



Molte specie marine, per numerose funzioni vitali, si affidano ai suoni.
Se questi vengono coperti da altri suoni prodotti dall'uomo, la capacità di sopravvivenza delle specie marine potrebbe diminuire.

Giuseppa Buscaino
PHD Senior Scientist CNR

**Studio del
Paesaggio sonoro
sommerso
dell'AMP Isole Tremiti**
Laboratorio del MARE. | Contralto Audio

Bioacustica ed Ecoacustica

Il fine è studiare i paesaggi sonori sommersi per la loro conservazione, tutela, gestione e valorizzazione. Bioacustica ed ecoacustica sono fondamentali strumenti di studio e di monitoraggio della biodiversità.

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Study of the Underwater Soundscape of the Tremiti Islands MPA

Bioacoustics originated as a complement to ethology to study the communicative dimension in animals. Widening its scope to the study of habitats and the monitoring of biodiversity (ecology), it becomes ecoacoustics, which studies the relationships between sounds emitted and received by various species in relation to the acoustic environment, also considering the interference of noise produced by human activities.

The **Sea Laboratory's project**, in collaboration with **Contralto Audio** and industry experts, is to **study the underwater soundscapes of the Tremiti Islands MPA** for their conservation, protection, management and enhancement.

Bioacoustics and ecoacoustics are fundamental tools for studying and monitoring biodiversity.

Ecoacoustics takes up and puts the '**soundscape**' as an expression of environmental quality back on strictly scientific lines, in an attempt to recognise changes induced by human actions both locally and globally, such as as a consequence of climate change, at an early stage.

The design phase was studied with the collaboration of:

Giuseppa Buscaino - *PHD Senior Scientist CNR*

Walter MX Zimmer - *Centre for Maritime Research and Experimentation (CMRE)*

Mario Di Cola - *Founder, Project Manager, CEO at Contralto Audio Srl*

Paolo Martignon - *Chief Scientist at Contralto Audio*

Ilaria Di Lauro - *Marine Biologist | for the SEA Lab*

Francesca Necci - *Marine Biologist | for the SEA Lab*



Everyone's professional contribution made it possible to outline the most relevant aspects of the scientific research that will start in 2023 in the Tremiti Islands MPA.

The project, which requires expertise in various fields and technology, will also involve divers visiting the Tremiti Islands for their activities at sea. In addition to the information and processing of the recorded data, the project will also provide an opportunity to inform how the natural environment lives through its sounds.

"Through them animals communicate, court each other, reproduce, find food by listening. It is therefore functional to the survival of species and ecosystems. Noise pollution has a negative impact. Even more so in an aquatic environment. Sound in water propagates much better than in air. If we think that humpback whales can be heard 400 kilometres away during courtship, any noise from commercial ship traffic or military sonar threatens their existence."

Today, the **soundscape** (as perceived by a listener) and the **acoustic environment** (as describable regardless of a listener's perceptive abilities) are recognised as a fundamental component of an ecosystem, which must be studied, monitored, protected, and even restored where altered by human action.

Why is it important to safeguard our sea?



The oceans of the entire Planet Earth cover about 70.9 % of its surface (Eakins & Sherman, 2010). Of all this blue expanse, the Mare Nostrum, the Mediterranean Sea, covers only 0.82 % of the total ocean surface (Jacques, 2011). Despite its small surface area, this basin has a high biodiversity (~1700 species) and a high rate of endemisms, making it a

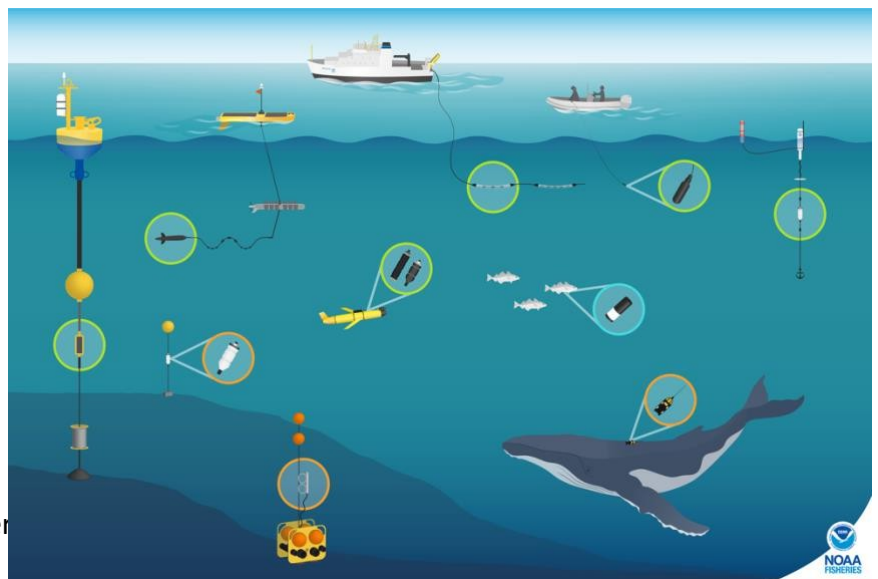
of the most important *hotspot* areas for marine biodiversity (Coll et al., 2010). In addition to specific biodiversity, our sea is rich in different types of environments (e.g. *Posidonia oceanica* meadows, coralligenous, submerged caves, etc.; Danovaro & Boero, 2019). Human overexploitation of marine resources, habitat degradation, together with fishing impacts, pollution, eutrophication and the establishment of alien species are the most important threats and causes of biodiversity loss, affecting most taxonomic groups (Coll et al., 2010).

One tool used to mitigate the negative effects of human activities on natural marine ecosystems is the creation of marine protected areas that have the ability to control and manage human activities, seeking to mitigate their effects (Lubchenco & Grorud-Colvert, 2015). In Italy, the first marine nature reserves were established under Law 979/82; in particular, the Ustica and Miramare marine nature reserves in 1986, the Tremiti Islands nature reserve in 1989, and Capo Rizzuto, Egadi Islands and Torre Guaceto in 1991.

...And, in it, what is the importance of the study of acoustic signals?

Recent studies have shown how the soundscape has also been altered by humans, but above all have highlighted how anthropogenic noise can negatively impact marine life (Duarte et al. 2021).

Passive acoustic monitoring (PAM) is an effective method for collecting, and analysing, animal sounds. In the past, this technique was mainly used for the study of marine mammals (Sousa-Lima, et al., 2013), more recently for the monitoring of fish, as there are more than 800 species in the world that emit sounds with different methods of sound production (Ladich & Fine, 2006). In addition to this, sound diversity was used to characterise biological diversity (Desideri et al., 2019).



It is therefore possible to carry out environmental census-monitoring activities using the "sound signatures" emitted by species in the habitat of interest.



And it is within the splendid setting of the Tremiti Islands that the Sea Laboratory Project will be developed, which, in collaboration with Contralto Audio and experts in the field, aims to study the submerged soundscapes of the Tremiti Islands MPA in order to gather information useful for their conservation, protection, management and valorisation.

The project, which requires expertise in various fields and technology, will also involve divers visiting the Tremiti Islands for their activities at sea. In addition to the information and processing of the recorded data, the project will also provide an opportunity to inform how the natural environment lives through its sounds.

Tremiti Islands MPA:

The archipelago of the Tremiti Islands, the only one in the Adriatic Sea, located about 12 miles north of the Gargano promontory and which became a Protected Marine Area in 1989, will be the splendid setting within which our project will be developed; consisting of three major islands, Caprara,

S. Domino and S. Nicola, separated by a small island, Cretaccio, and finally by a smaller island, located about 12 miles NE of the first three and over 30 miles from the Gargano coast, called Pianosa. In a total surface area equivalent to less than 3 Km^2 and 20 Km of coastal perimeter, the Tremite archipelago is an example of rare and uncontaminated beauty, starting from the underwater wonders of the seabed, with even numerous wrecks. to the emerged beauty of the Aleppo pine forest. (BOSS ADDITIONS)

What is the importance of the emission of acoustic signals in the environment?

Monitoring through the recording, detection and analysis of acoustic signals turns out to be an excellent way to understand how animals tend to interact with each other, assuming specific behaviours, both individual and group. The advantages deriving from the study and use of bio-acoustic techniques have allowed 'sound signatures' to be an efficient tool for the study of biodiversity, becoming a rather selective and specific recognition element that allows, with minimal environmental impact, the identification of specific species by listening to signals associated with them.

Understanding the soundscape can lead to increased knowledge in the field of biology and the study of animal behaviour, such as reproductive activity, systemic classification, phylogenetic links, selective pressures-environmental adaptation, habitat study and conservation strategies.

How is underwater noise characterised?

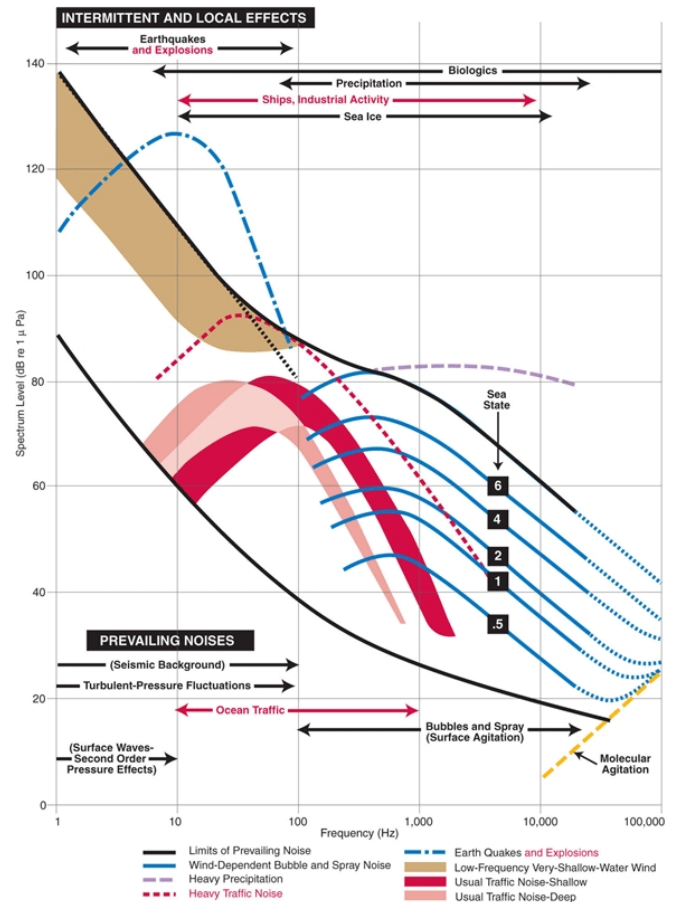
There are a multitude of different sounds in the marine environment, generated by an equal variety of natural sources (crashing waves, rain and marine life), but also generated by different artificial sources (ships and military sonar).

The various types of sound are distributed unevenly in space and time; we distinguish, for example, 'ambient noise' or background sound, the primary sources of which can be classified according to sound frequency.

-In the frequency range of 20-500 Hz, ambient noise is mainly due to noise generated by distant vessels;

-In the frequency range of 500-100,000 Hz, ambient noise is mainly due to spray and bubbles associated with breaking waves (increases with increasing wind speed);

-At frequencies above about 100,000 Hz, noise generated by the random movement of water molecules, called 'thermal noise', dominates (the ultimate limit to the minimum sound levels that can be measured).

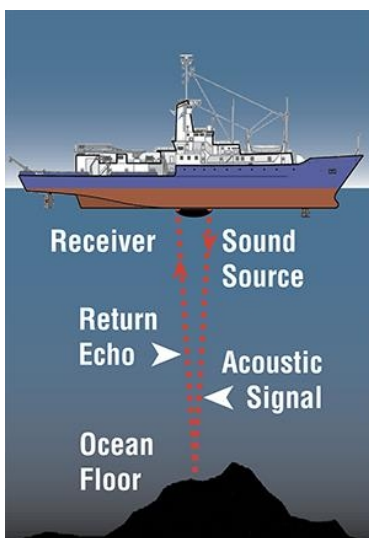


background sounds in the ocean can be summarised in a graph showing typical sound levels at different frequencies. The sound levels in this graph are in dB relative to 1 µPa in a broad frequency band of 1 Hz, which is usually written dB re 1 µPa²/Hz.

Marine life

Marine animals use sound to obtain detailed information about their surroundings. They rely on sound to communicate, navigate and feed themselves (think of marine mammals, such as dolphins, which use sound to locate and identify objects such as food, obstacles and other whales).

The emission of marine mammal calls can increase ambient noise levels by 20 to 25 dB underwater in some locations at certain times of the year.



There are two ways in which sound is used: passively and actively. In passive acoustics, the organism or user does not emit sounds of its own, but listens to sounds produced by animals, natural phenomena or people. By listening to sounds, one can learn a lot about the environment.

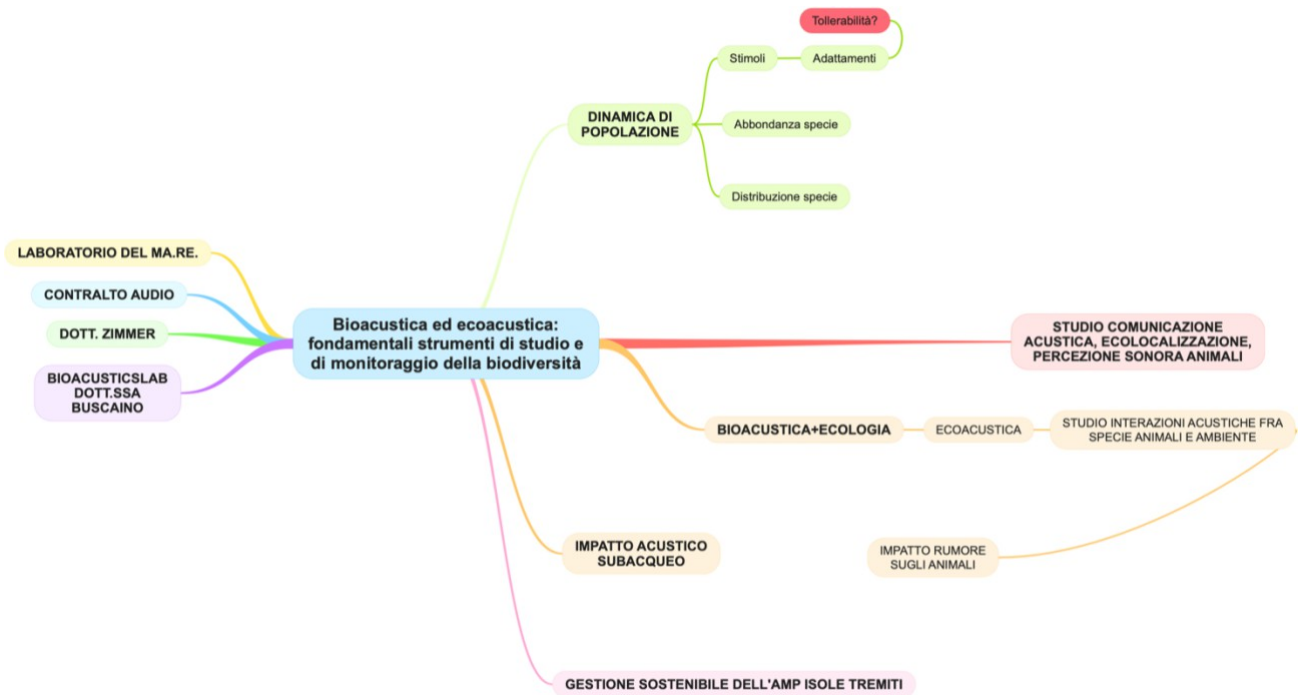
The second mode in which sound is used underwater is called active acoustics. In this case, sound is created by a source and then received by a receiver.

An example of people and animals using sound in a similar way is sonar and echolocation. People use sonar to explore the ocean and animals use echolocation to find food and identify objects.

Anthropogenic sounds

Sounds generated by human activities are an important part of the total acoustic background of the ocean (underwater sound used, for example, for communication, navigation, defence and fishing), while some sounds are just a by-product of another activity (noise generated by ships and offshore industrial activities).

Sounds generated by human activities cover a wide range of frequencies, from a few Hz up to several hundred kHz, and a wide range of source levels.



Analysis of the 'Underwater Soundscape of the Tremiti Islands MPA' Project



01_Introduction > Planet Sea under attack

- Anthropogenic and industrial actions
- Climate change
- Chemical and physical changes in the sea
- Geodiversity
- Changing the submerged sound environment

02_Bioacoustics and Ecoacoustics

03_The Science of 'Underwater Soundscape' to 2022

- overview of its evolution
- overview of its application

04_The importance of acoustic signal emission in the environment 05_The

importance of studying acoustic signals in the marine environment 06_How

underwater noise is characterised

07_How marine animals use sound

08_Anthropogenic sounds

09_Touristic Development of the Tremiti Islands

10_The development of practicable activities in the Tremiti Islands Protected Marine Area (1989) Zone A, B, C

11_Human Impact and Environmental Accounting of Activities in the MPA Analysis of increased activity in the sea

12_Changes in the underwater sound environment in the Tremiti Islands MPA (1989-2023)

13_Interactions with the underwater environment in the Tremiti Islands MPA | period 2018-2022

<i>increase</i>	<i>Description</i>
+++	Commercial/tourist navigation
-	Industrial navigation
+	Navigation for professional fishing
-	Navigation for local/artisanal fishing
++++	Boating <ul style="list-style-type: none">- for the activities of: Charters, rentals, boat trips, canoeing, Sup- supporting activities: diving, snorkelling, swimming- anchorages
+++	Diving activities
+++	Snorkelling activities

14_"Underwater Soundscape AMP Tremiti Islands" Project

Partners
Description
Innovative aspects
Scientific objectives
Scientific Protocol Study
Monitoring Stations Instruments
Project duration
Analysis and Prospects for Project Replication/Exportation to other MPAs (*)

15_Experimental phase

Survey and acquisition technology aspects
Geodiversity aspects of sites
Logistical and survey aspects (*survey station layout plan*)
Time aspects Primary
cost analysis
Study of a fundraising plan (*Experimental phase*)

16_Communication Plan

MPA
Entities

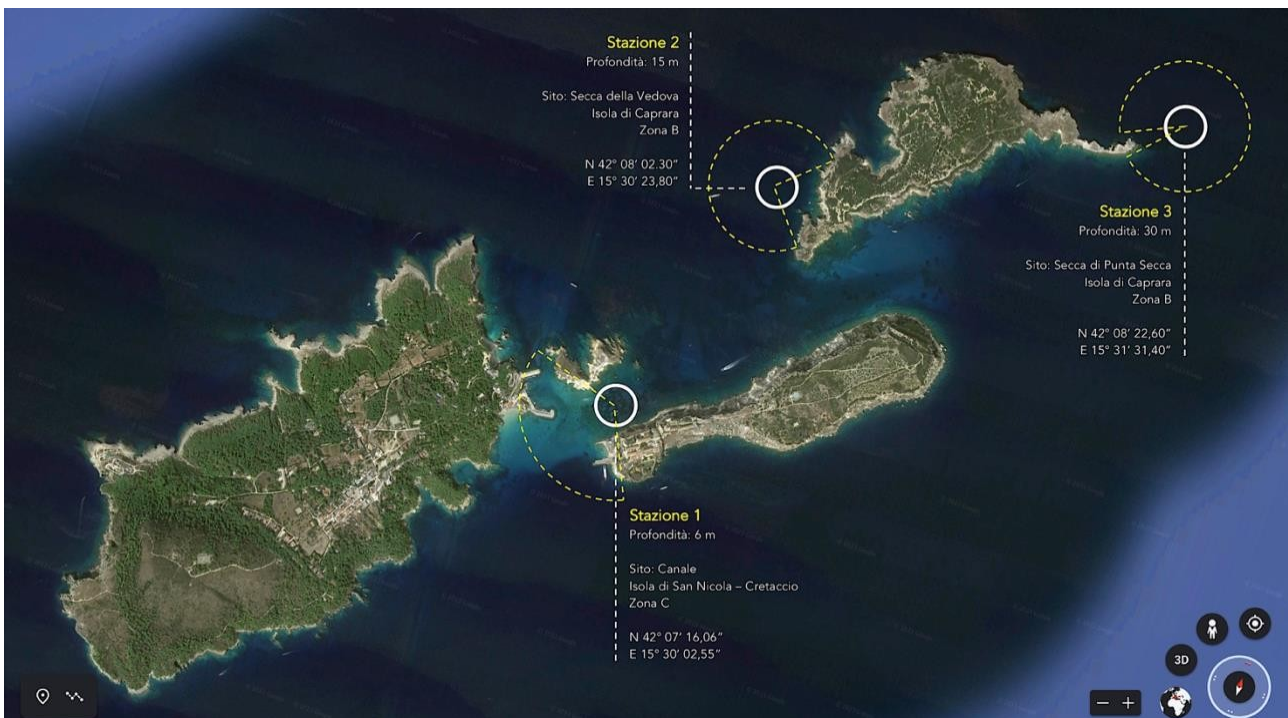
17_Cost analysis of the 'Underwater Soundscape AMP Tremiti Islands' Project

Commitment of
Partners Costs
Experimental Phase
Communication Plan
Personnel
Tools, Means and Logistics
Cost of the 'Underwater Soundscape AMP Tremiti Islands' project
Contingencies
Grants/Funding

18_Perspectives

Visibility return in scientific and technical terms
Economic return (*)

(planimetry of survey stations)



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