AQUO Project G.A. 314227

Newsletter

Issue No. 4, July 2015

Introduction

Achieve QUieter Oceans (AQUO) Project is a now entering its final six months of operation. Significant and interesting results have been achieved in all areas of the project and some of these are detailed in this newsletter.

Vibro-Acoustic Modelling

Alfonso Moreno, TSI and Celine Rousset, DCNS

In the framework of the AQUO project, the need to predict underwater noise generated by vessels has been identified as a key point to enable the shipbuilding industry to face the challenges of complying with the forthcoming directives for building quiet vessels. Numerical predictions also allow for a better understanding of the main phenomena involved in the generation of underwater radiated noise (URN). For instance, DCNS and University of Strathclyde have modelled the hull-propagation interaction effect on the SSPA Coastal Tanker to assess how much the vibro-acoustic response of the ship structure amplifies the direct URN from the propeller. The input data were based on the measurements performed in WP3. Different numerical methods covering the frequency range of interest were used: Finite and Boundary Element Methods (FEM/BEM) for low frequencies, Statistical Energy Analysis (SEA) for high frequencies and Reduced Component Mode Synthesis.

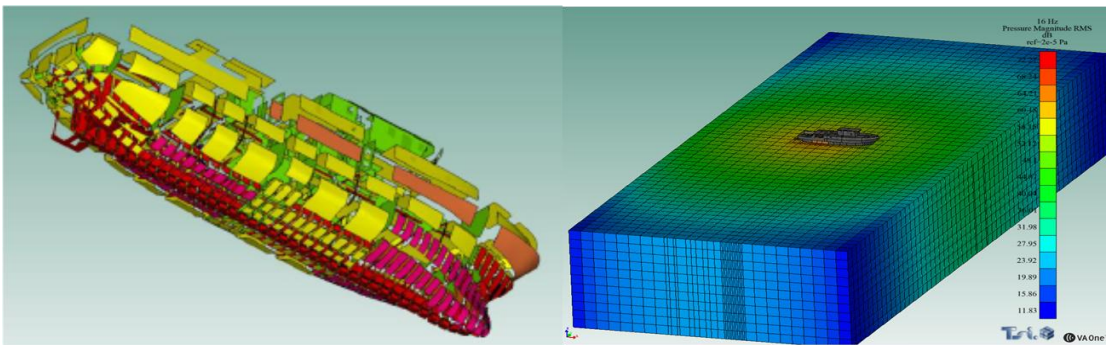
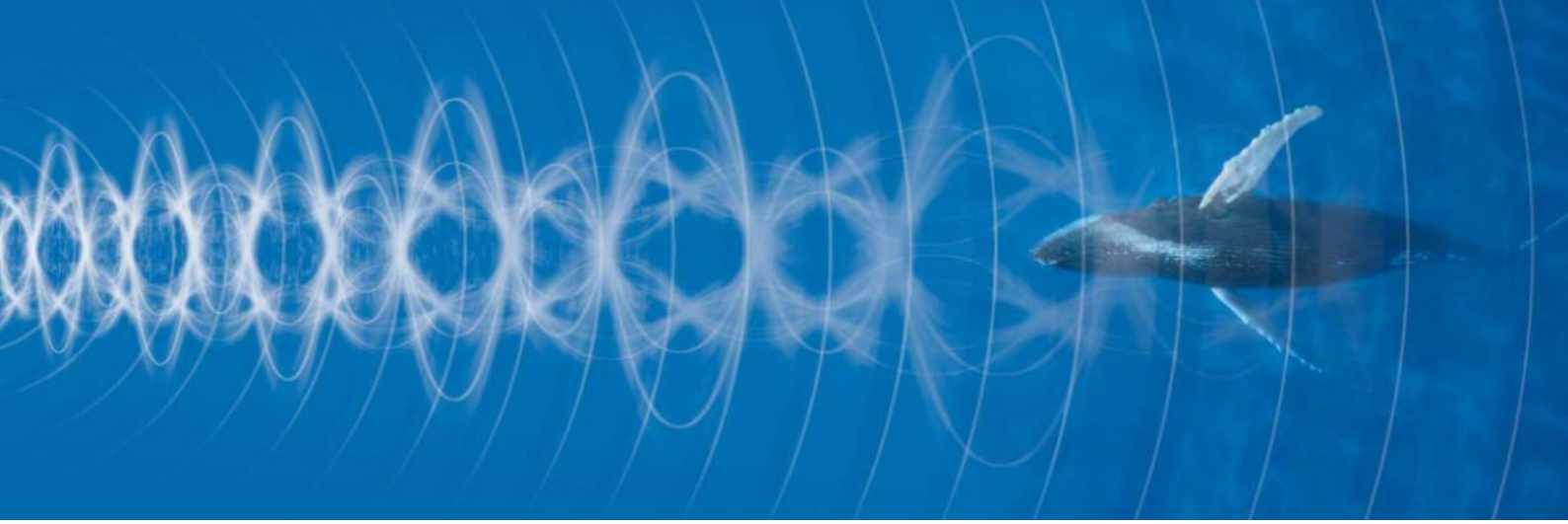


Figure 1 - Fishing Research Vessel Simulation

Going further, TSI has developed two numerical models: for low frequencies an Hybrid model FEM-BEM/SEA and for high frequencies a complete SEA model of a fishing research vessel (which was also measured at the beginning of the project) to predict the total URN of the vessel and to assess the most important underwater noise sources (machinery and propeller noise contribution). Finally, TSI compared their URN prediction to the results obtained from the full scale measurement, with good agreement observed between both.



Real-Time Ocean Shipping Noise Footprint Mapping Goes Live

Thomas Folegot, CEO Quiet-Oceans

Figure 2 - The three test sites for AQUO

Continuous noise monitoring and noise mapping is now operational for three areas in the Mediterranean Sea, and in the Atlantic Ocean. This major achievement has been made possible thanks to the joint effort between Quiet-Oceans (Brest, France) and the Laboratori d'Aplicacions Bioacustiques (Barcelona, Spain) which have merged their real-time modeling, analysis and measurement capabilities. The noise mapping service has been fully operational since February 2014, and has demonstrated a high level of quality with uncertainties of less than 3.8dB over a 6 month period.

This continuous production allows for the calculation of median levels of noise, and any percentiles at daily, weekly, monthly, quarterly, and soon annual scales. The standard frequencies are the 63 Hz and 125 Hz third-octave bands which fulfill the requirements of the Marine Strategy Framework Directive (MSFD). Since the service also addresses impact studies, other frequencies up to a few tens of kHz can be set-up.

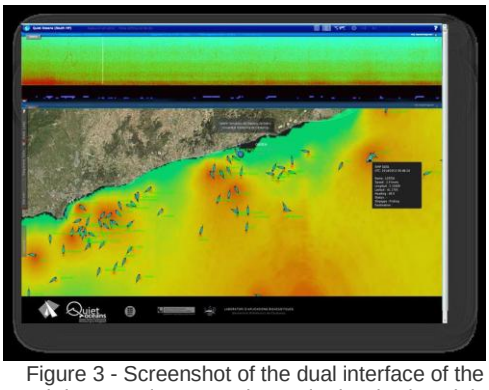


Figure 3 - Screenshot of the dual interface of the real-time passive acoustic monitoring (top) and the real-time noise mapping (bottom)

Integrated into the Listen to the Deep Ocean (LIDO) web-interface and data-management system, it provides the end-user with a comprehensive management tool.

The dual interface combines the bioacoustics analysis of the measured sounds by the hydrophones, and the physical analysis of the noise through the mapping of the surrounding noise in real-time.

Access to the database allows the retrieval and extraction of the results of the bioacoustics algorithms such as the detection and identification of marine mammal sounds and access to the daily, weekly, monthly, quarterly and annually statistics for the noise.

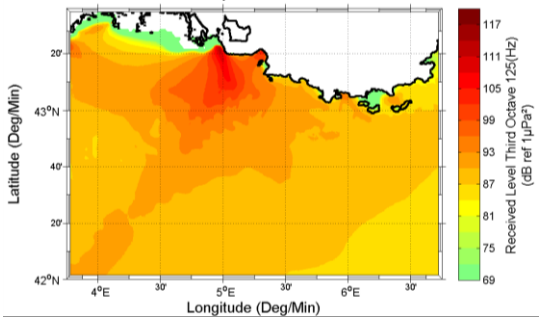
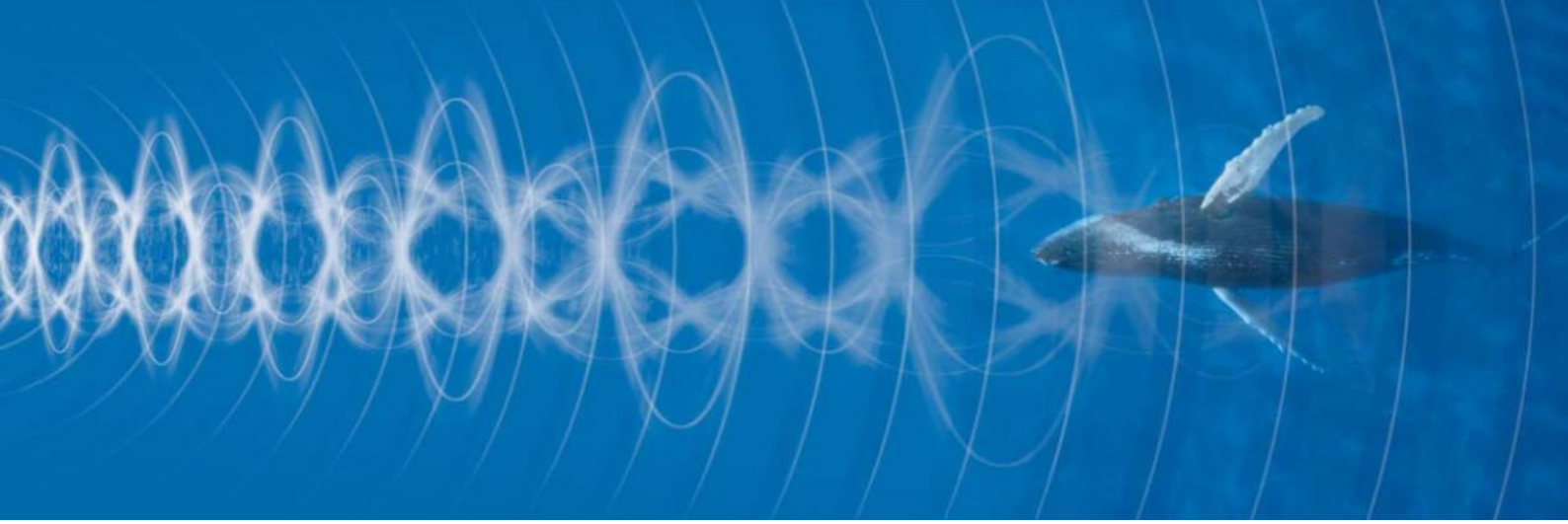


Figure 4 - Monthly median noise maps in February 2015 at ANTARES, France

The duality of the service allows managers to both monitor presence of specimen or groups of specimen in the vicinity of the hydrophones, and to evaluate the noise they are exposed to.



Bio-Acoustic Experiments

Masking effect of ship noise on harbor porpoise hearing

K. Lucke. IMARES - CMST, Curtin University

Figure 5 – Masking effect experiment

A key component of the AQUO project is the investigation of possible effects of ship noise on marine environment. The harbour porpoise (*Phocoena phocoena*) was chosen as representative species for marine mammals as it ranges widely throughout almost all European waters and is the most abundant toothed whale species in the North Sea. These animals have an excellent hearing sensitivity and rely on their acoustic sense to find prey, orientate themselves and avoid obstacles or predators.

A series of hearing tests was conducted on four of the animals in two facilities in the Netherlands (Dolfinarium Harderwijk and Ecomare) to test the possible masking effect of ship noise on the auditory perception in harbour porpoises. Masking is a process by which the threshold of hearing for one sound is raised by the presence of another sound. If a harbor porpoise fails to detect and appropriately react to the presence of a sound source (a conspecific or a threat) due to masking, it may have serious impacts on its fitness.

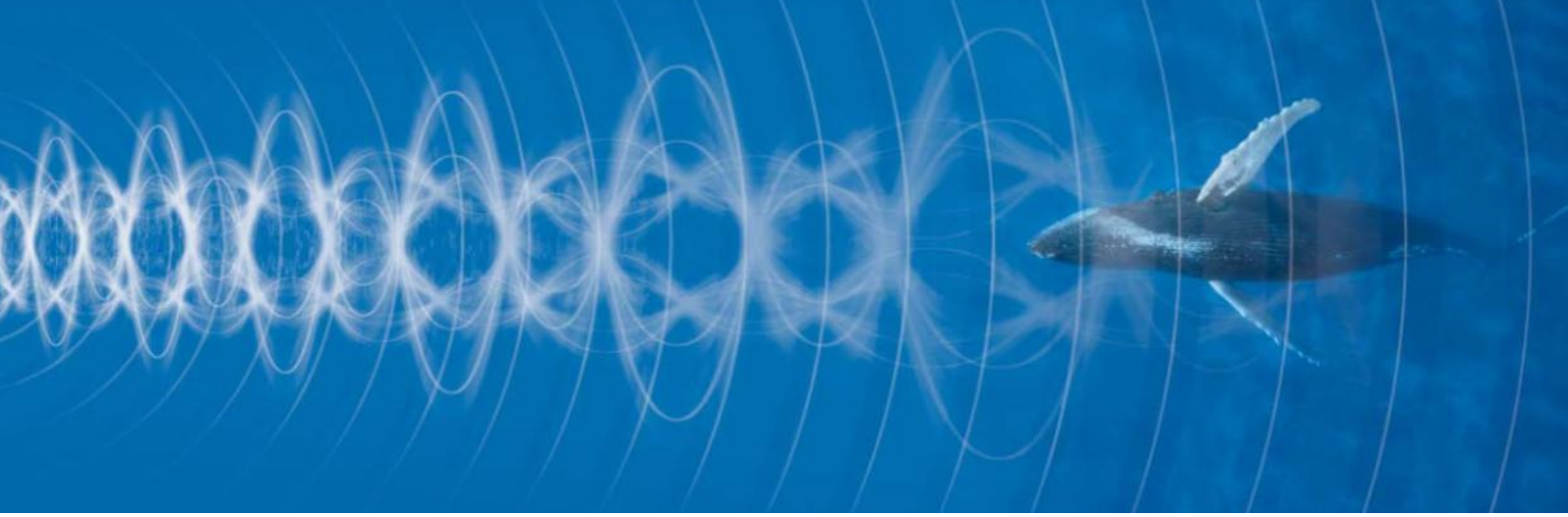
By measuring the animals' auditory brainstem response (ABR, a non-invasive method allowing a rapid assessment of data) the hearing sensitivity was tested in the absence of any masking noise and compared to detection levels achieved in the presence of ship-type noise.

The results show a frequency dependency of the masking effect. Ship noise has the potential to mask the perception of biologically relevant sounds for harbor porpoises over a much wider frequency range than previously thought.

The range over which ship noise will mask the auditory perception of narrowband signals can now be modelled if the source level as well as the spectral and temporal characteristics of the ship's acoustic signature are known and the sound propagation can be modelled for the area.

Figure 6 – Experiment with harbour porpoises

Existing and future considerations of the effects of underwater radiated sounds by ships and other sources need to take the full spectral content of the sound into account.



Effects of noise on marine invertebrates

Michel André, Laboratory of Applied Bioacoustics, Technical University of Catalonia, BarcelonaTech (UPC)

The extent to which ship noise in the sea impacts and affects marine life is a topic of considerable current interest both to the scientific community and to the general public.

Cephalopods potentially represent a group of species whose ecology may be influenced by artificial noise that would have a direct consequence on the functionality and sensitivity of their sensory organs, the statocysts. These are responsible for their equilibrium and movements in the water column.
Controlled Exposure Experiments, including the use of a 50-400Hz sweep revealed lesions in the statocysts of four cephalopod species of the Mediterranean Sea, when exposed to these low frequency sounds. The analysis was performed through scanning (SEM) and transmission (TEM) electron microscopical techniques of the whole inner structure of the cephalopods' statocyst. All exposed individuals presented the same lesions and the same incremental effects over time, consistent with a massive acoustic trauma observed in other species that have been exposed to much higher intensities of sound.

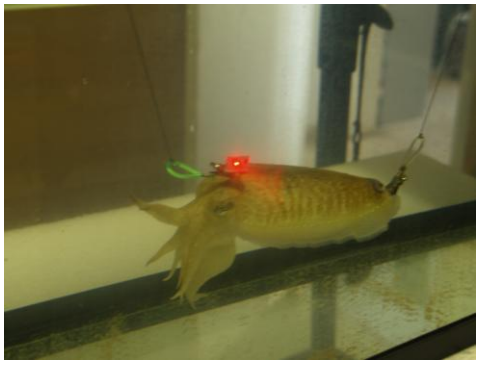


Figure 7 – Laser Doppler Vibrometer technique to determine the onset mechanism of body vibration when a cuttlefish is exposed to sound

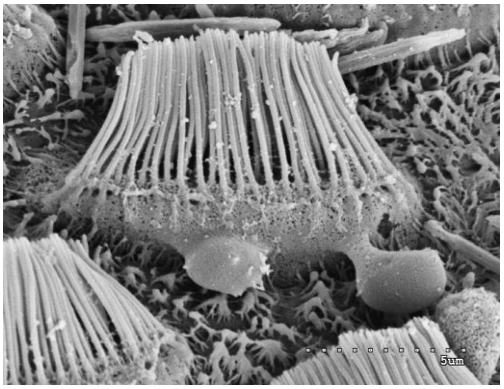


Figure 8 – Acoustic trauma in the sensory epithelium of a cuttlefish statocyst, where the hair cell show inner material extrusion

Because of a lack of available data in open-sea conditions and on the onset mechanism of the acoustic trauma (in order to determine whether these animals are more sensitive to particle motion or acoustic pressure, or to a combination or both), we conducted offshore noise exposure comparative experiments on common cuttlefish (Sepia officinalis), in similar conditions as during the laboratory study, in terms of sound characteristics, received levels and time exposure. Particle motion measurements were also performed at the same locations and depths where the individuals were exposed at sea. Scanning electron microscopy (SEM) revealed similar injuries in the inner structure of the statocysts, as those found in cuttlefish in previous laboratory experiments. As for the particle motion data, the amplitudes (total sum of x, y and z components) were decreasing with increasing distance between the sensors. These findings support the validity of our previous results in laboratory conditions. Although here, the lesions were quantified versus received noise levels and particle motion data, the analysis cannot yet determine threshold levels that would trigger the acoustic trauma. Acknowledging the validity of an experimental approach in laboratory conditions, this will constitute the next step of this research.

Recent Meetings

AQUO Plenary Meeting 5, Villanova, Spain – March 2015

With the end of the project drawing closer, the bi-annual consortium plenary meetings become ever more important. The most recent, hosted by UPC in sunny Villanova, Spain, was attended by representatives from the majority of consortium. The successes reported included the recent completion of several key deliverables and experiments, and an extensive list of dissemination activities at a wide range of conferences and events. Also discussed were the joint guidelines which will be produced in partnership with the SONIC project consortium, and which will be presented to the EU as a proposal for the future regulation of underwater radiated noise aspects, and enhanced by AQUO's own guidelines. These address noise measurement, prediction, and mitigation, as well as aspects related to impact on marine life and fuel efficiency.

AQUO End-Users Committee Meeting, Paris, France – April 2015

Figure 9 – AQUO End-Users meeting

The second end-users committee meeting took place recently in Paris, and was well attended both physically and virtually by a diverse range of members. The committee, which includes shipyards, ship owners, classification societies, NGO's and academic institutes were updated on the significant progress which has been made within the AQUO project, highlighting the key findings and outlining the way forward to the end of the project and beyond. Over the two days, the whole group was able to engage in very fruitful discussions on how the findings of the project can be used by industry, and how these findings will inform future research and governance of underwater radiated noise.

Forthcoming Events

Oceanoise 2015: AQUO partners will present and participate in roundtables at this conference taking place in Vilanova, Spain on 11th-15th May (http://oceanoise2015.com/)
OCEANS'15: 7 AQUO partners will present in a dedicated AQUO / SONIC session at this conference in Genoa, Italy on 18th - 21st May (http://www.oceans15mtsieeegenova.org/)
AQUO Progress Meeting 6: September 2015

www.aquo.eu

European Commission
SEVENTH FRAMEWORK PROGRAMME

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