Sea Conventions, International Agreements, ICES and MSFD Competence Centre

Regional Seas Conventions (RSCs) have an important role in the Common Implementation Strategy (CIS) of the Marine Strategy Framework Directive. The directive requires EU MS to coordinate their actions on marine waters, in these regions and sub-regions, using relevant mechanisms and structures of Regional Sea Conventions, as well as other relevant international forums (Article 6 of MSFD). Making use of the experience and existing cooperation in coordinated monitoring, RSCs have played an essential role in monitoring of underwater sound which has been or is being developed, in joint monitoring programmes.

In the Baltic Sea, the **HELCOM Expert Network on Underwater Noise (HELCOM EN-Noise)** supports the HELCOM countries in the development of a monitoring and impact assessment strategy, regarding underwater noise. Progress, built on BIAS project results, has advanced in agreeing common indicators and associated monitoring. Furthermore, the [regional monitoring sub-programme on continuous noise](#) was approved in 2018 (Outcome of HOD 54-2018, para. 4.11).

In the North East Atlantic, the **Intersessional Correspondence Group on Underwater Noise (ICG-Noise) working group** co-ordinates the activities of the OSPAR Contracting Parties on underwater noise. It is evaluating present (pressure) indicators and work has started to evaluate what would be the best way forward in developing impact indicators. OSPAR is building on the experience of the Joint Assessment and Monitoring Programme to further cover MSFD requirements.

The HELCOM and OSPAR work on impulsive sound monitoring has led to a single, combined register for impulsive sound, available at the **International Council for the Exploration of the Sea (ICES)**.

In the Mediterranean and Black Seas, the Agreement on the Conservation of Cetaceans of the Black Sea, Mediterranean Sea and contiguous Atlantic area (ACCOBAMS) is taking forward work on underwater noise (D11) on behalf of the Convention for Protection of the Mediterranean Sea against Pollution (Barcelona Convention), and the Convention on the Protection of the Black Sea Against Pollution. **The ACCOBAMS Joint ACCOBAMS/ASCOBANS/CMS Working Group on Noise** is supporting the development of the Mediterranean Strategy on Underwater Noise monitoring. It has recently prepared guidance for D11 in the framework of the UNEP/MAP EcAp initiative.

TG Noise reports regularly on update on regional initiatives to ensure progress in consistency and coherency between approaches of the European & Regional Seas Conventions.

2.Underwater Noise: Key Projects and Initiatives

This report presents a selection of key projects and initiatives and their relevant results, for the implementation of Descriptor 11 – introduction of energy, including underwater noise (criteria D11C1: impulsive sound sources and 11C2 – continuous low-frequency sound, respectively). This aims to make their findings and outputs more accessible and available and to ensure transparency and replicability.

2.1 Completed Projects & Initiatives in European marine waters

BIAS - Baltic Sea Information on the Acoustic Soundscape

Funding origin	EU LIFE+ Collaborative project
Lead organization	Swedish Defence Research Agency (Sweden)
Duration	2013 – 2016

The BIAS project was the first effort in EU waters to conduct a joint, large scale (basin wide), standardised monitoring project to measure underwater sound across national borders, with the purpose of establishing an ambient sound baseline.

BIAS focused exclusively on the monitoring of continuous low frequency sound (ambient noise). The project aimed at establishing a regional implementation plan for this sound category, with regional standards, methodologies, and tools allowing for cross-border handling of acoustic data and the associated results.

The Baltic Sea is a semi-enclosed sea bordered by nine states. It consists of 8 sub-catchment areas (basins) and numerous harbours. The density of shipping traffic in some parts of the Baltic are some of the highest in Europe. Estimates suggest that about 2000 sizeable vessels are at sea at any one time.

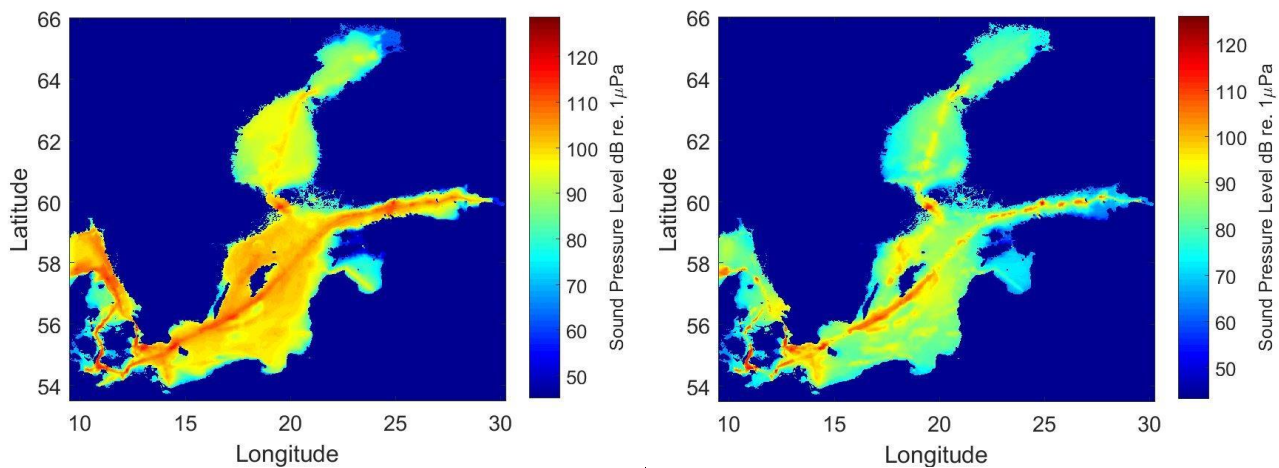
The regional approach of BIAS was important for several reasons. First, the MSFD specified a series of actions, such as monitoring and modelling of the average noise level to be carried out within the spatial division of marine regions or subregions, with the Baltic Sea constituting one of these (MSFD Article 6). Conditions, problems and needs vary between marine regions; therefore, each requires region-specific solutions. The transboundary nature of the marine environment calls for cooperation both at EU and regional levels. Underwater sound itself has a transboundary nature, especially low frequency sound that can propagate across the entire Baltic Sea. Furthermore, there are likely economic benefits from co-ordinated regional monitoring and assessment of underwater sound, as compared with the alternative of individual national approaches.

The objectives of BIAS were formulated to create the foundation for an efficient joint management of underwater sound in the Baltic Sea, by elucidating and solving, the major challenges of ambient sound monitoring. During its lifetime, BIAS cooperated closely with TG NOISE.

Thereby, the work conducted within the project was based on the TG Noise monitoring guidance and specifications, which were adjusted and further developed, based on practical experience gained through their application in the Baltic Sea region. Although the project focused on the Baltic Sea

region, its outcomes are also relevant for other marine regions of the EU.

Further, the BIAS project ran a field programme in 2014, where autonomous hydrophones were deployed at 36 locations offshore throughout the Baltic Sea. The sensors were serviced every third month for maintenance and data recovery before being redeployed. The data have been used to establish monthly statistical sound levels in terms of sound pressure levels as well as to “calibrate” a numerical model for sound in the Baltic Sea. Soundscape maps were produced for the entire Baltic Sea. Monthly maps for the third octave frequency bands 63, 125 and 2000 Hz were produced for three depth intervals and for different percentiles, see figure 1 for examples of soundscape maps from the project.



Soundscape maps of the monthly average sound pressure level during 2014, February (left) and August (right), for the 1/3 octave band 125 Hz, estimated over the whole water column. Colour-codes denotes the decibel level in each geographical position. These sound levels occurs 25 percent of the time or more. Blue-turquoise colour shows the natural ambient sound levels in the water about 60 to 90 dB re 1 μ Pa and orange-red about 100 dB re 1 μ Pa which is often sound of anthropogenic origin.

The results show that the Baltic Sea soundscape is dominated by sound from shipping lanes, but there are large variations in sound level both over time and space, due to variations in shipping traffic, and in environmental factors influencing the propagation of sound.

The soundscape maps constitute the cornerstones of a web-based, soundscape, planning tool, which facilitates a user-friendly interface between results and managers. The newly developed tool can be used to analyse the soundscape, both spatially and temporally and, thus, link pressure to impact, bringing us one step closer to GES.

BIAS has successfully channelled the dissemination of results, mainly through the forums of the HELCOM Baltic Marine Environment Protection Commission (Helsinki Commission) and HELCOM Expert Network on Underwater Noise (HELCOM EN-Noise). A cooperation between BIAS and HELCOM has developed, in particular with the working groups on Pressure and State & Conservation, as well as within the BalticBOOST project. Together with the Member States, the European Commission and other Regional Conventions, HELCOM is now regarded as the target audience for the outputs of the BIAS project. However, the experience and lessons learned are definitely relevant for other marine regions. The knowledge gained by BIAS is being shared through the BIAS Implementation Plan (Nikolopoulos et al., 2016) to the Member States of the EU.

In 2018, the Heads of Delegation, the executive organ of HELCOM, decided that ICES should be the host of the data portal for the HELCOM member states, where data will be uploaded to by the member states and stored. ICES will also host the web-based tool, which will be used to present monitoring data and sound scape maps. The data portal is planned to be up and running in late 2019.

Topics of relevance:

- *Standards for measurement and signal processing*: The BIAS project further developed standards for monitoring methods, and for the methods needed to convert raw data into usable sound pressure products. The standards were published as two separate reports.
- *Quality Assurance guidance*: The BIAS project developed quality assurance standards for systematic measurements and data analyses, feedback loops for error prevention, and inspection routines to control and harmonize project procedures among different performers. The internal audit reports for the quality assurance actions, and a description of the inter-organisation comparisons of the data processing methods (ring-tests) are provided in the BIAS quality assurance report. The QA guidance is highly relevant and can be applied also to other initiatives.
- *Soundscape planning tool*: One of the main legacies of BIAS is a GIS-based soundscape planning tool for continuous underwater sound in the Baltic Sea, containing both the modelled soundscape maps as well as measured data. The tool was developed for managers to facilitate their evaluation of underwater ambient sound. Specific needs and requirements of the end-users were incorporated into the tool design, through surveys among the targeted national authorities, within MSFD management and HELCOM. The BIAS soundscape planning tool is available through the BIAS website (see link below).
- *Implications/lessons learned for new projects*: BIAS learned much during its implementation that is of use for anyone planning to implement a joint monitoring programme. New project initiatives, in particular those under preparation in the North Sea Region and in the Atlantic will build upon the lessons learned from BIAS and its recommendations (see section 2.3).

The relevant public documents produced by BIAS are available at the project webpage

www.bias-project.eu >> Downloads >> Deliverables

AQUO - Achieve Quieter Oceans by shipping noise footprint reduction

Funding origin	European Commission - 7 th Framework Programme
Lead organization	DCNS, Naval Group (France)
Duration	2012 – 2015

The AQUO project has provided policy makers with practical guidelines to reduce shipping noise footprints. The practicality of the guidelines was ensured by involving shipyards and ship owners in an end-user committee of 23 major stakeholders from the maritime industry, in and beyond the borders of EU. These include: Anave, Confitarma, Armateurs de France, Engie, STX France, HHI, SHI, IHC, CMA CGM, NOAA, Port of Vancouver.

AQUO experts have developed tools to assess, not only the current situation with regards to the anthropogenic sound from shipping on a whole basin scale, but the quantitative tools that would

enable policy makers to assess scenarios with different noise mitigation measures, in the concerned area. These include solutions, either linked to ship design (including structure and machinery, propeller design and other sound and vibration contributors), or solutions related to shipping control and regulation.

The solution portfolio, aimed at answering the needs of several levels of maritime industry, was addressed with consideration of cost effectiveness (ensuring both fuel efficiency and noise mitigation reductions) and of fleet applicability (new builds or existing vessels). To complement the marine engineering studies, dedicated experiments have been conducted on three species, representing the 3 main orders potentially affected by noise: invertebrates, fishes and marine mammals. Bioacoustics criteria were implemented in the methodology, so as to quantify the effects on the fauna of a given scenario, in a given area.

Topics of relevance:

- a shipping underwater sound footprint assessment tool, using actual shipping traffic data and so including AIS (Automatic Identification System) data, coupled with multiparametric models and methods that predict radiated sound from ships, by addressing propeller behaviour, machinery radiation and hull hydrodynamics vibro-acoustic interactions with regards to sound;
- a standard for measuring underwater sound produced by shipping, quantifying in situ uncertainties from onsite experiments, including both deep and shallow water conditions which represent various EU waters;
- new vibro-acoustic, measurement tools and methods that can be applied to full scale experiments at sea and at model scale in test basins;
- fauna impact scaling approach to determine bioacoustics criteria and good practice for protection of marine life from underwater noise, based on analysis of available data and specific bioacoustics experiments on certain marine species,
- a list of design improvement solutions to reduce ship underwater radiated sound, without reducing fuel efficiency of the ship;
- a range of operational mitigation measures;
- practical guidelines summarising the benefits of the various scenarios (technical and operational solutions) in terms of noise and of fauna impact.

The relevant public documents produced by AQUO are available [online](#).

SONIC - Suppression Of underwater Noise Induced by Cavitation

Funding origin	European Commission - 7 th Framework Programme
Lead organization	Stichting Maritiem Research Instituut Nederland (Netherlands)
Duration	2012 – 2015

The aim of the SONIC project was to develop tools to investigate and mitigate the effects of underwater noise generated by shipping, both in terms of the footprint of an individual ship (a “noise footprint”) and of the spatial distribution of sound from a large number of ships contribution to the sound (a “noise map”). The project’s first objective was to enhance the understanding of noise

generated by a cavitating ship propeller. The second objective was to validate predictions of noise levels for individual ships, and to classify ships based on simplified noise models. SONIC's third objective was to map the noise generated by shipping in general and to propose mitigation measures for quietening the oceans.

The SONIC project was executed in close co-operation with the AQUO project, by sharing data, organising combined workshops and dissemination activities, and by joining forces on developing guidelines for industry and regulations.

Common Guideline Document – AQUO & SONIC European Added Value

The collaborative research projects AQUO and SONIC, partly funded by the EU 7th Framework Programme 'Oceans of Tomorrow', were required to establish common, non-mandatory guidelines for the assessment and mitigation of continuous underwater sound, originating from commercial shipping. Close cooperation was achieved as both projects were developed during same time and with targeted joint workshops.

The projects jointly developed a common guideline, which presents the main findings, and conclusions of the research performed within the AQUO and SONIC projects, and summarises the consortia's recommendations on the way ahead, to help assess the environmental status of European marine waters, with respect to continuous underwater sound. The guideline document is intended to support all stakeholders of potential future regulation of underwater noise from commercial shipping:

- Policymakers and maritime authorities for further assessment and decision-making process, in particular in relation to spatial planning of shipping lanes, and for use by the International Maritime Organization (IMO).
- The shipbuilding and maritime supplier industry in finding measures combining fuel efficiency with reduced underwater sound radiation and in anticipating potential effects on the design process and vessel cost.
- Ship owners and operators in finding measures combining fuel efficiency with reduced underwater sound radiation and in anticipating potential effects on ship operation and fleet planning.

Both projects aimed at providing policy makers and maritime industry stakeholders, with the most relevant methodologies to answer to the MSFD current requirements.

The project also showed the importance of local environmental characteristics – in implementing any common strategy it is important to take account of local conditions.

Download [here](#) the AQUO-SONIC Guideline Document.

MaRVEN – Environmental Impacts of Noise, Vibrations and Electromagnetic Emissions from Marine Renewable Energy

Funding origin	European Commission, DG Research and Innovation
Lead organization	DHI A/S (Denmark)
Duration	2012 - 2015

DHI A/S led a study of the environmental impacts of noise, vibrations and electromagnetic emissions from marine renewable installations. The MaRVEN project critically reviewed the available scientific evidence and the significance of those impacts, and then recommended solutions to mitigate or resolve the identified negative impacts. The investigation comprised several tasks, including:

- provision of a historical review of the publications related to environmental impacts of marine renewable energy devices
- an in-depth analysis of studies on the environmental impacts of noise and vibrations during installation and operation of marine renewable energy devices
- an in-depth analysis of studies on the environmental impacts of electromagnetic emissions during the operation of marine renewable energy devices
- an in-depth analysis of the current norms and standards related to sound, vibrations and EMF for marine renewable energy systems
- performance of relevant on-site measurements and field experiments to validate and build on the results obtained in above studies
- preparation of a programme for further research and development (R&D) with justified priorities

Topics of relevance:

- The in-depth review of noise impacts from marine renewable energy devices (MREDs) summarises the results of peer reviewed papers, grey literature reports and Environmental Impacts Statements from the past 20 years. This provides an important information source to understand the potential contribution of MREDs to impulsive and continuous low frequency sound input into the environment.
- The in-depth analysis of studies on effects of electromagnetic emissions (EMF) provides a comprehensive summary that adds to the knowledge on input of other forms of energy into the marine environment which is of relevance to descriptor 11.
- The in-depth analysis of current norms and standards related to sound, vibrations and EMF for MREDs contains a lot of information on standardisation (for data collection and analysis) and has thus direct links to processes undertaken within TG Noise and other fora (e.g. ANSI standards).
- The on-site measurements and the results of field experiments address some open questions directly relevant to D11. These are, for example, particle motion emissions during construction activities using impact pile driving, EMF emissions during operation of wind farms, sound pressure and particle motion emissions from wave generators and sound pressure emissions from tidal energy converters.

- The programme for further research and development (R&D) identifies key issues that should be tackled concerning sound and EMF from MREDS in the future. It is thus very relevant for the discussion of new indicators for D11.

Download [here](#) for the final study report.

Impacts of Noise and Use of Propagation Models to Predict the Recipient Side of Noise

Funding origin	European Commission – DG Environment
Lead organization	CEFAS (United Kingdom)
Duration	2014 - 2015

In 2014, DG Environment commissioned a study to investigate the impacts of noise, and use of propagation models, to predict the recipient side of noise. The study had the following objectives:

1. To evaluate the current knowledge of the impacts of noise on marine biota at all levels (individuals, populations, and ecosystems) and methods to assess these impacts.
2. To develop modelling techniques to predict the recipient side of noise, i.e. as it is received by marine fauna.

With the aim of developing a roadmap towards defining thresholds for good environmental status (GES), and evaluating the use of sound maps for GES assessment.

Topics of relevance: The roadmap consisted of the following four Actions:

1. **Agree standards for underwater sound monitoring.** It was important for GES assessment that sound levels are measured consistently by Member States. No suitable international standard existed for sound monitoring, and a general standard may in any case have been incompatible with the requirements of the MSFD.
2. **Commission studies to address knowledge gaps.** Targeted studies were needed to reduce the uncertainties that constrain management decisions relating to underwater sound. There were several suitable EU funding mechanisms (which could have been) used to address the knowledge gaps outlined above.
3. **Agree common standards for sound monitoring instruments.** There were a range of commercially available devices for monitoring underwater sound, and not all were adequate to meet monitoring requirements for the MSFD
4. **Define operational GES criteria.** For Descriptor 11 to become operational, quantitative criteria for attainment of GES assessment had first to be defined. There were several unresolved questions to be addressed in addition to the particular formulation of the targets, including the metrics and spatial resolution to be used. A GES target for ambient sound was not necessary for a 'hard threshold' above which GES was not attained when it could be expressed as a maximum proportion of time when sound levels exceeded a certain threshold.

Key elements of the work developed were to convene a workshop of international experts, aimed at addressing the current knowledge gaps, and to prepare a roadmap towards defining noise limits for GES. This final piece of work presenting the findings and roadmap are available at the [JRC / MSFD Competence Centre website](#).

Baltic BOOST

Funding origin	European Commission – DG Environment
Lead organization	HELCOM (Baltic Marine Environment Protection Commission - Helsinki Commission)
Duration	2015 - 2016

Baltic BOOST "*Best Practices for Action Plans to Develop Integrated, Regional Monitoring Programmes, Coordinated Programmes of Measures and Addressing Data and Knowledge Gaps in Coastal and Marine Waters*" was an EU co-funded project coordinated by HELCOM (15.09.2015 – 14.12.2016).

The Baltic BOOST project was designed to boost HELCOM activities. In particular, those related to the long-term cooperation between HELCOM countries, to produce joint assessments and agreements on measures, to improve the state of the Baltic Sea. More specifically, the project developed joint assessment approaches and set up data arrangements and databases, to support indicator-based assessments of the state of the Baltic Sea. These activities focused on strengthening HELCOM work on biodiversity and hazardous substances. The project, furthermore, increased the knowledge base on impacts of pressures affecting seabed habitats, as well as impacts of underwater noise, thereby taking first steps towards the development of joint environmental targets for such pressures.

The project included a theme dedicated to underwater noise, aiming at reviewing existing knowledge on the impact of noise in the Baltic Sea, exploring the possibility of determining acceptable levels of underwater sound for marine species, and listing possible measures to manage and mitigate relevant impacts on the Baltic Sea.

Topics of relevance:

- *Reporting requirements for the development of a regional registry of impulsive events:* The reporting requirements for the regional registry of impulsive events were defined in cooperation with the HELCOM EN-Noise, OSPAR and ICES (which hosts the registry). The HELCOM/OSPAR regional [registry](#) contains information on licenced events such as pile driving, controlled explosions from naval operations, and other activities that release energy from the Baltic Sea and the North East Atlantic. The registry is fully operational, and countries are in the process of reporting their national data, according to the agreed reporting format.
- *Proposal for a regional monitoring programme of continuous noise:* A proposal for a regional monitoring programme of continuous noise was drafted during the project period, which was later approved by the HELCOM Head of Delegation (2018). It proposed to combine a yearly minor assessment in 11 prioritised location stations, with a major assessment proposed every six years, over 38 stations. Further work within HELCOM (subsequent to the project's conclusion enabled the approval of the [regional monitoring sub-programme on continuous noise](#) in 2018 (Outcome of HOD 54-2018, para. 4.11).

- *Review of existing knowledge on impact of noise in the Baltic Sea:* A report on noise sensitivity of aquatic animals, in the Baltic Sea, was [prepared](#). It compiles and reviews the available knowledge on impact of anthropogenic noise in the Baltic Sea, in the chapter entitled 'Impact of noise on marine animals'. It further identifies a list of priority, noise sensitive species for the Baltic Sea based on the following criteria: hearing sensitivity; impact of noise; threat status; commercial value; and data availability. Harbour porpoise, harbour seal, ringed seal, grey seal, cod, herring and sprat were identified as priority species. The report also compiles available, biologically important, spatial-temporal information for the identified, priority, noise sensitive species in the Baltic Sea. The report will be published in the Baltic Sea Environment Proceedings series.
- *Principles for defining levels of underwater noise consistent with GES:* The HELCOM BalticBOOST Workshop on Underwater Noise was held in Copenhagen, Denmark, on 5-6 October 2016. Based on a [draft document](#) prepared by BalticBOOST the workshop developed principles for defining levels of underwater sound consistent with GES, that have been further amended, based on recommendations by the HELCOM Pressure and Gear Groups. The principles are meant to facilitate a coherent approach among the countries, and outline what would be considered good environmental status in relation to sound. They are meant to serve as a basis for further development of guidance levels, or thresholds of sound, consistent with good environmental status for the individual species.

Decision support trees for establishing environmental targets for impulsive sound, and continuous sound was also developed. The risk-based decision support trees is meant as a tool for identifying areas/situations where a reduction in pressure is needed.

Further work continued after the project's duration, within the regular HELCOM framework, which concluded with the agreement of the "[HELCOM input to establishment of environmental targets on underwater noise](#)" in 2018 ([Outcome of HOD 54-2018](#) para. 4.30). The HELCOM input was subsequently shared with EU TG NOISE.

- *Possible measures to manage and mitigate relevant impacts of underwater noise on the Baltic Sea:* A [document](#) compiling the reviews of internationally available, mitigation measures and country specific information (based on a questionnaire completed by Denmark, Finland, Germany, Lithuania, Russia and Sweden) was prepared by the project. It focuses on general mitigation measures as well as measures to mitigate piling, seismic surveys, shipping and recreational boating in detail, as well as some possible mitigation measures for naval sonars, high frequency impulsive sources, marine aggregate dredging operations, and explosives. An analysis of national feedback is also provided.

All results are available at the [project website](#).

UNAC-LOW - Underwater acoustic calibration standards for frequencies below 1 kHz

Funding origin	EU H2020 EMPIR Programme
Lead organization	TUBITAK (Turkey)
Duration	2016 - 2019

The project UNAC-LOW aimed to develop the European metrological capacity in underwater acoustics, providing traceable measurement capabilities for calibration of hydrophones and autonomous underwater acoustic recorders.

The project developed the scientific and technical research capabilities, in the field, within Europe and provide an improved metrology framework to underpin the absolute measurement of sound in the ocean, in support of regulation and EU Directives (such as the Marine Strategy Framework Directive) for which traceability is currently lacking.

Topics of relevance:

- ✓ Contributions to new international guidelines, recommendations and standards, mainly with committees: EURAMET TC-AUV, BIPM CCCAUV, ISO TC43 SC3, IEC TC87 WG15
- ✓ List of stakeholders` set-up, wide attendance at stakeholders` workshop with 100+ entries from research, industry and end users
- ✓ Deliverables include:
 - Documented calibration procedures for hydrophone calibration, using closed-chamber pressure methods (NPL, TUBITAK)
 - Field reports and guidelines for free-field calibration of autonomous recorders, in open-water sites (FOI, CNR, ISPRA)
 - Agreed strategies by each partner for provision of calibration services from established facilities

DEPONS - Disturbance Effects on the Harbour Porpoise Population in the North Sea

Funding origin	Six companies that work on the development of offshore wind energy: Vattenfall Wind Power Ltd, SMart Wind Ltd, Forewind, East Anglia Offshore Wind Limited, Eneco Luchterduinen and DONG Energy Wind Power A/S
Lead organization	Aarhus University (Denmark)
Duration	2012 - 2018

Harbour porpoises have been found to respond to underwater noise generated by piling of wind farm foundations at large distances. While they have also been found to return once construction activity ceases, the significance of piling noise disturbance to the survival and reproduction of harbour porpoises is not understood. The result is considerable uncertainty for the industry and governments alike in the planning of offshore wind farms.

Recognising that improved knowledge on the impacts of piling noise will be critical to be able to

expand offshore wind power in a cost-effective and timely manner in balance with a long-term viable North Sea harbour porpoise population, a group of offshore wind developers funded the international research program DEPONS. The project aimed to obtain fundamental new insights into harbour porpoise responses to underwater piling noise, as well as their small and large-scale general movement patterns.

The target group for the outcome were regulators, advisors and other stakeholders involved in offshore wind farm development. The results can also be used for assessment of impacts of other human activities as well, and thereby contribute to an improved basis for the management and conservation of the North Sea harbour porpoise population.

The objective of the simulations model developed in DEPONS was to simulate how harbour porpoise population dynamics are affected by pile-driving noise associated with construction of offshore wind farms. The model has been developed by DCE – National Centre for Environment and Energy at Aarhus University, Denmark with support from consulting firm Aragost.

The porpoise's survival are directly related to their energy levels, and the population dynamics are affected by noise through its impact on the animals' foraging behaviour. By ensuring that the animals' movement patterns, space use and reactions to noise are realistic, the population dynamics in the model have the same causal drivers in the model as in nature.

The model incorporates several techniques such as display of a background image, visual tracking of agents, event-based logging and simulation capture and replay in unit testing. The DEPONS 2.0 model will be an important tool for assessing the impact of construction of future wind farms before they are built.

Relevant information is available [online](#).

SHEBA - Sustainable shipping and environment of the Baltic Sea region

Funding origin	BONUS - Science for a better future of the Baltic Sea region
Lead organization	Environmental Research Institute (Sweden)
Duration	2015 - 2017

BONUS SHEBA aimed to analyse the drivers for shipping, obtain the present and future traffic volumes, and calculate a set of scenarios which will then feed into calculations of emissions into water, air, and underwater sound, using and extending the, currently, most advanced emission model, based on Automatic Identification System (AIS) ship movement data. One of the objectives of SHEBA was to conduct an impact assessment of ship-generated underwater sound, in the Baltic Sea. Further, the project provided an integrated assessment of policy options, to mitigate pressures linked to shipping, which quantifies, as far as possible, anticipated changes in ecosystem services, compared to an established baseline. This includes an analysis of trade-offs between options, as well as synergies, and the marginal changes in costs and benefits of options, to reduce environmental pressures from shipping, and support the achievement of good environmental status, as required by the Marine Strategy Framework Directive.

The methodology for predicting underwater sound emissions of individual ships was taken one step forward, based on existing empirical acoustical models for ships. The methodology links model-based sound source spectra, to specific vessels and activities, e.g. ship type, speed and AIS-information. By

combining the sound source model with the Ship Traffic Emission Assessment Model (STEAM), density maps of sound sources for 2014-2015 were produced. The maps, developed in the project, facilitate a large-scale inventory of shipping sound, which does not require any monitoring data, and could be used for minor assessment of the soundscape status (cf. BIAS project). Further, SHEBA tackled challenges in areas where the knowledge needs to be improved, in order to achieve an effective management in the future. In addition, behavioural response experiments were carried out, to improve the understanding of reaction of fish in the Baltic Sea.

Topics of relevance:

- Conduct an impact assessment of ship generated, underwater sound in the Baltic Sea
- Combining a sound source model with the Ship Traffic Emission Assessment Model (STEAM), resulting in yearly density maps of sound sources.
- Studying behaviour reaction in Baltic Sea fish species, to playback ship noise.

The relevant information and public documents produced by SHEBA are available [here](#).

Copernicus Marine Environment Monitoring Service (CMEMS) and Quiet-Oceans initiative on Underwater Noise Mapping

Funding origin	Various: EU Copernicus Programme; EC 7 th FP; HORIZON2020
Lead organization	Quiet-Oceans (France)
Duration	2009 - 2017

Copernicus is a European Union Programme, aimed at developing European information services, based on satellite Earth Observation and in situ (non-space) data. The Programme is coordinated and managed by the European Commission. It is implemented in partnership with the Member States, the European Space Agency (ESA), the European Organisation for the Exploitation of Meteorological Satellites (EUMETSAT), the European Centre for Medium-Range Weather Forecasts (ECMWF), and the EU Agencies and Mercator Océan.

The Copernicus Marine Environment Monitoring Service (CMEMS – marine.copernicus.eu) address several areas. These services have reached different degrees of maturity. Some are already operational> Marine monitoring is currently in a pre-operational mode.

The MyOcean (2009-2012), MyOcean2 (2012-2014) and MyOcean follow-on (October 2014- March 2015) projects, funded respectively by the EU's Seventh Framework Programme for Research (FP7 2007-2013) and HORIZON 2020 (EU Research and Innovation programme 2014-2020), led the demonstration phases of the future Copernicus Marine Environment Monitoring Service (CMEMS). The MyOcean consortia were coordinated for 6 years by Mercator Ocean, the French centre for analysis and forecasting of the global ocean. In November 2016, the European Commission and Mercator Ocean signed an Agreement to implement and manage the Copernicus Marine Environment Monitoring Service.

In this framework, Mercator Ocean International and Quiet-Oceans initiated in 2017 a partnership to provide an operational service of underwater sound mapping to address the MSFD, under the

umbrella of the Copernicus Marine Environment Monitoring Service. The partnership enhanced the CMEMS services, as provider of oceanographic nowcasting, and needed to provide an operational sound mapping service. The partnership focused on demonstrations of coastal and operational sound mapping and analysis, to fulfil descriptor 11.1.2 of the MSFD.

In practice, Quiet-Oceans implemented the Quonops(c) Noise Prediction System and provided demonstrations of sound mapping services, contributing to the implementation of the MSFD, and maintains them until the end of December 2020, as well as promote them among National focal point, for the implementation of D11 and Member States, currently using the CMEMS service.

Topics of relevance:

- Operational online tool, to produce on-demand noise maps of continuous noise (anthropogenic and natural), that do not need a high level of expertise to use
- Live (near-real time noise mapping) and Historical (statistical noise maps for periods in the past) subscriptions available
- Coverage includes all European waters, based on Copernicus Marine Environment Monitoring Service, and EMODNet input data
- A dedicated subscription, dedicated to the MSFD (large area, 63Hz and 125Hz one-third octave mapping)

The demonstrations are available [online](#). The service is available worldwide and accessible for free (with limited time, coverage and functionalities), or through [subscriptions](#).

Quonops Online Services reached the 1.5 million of noise maps produced, at the beginning of 2019.

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

Funding origin	European Commission – DG Environment
Lead organization	CTN (Spain)
Duration	2017 - 2018

This project was co-funded under the DG ENV/MSFD Second Cycle/2016 programme and coordinated by the Marine Technology Centre (CTN) (Spain), with participants from Spain, France, Italy, Slovenia, Croatia, Greece and Malta.

The project objective was to enhance cooperation among Member States (MS) in the Mediterranean Sea, and to implement the Second Cycle of the Marine Directive and, in particular, to assist them in the preparation of their MSFD reports by 2018, through:

- promoting a common approach, at Mediterranean, level to update GES and Environmental targets related to Descriptor 11, in each MS marine strategies
- development of methodological aspects, for the implementation of ambient noise monitoring programs (indicator 11.2.1)
- development of a joint monitoring programme of impulsive noise (Indicator 11.1.1), based on a common register, including gathering and processing of available data on underwater noise.

Topics of relevance:

- Creation of the “Joint impulsive noise register in the Mediterranean Region”. The register was developed in coordination with ICES, to ensure compatibility with the existing register for OSPAR/HELCOM areas. Also, it provides a tool for the calculation of the spatial distribution and the temporal extent of D11C1, according to the Commission Decision (EU) 2017/848. This register is available in this link: http://80.73.144.60/CTN_Geoportal/home/
- Development of methodologies and best practices for underwater noise monitoring, in the Mediterranean Region: schemes, technologies and standardization.
- Development of three pilot projects in Spain, Malta and Greece, for ambient noise monitoring, including one modelling/mapping exercise.
- Cooperation with Barcelona Convention through the performance of two workshops, with national representatives of competent authorities and researchers from non-EU countries.

More information is available at the [project website](#).

2.2 European Ongoing & New Initiatives

Joint programme for Ocean Noise in the Atlantic Seas - JONAS

Funding origin	EU – INTERREG Atlantic area Programme
Lead organization	University College Cork, MaREI (Ireland)
Duration	2019 - 2021

JONAS aims to address the risks of acoustic pressures on biodiversity, focusing on sensitive receptor species in the NE Atlantic, by streamlining ocean noise monitoring and risk prediction. Cost effective, risk-based approaches to monitoring and modelling noise, across the maritime territories of the Atlantic Arc countries (France, Ireland, Portugal Spain and the UK) will be developed. These will be appropriate to the scale of the area, the levels of anthropogenic pressure, and the susceptibility of receptor species. JONAS draws on the outcomes of the BIAS Life+ project, adapting and generalising methods and standards from the Baltic, to reflect the scale and complex oceanography of the NE Atlantic region. JONAS will also cooperate closely with the JOMOPANS project, which is currently addressing underwater noise in the adjoining North Sea Area, and with QUIETMED in the Mediterranean.

Topics of relevance & expected results:

JONAS will address real-time noise management at local scale, particularly in sensitive areas, and support policy partners to develop Regional-scale approaches, that benefit vulnerable biodiversity and support MSFD implementation. The value of JONAS will be maximised by creating an innovative common operational platform, and providing maritime decision support, for both real-time and long-term adaptive management of sensitive marine areas.

More information is available [online](#).

Joint Monitoring Programme for Ambient Noise North Sea - JOMOPANS

Funding origin	EU – INTERREG North Sea Programme
Lead organization	Rijkswaterstaat (The Netherlands)
Duration	2018 - 2020

In early 2018, the three-year project “Joint Monitoring Programme for Ambient Noise in the North Sea” (EU Interreg North Region Programme) ‘JOMOPANS’ started. International concern focused, increasingly, on the potential negative effects of anthropogenic underwater noise, on sensitive marine fauna. Questions regarding sound sources, sound transmission, and the distributions of vulnerable species, in the North Sea, must all be tackled transnationally, as specifically required by the EU Marine Strategy Framework Directive, and by the OSPAR Convention. JOMOPANS will develop a framework for a fully operational joint monitoring programme, for ambient sound, for the North Sea region. The project will deliver the tools necessary for managers, planners and other stakeholders, to incorporate the effects of ambient sound, into their assessments of the environmental status of the North Sea, and to evaluate measures to improve the environment.

Topics of relevance & results:

- The project develops soundscape maps for the North Sea. The relative importance to the soundscape of different sound sources (such as ships and wind) will be determined, together with the variation in continuous sound pressure levels and sources, in different parts of the North Sea.
- In total 14 measurement stations around the North Sea are now employed and gather long term sound data. These data will be combined with modelling, to obtain validated soundscape maps of the North Sea.
- A management tool will be developed, which combines distribution maps of sensitive species, with the soundscape maps. Marine policy makers will be able to use this information to evaluate Good Environmental Status (GES), in relation to underwater sound. This tool will in the future also allow managers to design and assess appropriate measures, to reduce the risk of environmental impacts of underwater sound.
- JOMOPANS contributes to standardisation of underwater sound, by developing and publishing project standards on terminology, measurements, calibration and modelling.

More information and outputs are available [online](#).

Soundscape - Soundscapes in the North Adriatic Sea (NAS)

Funding origin	EU – INTERREG V-A, Italy -Croatia CBC Programme
Lead organization	Institute of Oceanography and Fisheries (Croatia)
Duration	2019 - 2021

Soundscape - Soundscapes in the North Adriatic Sea (NAS), and their Impact on Marine Biological Resources project, is funded by 2014-2020 Interreg V-A, Italy -Croatia CBC Programme. This project is led by the Institute of Oceanography and Fisheries (IOF), in Croatia, and involves 3 partners from Croatia (BWI, TIPH, CMEE) and 5 in Italy (CNR-ISMAR, CNR-IRBIM, ARPA-FVG, CF, Marche Region).

The project started in January 2019 and is scheduled to end in June 2021.

The main objective of the project is to create a cross-border technical, scientific and institutional cooperation, to face together the challenge of assessing the impact of underwater environmental noise on the marine fauna, and in general on the NAS ecosystem. This cooperation aims to ensure an efficient protection of marine biodiversity, and to develop a sustainable use of marine and coastal ecosystems and resources. Marine Strategy Framework Directive (MSFD) Descriptor 11(D11) points to the need to monitor and manage underwater noise, to achieve Good Environmental Status (GES) of EU marine waters by 2020.

During the project underwater noise maps for the NAS will be created, based on measurements by means of hydrophone network and modelling approach. Together, with evaluation of the noise impact on marine biological resources, these maps will be implemented inside management tool, accessible for all stakeholders, helping to tackle anthropogenic noise polluting activities, of the marine environment of the NAS, in a coordinated way.

The objectives of the project are to be pursued in three ways:

- i. Implementing a shared monitoring network, for a coordinated regional and transnational assessment of the underwater noise in the NAS, in accordance with the MSFD, specific to the soundscape ecology of the EUSAIR region.
- ii. Evaluating the noise impact on marine biological resources, to protect biodiversity through the assessment of acoustic diversity index, and noise enhanced habitat suitability in the NAS, and by raising of public awareness, regarding impact of underwater noise.
- iii. Developing and implementing a planning tool, for straightforward management of underwater noise, in accordance with the MSF and MSP Directives. Identifying feasible measures, agreed upon with stakeholders, to mitigate impacts of noise pollution on biodiversity, while allowing a sustainable development of maritime uses.

Expected relevant outcomes:

- Shared monitoring network and harmonized data processing set up
- Underwater noise maps, in the NAS, within the EUSAIR, area prepared
- The impact of underwater noise on target organisms, based on soundscape model estimates
- Enhanced ecological modeling tool (including noise), integrated with MSP tools, to manage co-existence of anthropogenic activities and cumulative impact, and to ensure sustainable use of the resources
- Trans-boundary collaboration for management and possible mitigation actions, to reduce the noise impact on biodiversity developed
- Methodologies and good practice transferred to stakeholders

More information available [online](#).

QUIETMED2 - Joint programme for GES assessment on D11-noise in the Mediterranean Marine Region.

Funding origin	European Commission – DG Environment
Lead organization	Marine Technology Centre (CTN) (Spain)
Duration	2019 - 2021

QUIETMED2 project will support the implementation of the second cycle of the MSFD, in particular, to implement the new GES Decision (Commission Decision (EU) 2017/848 of 17 May 2017). This project is funded by DG Environment of the European Commission, within the “DG ENV/MSFD 2018 call”. QUIETMED2 is coordinated by Marine Technology Centre (CTN) (Spain).

The QUIETMED2 project aims to support Member States Competent Authorities in assessment of the extent to which GES, on Descriptor 11-Underwater noise, has been achieved in the Mediterranean Region, by providing practical outcomes to implement the new GES Decision through: i) a joint proposal of a candidate, for an impulsive noise indicator, in the Mediterranean Region; ii) a common methodology for Competent Authorities, to establish threshold values on impulsive noise, in the Mediterranean region; iii) a data and information tool, to support the implementation of the monitoring programmes, of impact of impulsive noise, based on the current joint impulsive noise register, developed under QUIETMED project, which will be demonstrated on; iv) an operational pilot of the tool; and v) several activities to boost current regional cooperation efforts of the Barcelona Convention, developing new Mediterranean Region cooperation measures.

The consortium is made up of 11 entities (including two National Authorities) from 8 EU Member States (Spain, Italy, Malta, Greece, Cyprus, Croatia, Slovenia and Denmark). 7 of these Member States (MS) share marine regions and sub-regions (The Western Mediterranean Sea, the Adriatic Sea, the Ionian Sea and the Central Mediterranean Sea and the Aegean Sea). The consortium is linked to the Barcelona Convention (UNEP/MAP) and to other Conventions as OSPAR and HELCOM.

This project supports the cooperation needs of all EU Member States' competent authorities, in the Mediterranean Marine Region, in their implementation of the next 6-year cycle of MSFD, to address it in a coherent manner.

Expected relevant outcomes:

- Joint proposal candidate impact indicator, for impulsive noise, for the Mediterranean region.
- Joint proposal of a methodology, to establish thresholds in the Mediterranean region.
- Development of data and information tool, to support the update monitoring programmes of impulsive noise impact indicator, based on the current joint impulsive noise register, developed under QUIETMED.
- Implementation of an operational pilot, for an impulsive noise impact monitoring programme, to test its feasibility and operational use of the data, and information tool to support the update of monitoring programme.
- Two training sessions for Competent Authorities from Member States, to provide technical support: a) to better implement the new GES decision b) to establish new coordinated measures (tools, methods and results).

- Improvement of the cooperation and coordination with the EcAp process and the Barcelona Convention, through the active participation of non-EU representatives.

More information available at the [project website](#).

CeNoBS - Support MSFD implementation in the Black Sea through establishing a regional monitoring system of cetaceans (D1) and noise monitoring (D11) for achieving GES

Funding origin	European Commission – DG Environment
Lead organization	Mare Nostrum (Romania)
Duration	2019 - 2021

The Black Sea is one of the most vulnerable regional seas, and Romania and Bulgaria are the European Member States responsible for implementation of MSFD, in close collaboration with the other non-EU countries. The two descriptors tackled by this project are : Descriptor 1 – marine mammals/cetaceans; and Descriptor 11 – underwater noise in the Black Sea, to improve the second cycle of MSFD implementation, by achieving greater consistency and coherence in determining, assessing and achieving good environmental status. The proposed activities will fill the lack of background data on the distribution/abundance of BS cetacean populations, and on bycatch pressure and the lack of national expertise to implement effective noise monitoring. The main objectives are to assess D1 cetacean related criteria, and establishment of thresholds values, to assess and support the development of D11 monitoring in the Black Sea, and to enhance coordination among the Black Sea region, through the dissemination of the project activities, results and outcomes.

CeNoBS is a 24 months project that aims to achieve 3 specific objectives:

- Specific Objective 1: Assessing D1 cetaceans related criteria and establishment of thresholds values
- Specific Objective 2: *Assessing and supporting the development of D11 monitoring in the Black Sea*
- Specific Objective 3: Enhancing coordination among the Black Sea region, through the dissemination of the project activities, results and outcomes

CeNoBS is coordinated by Mare Nostrum (NGO) and involves 10 partners from Romania and Bulgaria and Third Countries: Ukraine, Monaco, Georgia and Turkey. The project is funded by DG Environment to support implementation of the Marine Strategy Framework Directive (MSFD) in the Black Sea.

More information available [online](#).

RAGES - Risk-based Approaches to Good Environmental Status with case study on D2 (non-indigenous species) and D11 (underwater noise)

Funding origin	European Commission – DG Environment
Lead organization	University College Cork, MaREI (Ireland)
Duration	2019 - 2021

The RAGES project is a 2-year project, funded by DG Environment, to support implementation of the Marine Strategy Framework Directive (MSFD). The project began in January 2019 and consists of a consortium of partners, including competent authorities from four countries: Ireland (UCC and DHPLG), France (MTES and INERIS), Spain (DGSCM-SGPM and IEO, UPV) and Portugal (DRAM, DGRM, ARDITI, FCUL, IPMA and SRA-DROTA).

Through six work packages, the project aims to develop a standardised Risk-Based Approach (RBA) that incorporates risk into regional assessment, monitoring and programmes of Measures. This RBA will then be tested, at a sub-regional scale, on the issues of nonindigenous species (Descriptor 2), and underwater noise (Descriptor 11) and ultimately, the RBA will be refined, based on the outcome of its application to these two descriptors.

Activities related to underwater acoustic noise are included specifically in Work Package 4. The main goal of the WP is to establish the criteria on which to base risk assessment, in relation to continuous anthropogenic noise (D11.2 Indicator). Using these criteria, levels of risk will be established, as well as a process to assign a level of certainty to these risk categories. As regards acoustic data measurements, the deployment of a passive acoustic monitoring device is planned in the Gulf of Biscay, which will take data a period of 3 months (at the moment deployment is planned for the first week of July). Experimental data will then be correlated, with propagation modelling, to validate the theoretical model. The campaign of measurements is not simply an experimental noise assessment, it is also a test bench for new technology, applied to the PAMs (passive acoustic monitoring system). The entire device has been built by the UPV team, and several modifications have been implemented in the last version of the system (e.g. data logger capacity has been enhanced, allowing almost continuous monitoring during 3 months, or increase the sampling frequency of the DSP board, being possible measure signals in the marine mammals frequency range). The deployment therefore represents a valuable opportunity to test this equipment and assess its value for the future.

More information available at the [RAGES project website](#) and at the twitter handle @msfdrages.

AGESCIC – Achieve Good Environmental Status for Coastal Infrastructure Construction

Funding origin	EU – LIFE Programme
Lead organization	Naval Group (France)
Duration	2019 - 2021

With more than 400 projects per year in the EU, coastal constructions are an important source of water pollution, with turbidity and underwater noise. These cause severe damage on biodiversity, especially benthic fauna, fish, mammals, cephalopod, microalgae and seagrass.

The AGESCIC project, a EU Life funded project, aims at bringing new technology solutions, to reduce the marine environmental impacts of coastal works, especially for both underwater noise and

turbidity impacts, on marine fauna and ecosystems. AGESCIC is related to the new European ocean protection strategy, through the Marine Strategy Framework Directive (MSFD) 2008/56 / CE (descriptors 6 and 7 for turbidity and 11 for underwater noise), to reach Good Environmental Status for oceans.

In practice, AGESCIC's innovation is made of a suite of three complementary technology solutions, dedicated for coastal infrastructure construction that will mitigate the pressure, monitor pressure and receptors, and restore the ecosystem. The first stone of the complete solution is the SubSea Quieter® (SSQ), an innovative underwater noise and turbidity containment system, made of an air-filled membrane. To report on the efficiency of the SSQ, and to continuously ensure compliance with the regulation during operations, the solution is also made of SmartPAM+. Based on Quiet-Oceans' and UPC existing SmartPAM passive acoustic monitoring buoy, SmartPAM+ is a smart connected buoy that monitors, in real time, the levels of turbidity, the levels of underwater noise and the presence of marine mammals, to give a comprehensive monitoring board. Finally, the AVOREST system, based on sound attraction device and an artificial habitat for fish and larvae, is added to reduce the impact on fish, and recover the ecological functions of the work area.

A pilot real-scale demonstration of the solution is planned for 6 to 12 months, on a coastal construction project in France in 2020. The physical resistance of the SSQ® system, in real conditions, will be validated, as well as the procedures for deployment, maintenance and recovery. The data transmitted by SmartPAM+ will be validated using independent calibrated sensors, but also serve to validate the efficiency of the SSQ, on both the reduction of the environmental perturbation, and the benefits for the ecosystem, and especially the noise and turbidity species, present in the area. Finally, the performance of the ecological restoration system AVOREST systems will be evaluated, using the bio-acoustic data collected near the artificial habitat.

More information available at the [project website](#).

Underwater noise impact reduction of the maritime traffic, and real-time adaptation to ecosystems

Funding origin	EU – LIFE Programme
Lead organization	Naval Group (France)
Duration	2019 - 2022

Levels of underwater noise have massively increased over the past 50 years, mainly due to marine shipping, with negative impacts on marine wildlife. LIFE-PIAQUO (Underwater noise impact reduction of the maritime traffic, and real-time adaptation to ecosystems), headed by the French state-owned Naval Group, will develop measures to reduce this noise pollution. These include optimising propeller design to limit cavitation, which reduces bubble formation, and conducting ship speed reduction trials in vulnerable areas, based on real-time underwater noise readings.

The project team will also support harbour authorities and Marine Protected Area managers to implement noise-reduction practices. One result will be the mapping of noise emission levels over a wide area, using a network of buoys fitted with sensors, to help authorities test incentives to reduce underwater noise.

More information available [online](#).

LIDO – Listening to the Deep-Ocean Environment

Funding origin	Various funds
Lead organization	Technical University of Catalonia, Barcelona Tech (UPC) (Spain)
Duration	2007 - ongoing

Originated in the European Sea-Floor Observatory Network of Excellence (ESONET), in 2007, the Laboratory of Applied Bioacoustics (LAB), from the Technical University of Catalonia, Barcelona Tech (UPC) is currently leading an international project titled “Listen to the Deep Ocean Environment (LIDO), and is extending existing techniques for sound measurement, and passive acoustic monitoring to cabled deep sea platforms and moored stations. The software framework, called SONS-DCL, is currently active at the [ANTARES](#), France neutrino observatory, the [OBSEA](#), Spain shallow water test site, the [NEPTUNE](#) Canada observatory, the [JAMSTEC](#), Japan network of underwater observatories and at the [NEMO](#), Sicily site after the observatory has been redeployed. Part of the system is being tested for suitability on autonomous gliders and towed arrays, in collaboration with the [NURC](#) (NATO Undersea Research Center), and is implemented in several autonomous radio-linked buoys. It is also currently analysing all the [CTBTO](#) (Preparative Commission for the Comprehensive Nuclear-Test-Ban Treaty Organization) data files, from 11 hydroacoustics stations in the Southern Hemisphere. The software contains several independent modules to process real-time data streams. Among these, there are dedicated modules for sound assessment, detection, classification and localization of cetaceans, and other acoustic events.

The sound measurement module computes statistics on fixed length intervals, especially following the recommendations of the European Marine Strategy Framework Directive (2008/56/EC), as well as sound trends over large time series. In particular, the Descriptor 11.1 (Tasker et al. 2011) focuses on high amplitude impulsive anthropogenic sound, within a frequency band of 10Hz and 10 kHz, assessed using either sound energy over time (Sound Exposure Level SEL), or peak sound level of the sound source. Meanwhile, the Descriptor 11.2 addresses background noise without distinguishable sources, that can lead to masking of biological relevant signals, alter communication signals of marine mammals, and through chronic exposure, may permanently impair important biological functions. This latter indicator requires a set of sound observatories, to enable trends in anthropogenic background sound to be followed (sound within the 1/3 octave bands 63 and 125 Hz, centre frequency).

It also displays real-time acoustic maps that are constructed in collaboration with Quiet-Oceans, as well as alerts on different acoustic events for mitigation.

The development and implementation of the real-time component of SONS-DCL (the software package behind LIDO), in existing observatories, has offered a unique opportunity to monitor sound, at a spatial and temporal scale, never previously realised. Access to the continuous flow of data has allowed the development of an exclusive database of sound sources, that are permanently updated, and used to calibrate the algorithms. These are applicable to almost any scenario, sea state, geographical location and sound level.

The system can be implemented on cabled observatories, autonomous radio-linked buoys, moored antennas, autonomous vehicles (including gliders), towed arrays and existing data sets.

The software package contains several independent modules to process real-time data streams. Among these, there are dedicated modules for sound assessment, detection, classification and localization of acoustic events, including marine mammals and fish vocalizations. To summarise the

LIDO system, it takes, as input, an acoustic data stream and produces, as output, the characterisation of the acoustic events that were detected in the data (written to an XML file), spectrograms for quick visualisation and compressed audio. These outputs are then made available on the Internet where they can be viewed with a specific application. A custom alert service is also available, warning the user of the presence of acoustically sensitive species, in the vicinity of the activity. SONS-DCL is designed to be modular and dynamic (allowing the choice of detectors/classifiers), depending on the objectives and geographical areas. SONS-DCL is conceived for ease of operation (non-expert), and provides a monitoring system that automatically operates 24/7, without the need of post processing.

Relevant information is available [online](#).

JPI Oceans Action – Munition of the Sea

Funding origin	EU- Horizon 2020 research and innovation programme
Lead organization	JPI-OCEANS Secretariat (Belgium)
Duration	2011 - ongoing

The JPI Oceans Action on munition in the sea was proposed by the Strategic Advisory Board, in April 2014, and approved by the JPI Oceans Management Board in November 2015. The aim of the Action was coordinate research and innovation to assess risks, define priorities and suggest intervention options, with regards to munition, in the marine environment. The outcomes of the action will be used to support identification, monitoring and elimination of threats, through more systematic and sound approaches.

The added-value of this JPI Oceans Action consists of three aspects:

1. Introducing and structuring a European scientific, interdisciplinary and cross-sectoral cooperation;
2. Providing an interface between scientific expertise and operators;
3. Contributing to cost and time efficient solutions.

Relevant impacts:

- **Science Support:** provision of services to support operators and provide risk-assessment, through: use of 3D numerical models to provide meaningful data for the risks effect of shallow/deep water explosions, chemical leakage, diver visibility, sediment transport; impacts of blast waves and underwater sounds, generated from controlled and spontaneous detonations; estimation of corrosion phenomena and consequences; recognition and identification of munitions, increasing the accuracy and efficiency in the post-processing of sonar and visual data;
- **Technology Transfer:** technology transfer and development of new technologies for: high resolution, acoustic, magnetic and visual seabed mapping, to measure sea conditions and marine ecosystems; to mitigate effects of blast waves and underwater sounds, from controlled detonations on marine life and infrastructure; autonomous and robotic systems, chemical sensors for aquatic systems and assessment of health of marine ecosystems; safety conditions for operations on the sea floor, along with confirmed procedures to monitor the release of toxic compounds; to protect current infrastructure and improve safety for new infrastructure; to avoid the introduction of potentially harmful chemicals into the human food

web, via aquaculture facilities; improving defence and national security.

- **Exchange of Practices and Knowledge:** science-to-policy transfer, with knowledge support to select best options; improvement of existing knowledge base, method standardization and intercalibration; exchange of practices, standardization of guidelines; improvement of experts' personal skills .

More information available at JPI Oceans Action [online](#).

2.3 Other ongoing and new international initiatives

US Atlantic Deepwater Ecosystem Observatory Network (ADEON) initiative

Funding origin	US Department of the Interior- Bureau of Ocean Energy Management, US Department of Commerce- National Oceanic and Atmospheric Administration, US Office of Naval Research, US National Oceanographic Partnership Program.
Lead organization	University of New Hampshire (USA)
Duration	2019 - 2021

The Atlantic Deepwater Ecosystem Observatory Network (ADEON), for the U.S. Mid- and South Atlantic Outer Continental Shelf (OCS), was deployed in November 2017. This observatory network will generate long-term measurements of both the natural and human factors active in this region, thus informing the ecology and soundscape of the OCS. These data will further provide a mechanistic understanding of the cumulative impacts these factors have on marine resources and provide insight for ecosystem-based management efforts. Long-term observations of living marine resources and marine sound will assist Federal agencies, including the U.S. Bureau of Ocean Energy Management, Office of Naval Research, and National Oceanic and Atmospheric Administration, in complying with mandates in the Endangered Species Act, Marine Mammal Protection Act, and Sustainable Fisheries Act.

ADEON Objectives:

1. Establish an ecosystem observation network.
2. Develop standardised measurement, processing, and visualisation metrics, for comparing ADEON observations with data from other monitoring networks.
3. Assess baseline soundscape and ecosystem conditions in support of predictive environmental modelling and trend analyses in the planning areas.
 - How do soundscape and ecosystem components vary with water depth across the OCS?
 - How do the soundscape and ecosystem components vary with latitude along the OCS?
 - Where are the hot spots of human activity for consideration in ecosystem impacts?
4. Assess the spatial and temporal distribution of the soundscape and biological scatterers with distance from the mooring locations.
 - What are the environmental factors that define and constrain the horizontal range of appropriate extrapolation of observations measured at the stationary mooring sites?
5. Develop and apply new methods for the effective visualization of 5D soundscape data to

interactive analysis tools that enable users to explore, analyse, and integrate ancillary ecosystem data with the 5D soundscape.

6. Develop a robust data management system that archives and provides public access to multiple data streams to encourage future development of ecological models.

ADEON Progress:

As of end 2019, three project standards are finalized and available from the following DOIs

TITLE	AUTHORS	YEAR	DOI
ADEON Hardware Specification	Martin, Bruce; Hillis, Craig; Miksis-Olds, Jennifer; Ainslie, Michael; Warren, Joseph; Heaney, Kevin	2018	https://doi.org/10.6084/m9.figshare.6809711
Underwater Soundscape and Modeling Metadata Standard	Ainslie, M.A.; Miksis-Olds, J.L.; Martin, B.; Heaney, K.; de Jong, C.A.F.; von Benda-Beckmann, A.M.; Lyons, A.P.	2018	https://doi.org/10.6084/m9.figshare.6792359.v2
ADEON Calibration and Deployment Good Practice Guide	Warren, J.D.; Ainslie, M.A.; Miksis-Olds, J.L.; Martin, B.; Heaney, K.D.	2018	https://doi.org/10.6084/m9.figshare.6793745

Two further standards, still under development, are available in draft form from the project web site. These are the data processing and terminology standards.

More information and reports available at [website](#).

The International Quiet Ocean Experiment (IQOE) initiative

Funding origin	Alfred P. Sloan Foundation provided funding for the development of IQOE. SCOR and POGO are contributing additional resources for implementation.
Lead organization	Scientific Committee on Oceanic Research (SCOR) and the Partnership for Observation of the Global Oceans (POGO)
Duration	2011 - ongoing

The International Quiet Ocean Experiment (IQOE) was started as initiative of the Scientific Committee on Ocean Research (SCOR), USA, as (one of the) first initiatives to bring together scientists who study sound in the ocean at a large scale. IQOE will use a variety of approaches to implement the project, including working groups. The following working groups have been established:

Acoustic Measurement of Ocean Biodiversity Hotspots

Several types of ocean environments have high biodiversity, such as coral and deep-water reefs, mangrove forests, and kelp forests. These areas are important to human society and for functioning of ocean ecosystems, but are endangered by local, regional, and global changes. Assessment of the biodiversity of ocean areas is hindered by the requirement for frequent observations by human divers. However, many organisms in these areas make sounds that can

be measured continuously. This working group aims to develop the potential to monitor sound high-diversity ocean areas continuously to help characterize and understand biodiversity.

Arctic Acoustic Environment

The Arctic Ocean remains relatively pristine acoustically. However, the warming and decrease in ice cover across its basins will change its acoustic properties. Meanwhile, oil and gas exploration, shipping, tourism, and other sound-producing activities may increase. This working group aims to produce an acoustic baseline against which future sound increases can be compared.

Data Management and Access

A goal of the IQOE is to create time series of acoustic data in key locations of the global ocean to document how sound in the ocean has changed over time. The IQOE aims to notably increase the openly available and easily accessible acoustic observations and related biological and experimental results. This working group will develop data management and data access policies for scientists and data centers involved in the program.

POGO Working Group

This working group of the Partnership for Observation of the Global Oceans (POGO) implemented specific elements of the IQOE Science Plan related to capabilities of POGO member institutions. This working group (1) led an effort to create an Essential Ocean Variable (EOV) related to sound, for use by the Global Ocean Observing System; and (2) revised the list of passive acoustic observing assets first presented in Appendix 2 of the IQOE Science Plan and made this updatable online.

Standardization

Standardization of experimental protocols and observational techniques and calibration of instrumentation (such as acoustic recorders) enable comparison of results. This working group will recommend best practices for experiments, observation, reporting, and other means to ensure that results are comparable and can be integrated to standardize data across large spatial and long-time scales.

Relevant information and public documents are available [online](#).

NOAA/NPS Ocean Noise Reference Station Network

This network of hydrophones is a collaborative effort between the Office of Oceanic and Atmospheric Research (OAR) of the Pacific Marine Environmental Laboratory (PMEL), all National Marine Fisheries Science Science Centers, the NOAA's National Ocean Service National Marine Sanctuary System, and the U.S. National Park Service to establish and collect consistent and comparable long-term acoustic data sets covering all major regions of the U.S. A.



Network of permanent hydrophones in U.S.A Exclusive Economic Zone designated as NOAA/NPS Ocean Noise Reference Stations. Source : <https://www.pmel.noaa.gov/acoustics/noaanps-ocean-noise-reference-station-network>

This network of reference stations is used to detect and characterize: (1) sounds produced and used by living marine resources (e.g., endangered marine mammals); (2) natural sources of noise from physical oceanographic processes; and (3) anthropogenic noise sources that contribute to the overall ocean noise environment. The overall objective is to monitor long-term changes and trends in the underwater ambient sound field.

The hydrophone moorings are currently deployed in the following areas:

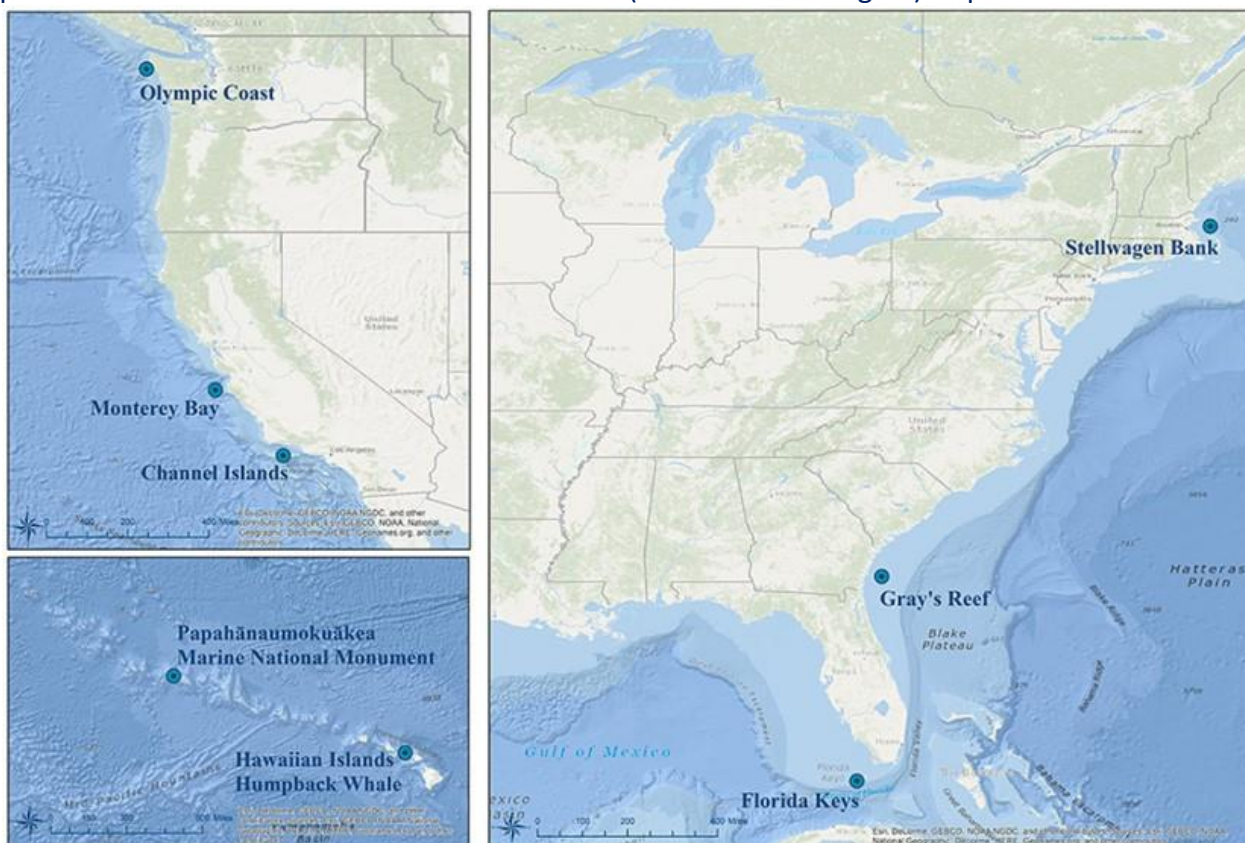
Station	Location	Partners	Latitude	Longitude	Water Depth [m]	AUH Depth [m]	Initial Deployment	Most Recent Deployment
NRS01	Alaskan Arctic	NOAA/AFSC	72.44	-156.55	1,000	500	October 2014	September 2015
NRS02	Gulf of Alaska	NOAA/PMEL	50.25	-145.13	4,250	500	January 2015	August 2016
NRS03	Olympic Coast National Marine Sanctuary	NOAA/NWFSC & NOAA/OCNMS	47.77	-125.52	936	488	September 2014	September 2017
NRS04	Hawaiian Islands	NOAA/PIFSC	22.33	-157.67	~4,900	900	July 2015	July 2017
NRS05	Channel Islands National Marine Sanctuary	NOAA/SWFSC	33.9	-119.58	1,000	900	October 2014	November 2015
NRS06	Gulf of Mexico	NOAA/SEFSC	28.25	-86.83	1,230	900	July 2014	April 2016
NRS07	Southeastern continental U.S. (SE US)	NOAA/SEFSC	29.33	-77.99	870	900	April 2015	August 2016
NRS08	Northeastern continental U.S. (NE US)	NOAA/NEFSC	39.01	-67.27	~3,550	900	June 2014	April 2016
NRS09	Stellwagen Bank National Marine Sanctuary	NOAA/SBNMS	42.4	-70.13	79	79	October 2014	November 2016
NRS10	Tutuila Island, National Park of American Samoa	NPS & NPAS	-14.27	-170.72	33	33	June 2015	July 2017
NRS11	Cordell Bank Coast National Marine Sanctuary	NOAA/CBNMS	37.88	-126.44	534	500	October 2015	October 2017
NRS12	Buck Island Reef National Monument, U.S. Virgin Islands (US VI)	NOAA & NPS	17.79	-64.65	40	40	November 2016	May 2017

More details are available [online](#).

Sanctuary Soundscape Monitoring Program

NOAA and the U.S. Navy are working to better understand underwater sound within the National Marine Sanctuary System. For the next few years, these agencies will work with numerous scientific partners to study sound within seven national marine sanctuaries and one marine national monument, which includes waters off Hawaii and the east and west coasts. Standardized measurements will assess sounds produced by marine animals, physical processes (e.g., wind and waves), and human activities. Collectively, this information will help NOAA and the Navy measure sound levels and baseline acoustic conditions in sanctuaries. This work is a continuation of ongoing Navy and NOAA monitoring and research, including efforts by NOAA's Office of National Marine Sanctuaries.

Monitoring will take place in Stellwagen Bank, Gray's Reef, and Florida Keys national marine sanctuaries (East Coast); Olympic Coast, Monterey Bay, and Channel Islands national marine sanctuaries (West Coast); and Hawaiian Islands Humpback Whale National Marine Sanctuary and Papahānaumokuākea Marine National Monument (Pacific Islands Region) as presented below.



U. S. Marine Sanctuaries participating in the Sanctuary Soundscape Monitoring Program. Upper left: (West Coast) Stellwagen Bank, Gray's Reef, Olympic Coast, Monterey Bay, and Channel Islands national marine sanctuaries; lower left: (Pacific Islands Region) Hawaiian Islands Humpback Whale National Marine Sanctuary and Papahānaumokuākea Marine National Monument; right: (East Coast) Florida Keys national marine sanctuaries. Source: NOAA.

More details are available [online](#).

MARAMBS – Marine Animal Ranging Assessment Model Barents Sea

Funding origin	PETROMAKS2 — program petroleum
Lead organization	DHI (Norway)
Duration	2016 - 2019

The project involved the development of an online software tool (MARAMBS) to describe and explain the presence and movement patterns of the most vulnerable marine species (marine mammals, fish and birds) in the Barents Sea, and their reaction to underwater noise from Exploration and Production (E&P) activities.

MARAMBS applies cutting edge dynamic habitat and agent-based modelling techniques, that describe the relationship between occurrence of marine life and environmental variables. For the online noise impact assessment, exposure thresholds for relevant species of marine mammals in the Barents Sea are provided, and split into behavioural response, Temporary Threshold Shift (TTS) and Permanent Threshold Shift (PTS). The thresholds transfer into different impact ranges which, in a risk assessment scheme, can be used to estimate the significance of the response of the animals, by intersecting the impacts ranges with the distribution of the species in question, during the relevant season and year.

The project is led by DHI in collaboration with Equinor ASA, ConocoPhillips, Total, the Norwegian Institute for Nature Research (NINA) and the Institute for Marine Research IMR.

Information about the online risk assessment tool is available [online](#).

3. Main Conclusions

In the advice given by TG Noise to the Marine Directors, in November 2014⁵, TG Noise recommended that starting of monitoring of the existing indicators should be the highest priority for Member States. Since then, significant progress has been made with implementation of monitoring of underwater sound.

The combined HELCOM and OSPAR Impulsive Noise Registry has become operational and hosted at the International Council for the Exploration of the Sea (ICES), so in the Baltic Sea and North-East Atlantic Ocean regions, a joint register for impulsive sound is now available. In the Mediterranean and Black Seas, efforts are also being made to establish a register for impulsive sound.

Regarding monitoring of ambient sound, the BIAS project in the Baltic Sea has been completed, and concrete initiatives in the Mediterranean Sea, the North Sea, the Atlantic area and Adriatic Sea are now in different stages of implementation. These initiatives will further expand the areas where monitoring of underwater sound is implemented.

After the last five years, it has become clear that significant efforts have been made to enhance implementation of monitoring and management of underwater noise, by providing the scientific support and funding to the implementation of the MSFD and, in particular, monitoring programmes. It is clear that the currently used methods can and will deliver relevant information on underwater sound levels. The international cooperation to further implement and continue monitoring should be maintained. The Joint Monitoring Programmes for underwater sound are realistic, effective and, most importantly, provide information for both individual Member States and at regional scale, that cannot be obtained by individual monitoring campaigns.

5

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4. Acronyms

ACCOBAMS	Agreement on the Conservation of Cetaceans in the Black Sea, the Mediterranean Sea and the contiguous Atlantic area
ADEON	Atlantic Deepwater Ecosystem Observatory Network
AGESCIC	Achieve Good Environmental Status for Coastal Infrastructure Construction
AQUO	Achieve Quieter Oceans by shipping noise footprint reduction
Baltic BOOST	Best Practices for Action Plans to Develop Integrated, Regional Monitoring Programmes, Coordinated Programmes of Measures and Addressing Data and Knowledge Gaps in Coastal and Marine Waters
BIAS	Baltic Sea Information on the Acoustic Soundscape
CMEMS	Copernicus Marine Environment Monitoring Service
DEPONS	Disturbance Effects on the Harbour Porpoise Population in the North Sea
LIDO	Listening to the Deep-Ocean Environment
MSFD	Marine Strategy Framework Directive
MaRVEN	Environmental Impacts of Noise, Vibrations and Electromagnetic Emissions from Marine Renewable Energy
NOAA	National Oceanographic and Atmospheric Administration (US)
HELCOM	Baltic Marine Environment Protection Commission - Helsinki Commission
HELCOM EN-Noise	HELCOM Expert Network on Underwater Noise
ICES	International Council for the Exploration of the Sea
ICG-Noise	Intersessional Correspondence Group on Underwater Noise (ICG-Noise)
IQOE	International Quiet Ocean Experiment
JRC	Joint Research Centre
JOMOPANS	Joint Monitoring Programme for Ambient Noise North Sea
JONAS	Joint programme for Ocean Noise in the Atlantic Seas
QUIETMED	Joint programme on noise (D11) for the implementation of the Second Cycle of the MSFD in the Mediterranean Sea
SHEBA	Sustainable shipping and environment of the Baltic Sea region
SONIC	Suppression of Underwater Noise Induced by Cavitation
TG NOISE	Technical Group on Underwater Noise
UNAC-LOW	Underwater acoustic calibration standards for frequencies below 1 kHz

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