

SOUND SCAPE

SOUNDSCAPES IN THE
NORTH ADRIATIC SEA
AND THEIR
IMPACT
ON MARINE BIOLOGICAL
RESOURCES



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THE FIRST EXTENSIVE STUDY
ON UNDERWATER NOISE
IN THE MEDITERRANEAN SEA

Project Partners



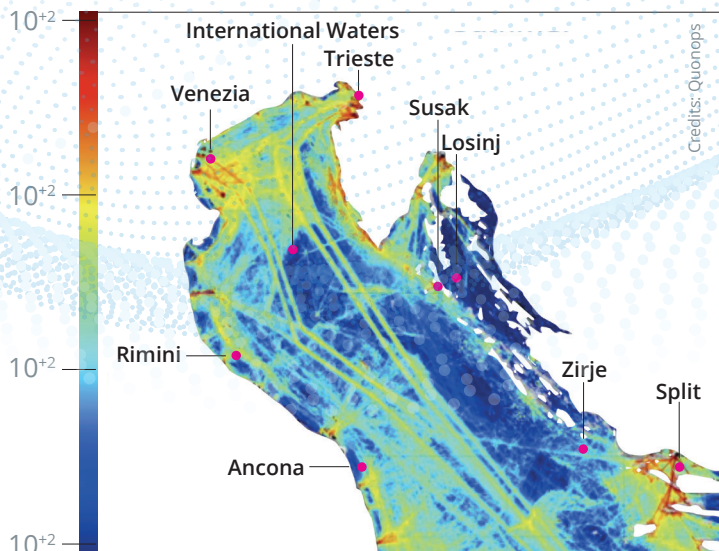
UNDERWATER NOISE POLLUTION MATTERS

Marine organisms infer relevant information by listening to the underwater soundscape and they can use sound for communication, foraging and navigation.

Many of the human activities that take place at sea contribute to increasing underwater noise pollution. Anthropogenic noises have the potential to mask biological signals and to cause behavioural reactions, physiological problems, injuries and even death in marine animals.

The Northern Adriatic Sea (NAS) is the shallowest, northernmost part of the semi-enclosed Adriatic Sea. It hosts a precious and very vulnerable biodiversity, Natura 2000 sites and marine and coastal protected areas (MPAs). Despite this, NAS is highly impacted by increasing tourism and resource exploitation. Maritime traffic is very intense inside the NAS.

The next figure shows the density of vessel traffic and the monitoring network.

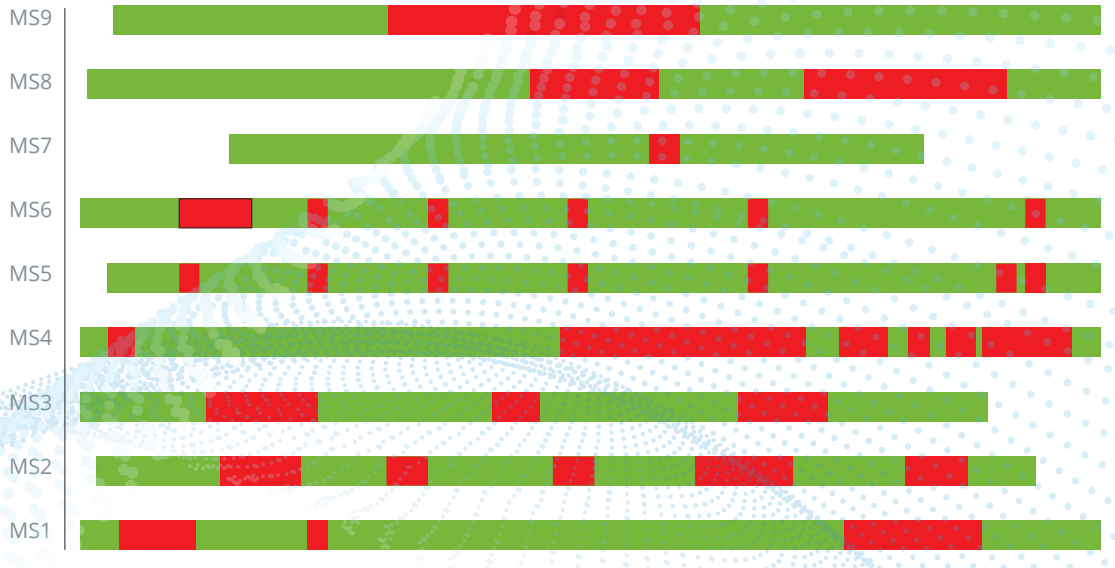


The Soundscape Project characterized the NAS underwater noise

SOUNDSCAPE set up an international cross-border network of nine monitoring stations with the same type of instruments and shared protocols for data acquisition.

DATA COVERAGE

Credits: CNR ISMAR



02/20 03/20 04/20 05/20 06/20 07/20 08/20 09/20 10/20 11/20 12/20 01/21 02/21 03/21 04/21 05/21 06/21 07/21

● Acquired and passed data

● Missing data

During SOUNDSCAPE, the monitoring equipment was set up and deployed. Broadband acoustic data was collected continuously for 15 months, covering all seasonal variations in underwater noise sources.



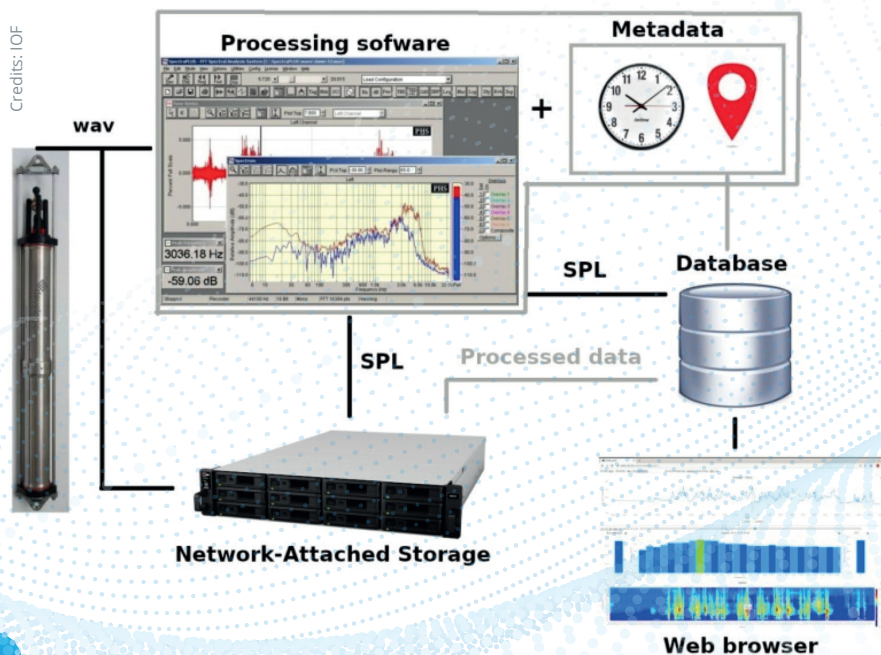
Credits: ARPA FVG



Credits: Blue World Institute

1-YEAR-LONG CONTINUOUS DATA ON UNDERWATER NOISE

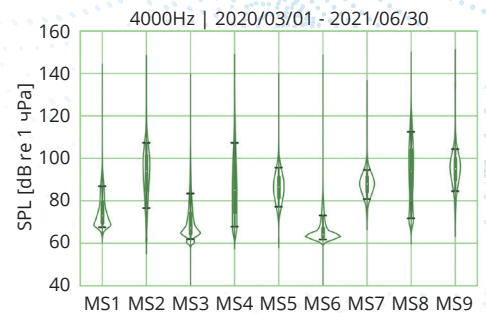
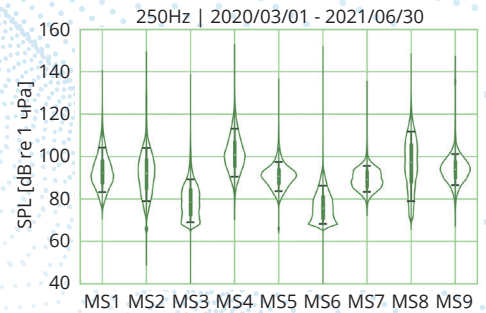
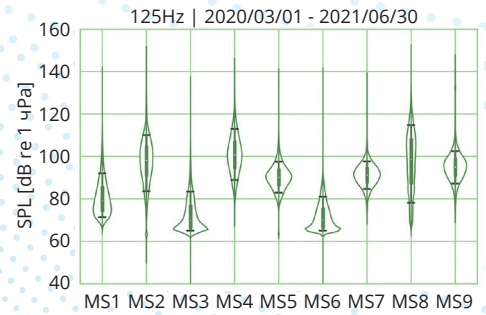
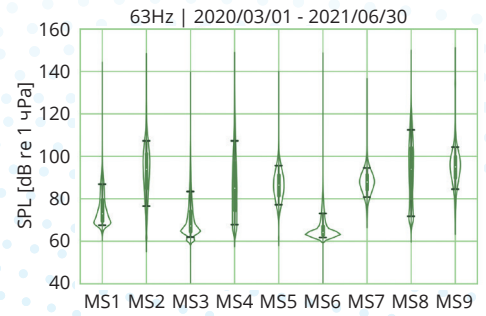
The underwater noise levels have been identified as a target for the monitoring, as they reflect the quality of the marine environments. The processing of the SOUNDSCAPE data helped to split the noise levels between a wide band of frequencies (50 Hz - 22100 Hz), including the MSFD (Marine Strategy Framework Directive) requested frequencies. The MSFD 11.2.1 Indicator requires the monitoring of the average values of sound pressure levels (SPL) (re 1 μ Pa RMS) over a year within the 63 Hz and 125 Hz 1/3 octave bands standard centre frequencies.



SOUNDSCAPE adopted shared procedures for uploading/downloading and processing data collected in shared databases both in Italy and Croatia.



For the first time, **Soundscape** provided a shared assessment on annual and seasonal noise level distribution in the NAS. The **Soundscape** data confirm the relevance of underwater noise pollution in the NAS and the need of evaluating its impact on biodiversity within the maritime management.

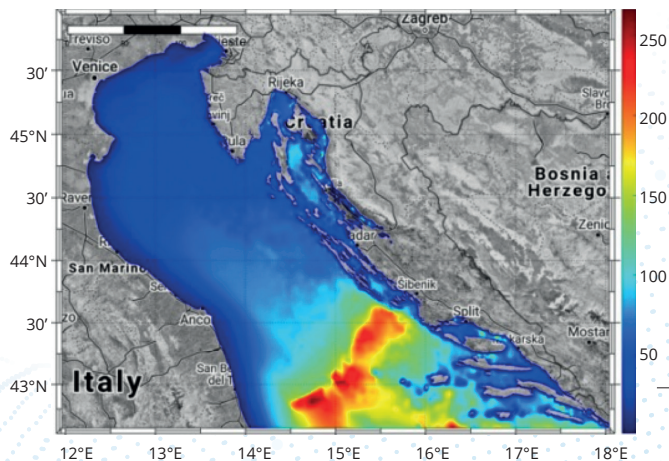


UNDERWATER NOISE MODELLING

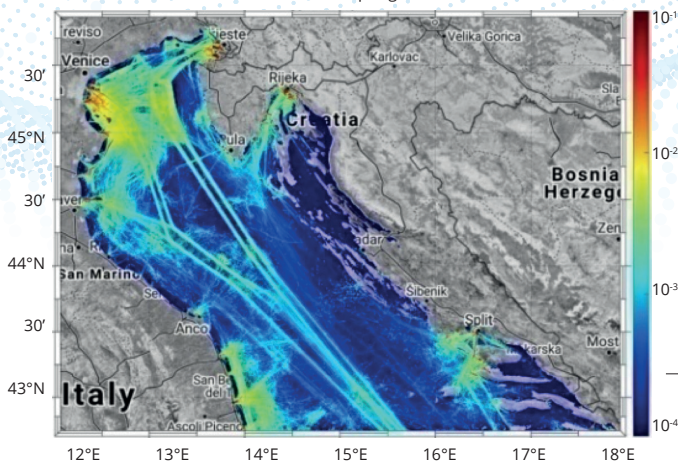
A mathematical model can provide an estimate of the spatio-temporal distribution of noise. Based on the state of art of the underwater modelling systems, SOUNDSCAPE simulated a three-dimensional noise distribution, accounting for one year of environmental and anthropogenic inputs.

Noise mapping allows to understand human-made noise pressure to fulfill the requirements of the Marine Strategy Framework Directive (MSFD) of the European Union.

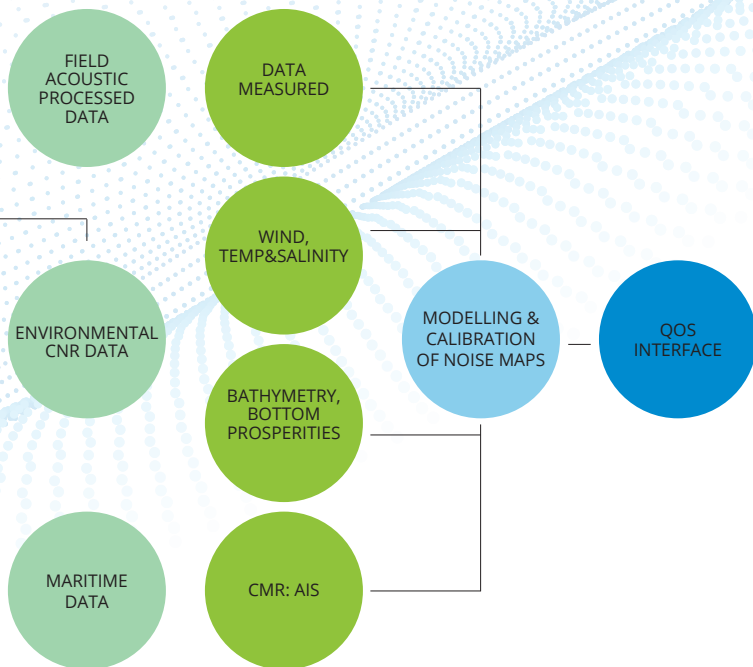
Bathymetry (source Emodnet)
Reprocessed by Quiet_Oceans, Resolution 50 m



Type of Ship: All
AIS data in Spring 2020



Credits: Quonops

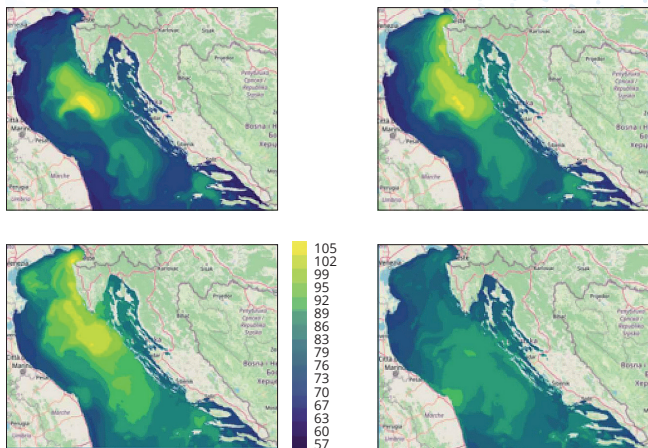


For the first time
the underwater noise
prediction system modelled
the underwater acoustic noise
distribution over the whole
Northern Adriatic region.

*SOUNDSCAPE provided a first atlas on underwater
noise monthly maps in the North Adriatic Sea.
This helps filling relevant gaps in Mediterranean
noise distribution knowledge.*



Credits: Elisabetta Zavoli



Adriatic baseline noise-level map, generated for February 2020 and calculated on the whole water column. Monthly average SPLs (dB re 1 μ Pa) for 1/3 octave band frequencies centred at 63.125 Hz (top panels from left to right) and 250 and 4000 Hz (bottom panels).

Source: Quonops Online Services

The maps are referred to an exceptional period: the year 2020 and its lockdown time (from Jan 2020 to May 2020) due to the pandemic. Limited vessel traffic and no other human activities were permitted.

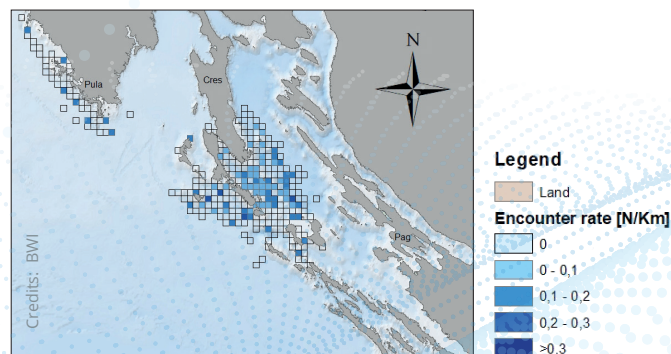
Soundscape had
the unique chance
to record and map the
underwater noise during
a “low-human-impact”
timeframe.



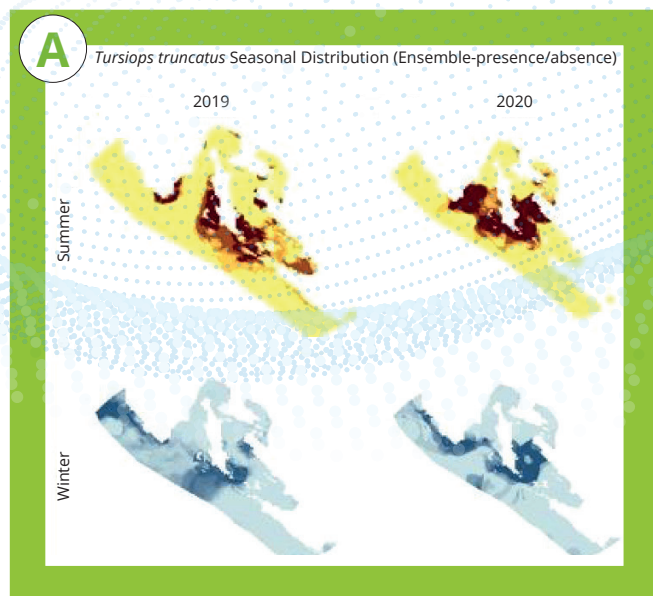
FROM SOUNDSCAPE ASSESSMENT TO BIODIVERSITY PROTECTION

SOUNDSCAPE has offered the chance to review the existing knowledge on two target species bottlenose dolphins (*Tursiops truncatus*) and loggerhead turtles (*Caretta caretta*), to study their spatial and temporal distribution in Cres-Lošinj archipelago (Croatia) and to investigate their relation with local environmental and anthropogenic factors, including noise levels.

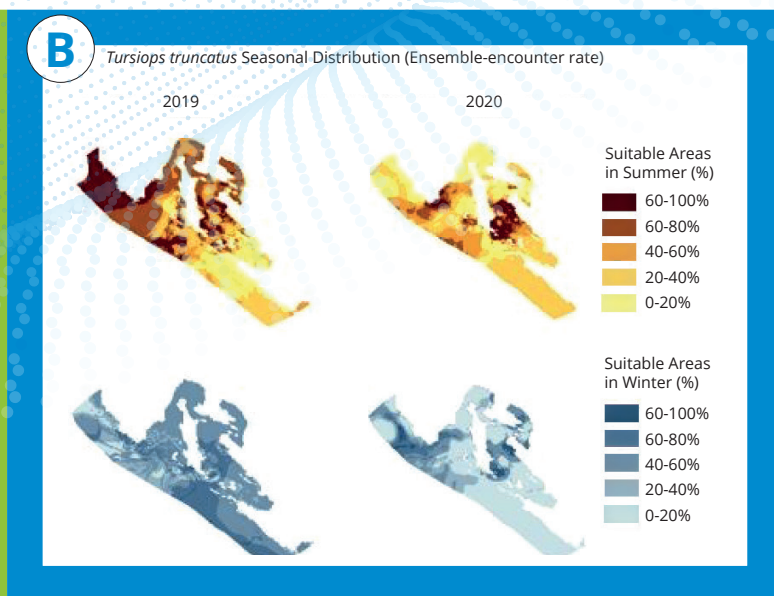
Through **Soundscape** it has been possible to review the sensitivity of the target species and to develop studies on target organisms and their interactions in a specific area of Croatia.



Modelled with P/A data



Modelled with ER data





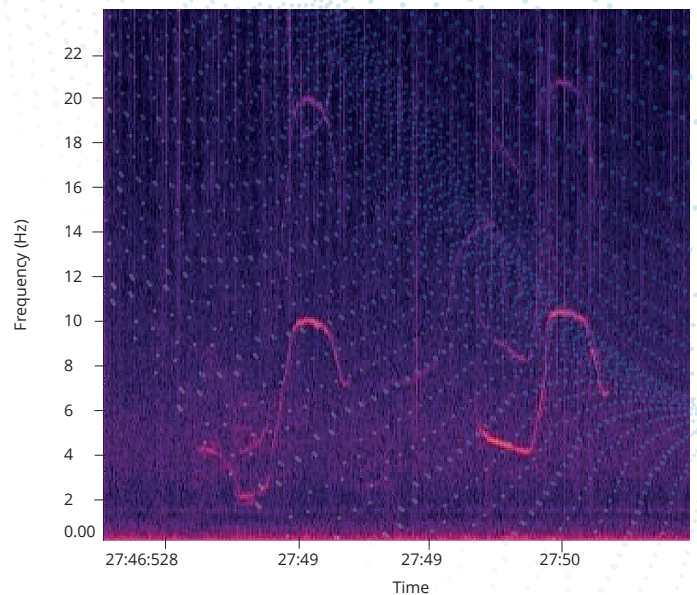
Boat-based surveys of the study area were conducted; data on locations of dolphin encounters, group size and age-class composition, behavior and interactions with fisheries were collected.

As part of the SOUNDSCAPE project, small-boat traffic has been monitored using a theodolite to understand if spatio-temporal changes in the species distribution relate to anthropogenic pressure. This represents also a chance to include recreational boats in numerical models for the first time.



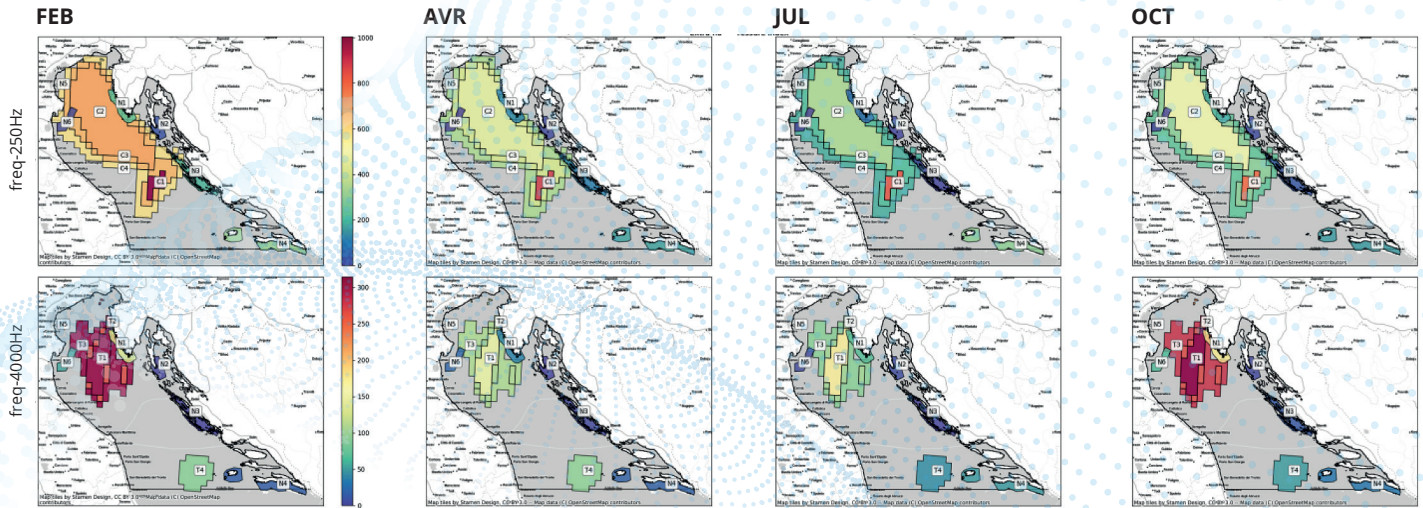
Thanks to SOUNDSCAPE, new habitat suitability models integrating all available data on target species distribution have been created. The data included environmental and anthropogenic factors as boats and, for the first time, noise distribution. Models identify spatial and temporal patterns in preference of target species for certain parts of the area.

Biophony in the acoustic recordings was recognized and analyzed. Significant differences in bottlenose dolphins' whistle parameters have been observed between the summer and winter season, i.e. in relation to levels of underwater noise produced by the boat traffic, in agreement with previous studies.



A pressure index based on sound pressure level distribution was developed and centered on 250 and 4000 HZ at 1/3 octave band wide. The areas with a higher noise pressure correspond to areas having higher abundance of the target species.

EXTRA NOISE PRESSURE



Credits: CNR ISMAR

The results show that the Adriatic soundscapes are widely influenced by the complex system of maritime transportation. Mitigation measures should be focused on specific target areas, taking into account UWN mitigation within national maritime spatial plans.

Medium-long-term future scenarios foresee an increase in traffic density. Careful management of human activities is required.



Credits: Fondazione Cetacea

SHARING SOUNDSCAPE WITH THE PUBLIC

Underwater noise pollution is an unusual concept for the general public: generally speaking we are not aware of the role the soundscape has in our lives and this is even less understandable when considering the Costeau's underwater so-called 'silent world'.

This project aims to increase the awareness of the public on the relevance of the underwater soundscape for marine organisms and the effects of man-made noise pollution on the ecosystems.

Soundscape involved the public with workshops, lectures, exhibitions and performances.

The project communicated the impact of anthropogenic noise on the marine environments through art, by involving senses and rising emotions in the public: it carried out important collaborations with Venice Biennale, Ocean Space, Science Gallery Venice, AdriaticoMediterraneo festival in Ancona, "Il suono in mostra" sound exposition in Udine, exposition ENT1 Venice/Auckland, Galata Museum in Genoa...



Different Waves is a performative concert which combines recorded noises, lights and noise waves. It helps the public to understand soundscape complexity and the effects of underwater noise pollution.

Workshop and communication events were organized in order to raise awareness in specific target groups.

The project experiences and results were transferred to the Stakeholders dealing with marine environment, at local, regional, national and EU levels, through meetings and workshops organized by the partners.

Stakeholders included Natura 2000 sites /MPAs managers, associations related to shipping and fishing sectors, as well as NGOs working in sea conservacy and education and training organisations.

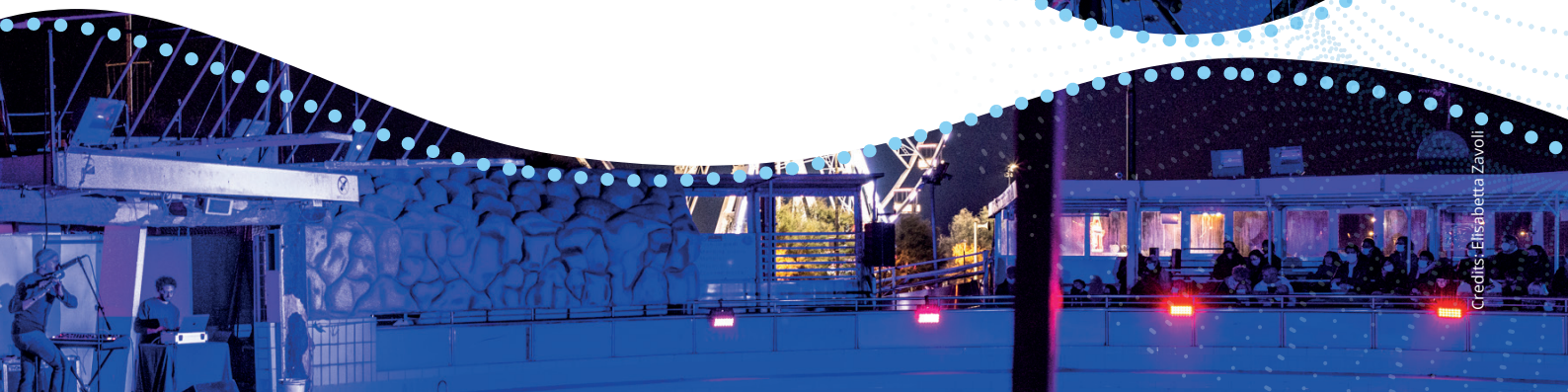
The project results were presented during specific events for Croatian and Italian authorities and at EU level in order to support policy makers for the development of strategies for an integrated approach to the NAS area.



Credits: Mattia Fornaciari



Credits: Elisabetta Zavoli



Credits: Elisabetta Zavoli

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- Lead partner: INSTITUTE OF OCEANOGRAPHY AND FISHERIES (**IOF**)
 - NATIONAL RESEARCH COUNCIL (**CNR**)
 - BLUE WORLD INSTITUTE OF MARINE RESEARCH AND CONSERVATION (**BWI**)
 - ENVIRONMENTAL PROTECTION AGENCY OF FRIULI VENEZIA GIULIA (**ARPA FVG**)
 - CETACEA FOUNDATION (**CF**)
 - MARCHE REGION (**REM**)
 - MINISTRY OF ECONOMY AND SUSTAINABLE DEVELOPMENT (**MESD**)
 - TEACHING INSTITUTE FOR PUBLIC HEALTH, PRIMORIE-GORSKI KOTAR COUNTY (**TIPH**)

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