Marine ecology
Conservation of Marine ecosystems
Sustainable development
Underwater passive acoustics & eco-acoustics
Marine ecology
Conservation of marine ecosystems
CHORUS
In short

Our daily life
We measure and analyze the sounds produced by marine organisms and human activities to study the state, the functioning and the changes in marine ecosystems.

Our research activity, scientific experience and projects combined with a multidisciplinary team nurtures CHORUS with up-to-date knowhow in underwater passive acoustics at world-class levels.

Our vocation
To contribute to the conservation of marine environments and the development of sustainable human activities at sea using passive acoustics.

Our actions
• To contribute to a better knowledge and to monitor ecosystem health using passive acoustics,
• To better understand and monitor potential impacts of anthropogenic noise on marine fauna,
• To teach and inform stakeholders in the marine realm about eco-acoustics and the impact of man-made noise on organisms.

We founded the CHORUS Institute (NGO, French law 1901) based on over 15 years of experience in academic research and teaching and in the creation and direction of a private company.
Our fundamentals

BIOPHONY
ALL SOUNDS PRODUCED
BY LIVING ORGANISMS

MARINE
SOUNDSCAPES

GEOPHONY
ALL SOUNDS PRODUCED
BY NATURAL ABIOTIC SOURCES

ANTHROPOPHONY
ALL SOUNDS PRODUCED
BY HUMAN ACTIVITIES
Our values

Our actions for conservation and sustainable development

INDEPENDANCE AND OBJECTIVITY

ENVIRONMENTAL AWARENESS AND COMMITMENT

SCIENTIFIC EXCELLENCE AND INNOVATION

PASSION

RESPONSIVENESS AND COMMITMENT TO OUR PARTNERS

We are involved in programs for the conservation of the brown meagre and grouper species of the Mediterranean Sea together with the Calanques National Park, the Gulf of Lion Marine Nature Park, the Côte Bleue Marine Park, the MPN Tavolara Punta Coda Cavallo, and the French Agency for Biodiversity.

We monitor the eco-acoustic quality of seagrass meadows and coralligenous reefs of the Western Mediterranean together with the Water Agency Rhône Méditerrannée Corse via the CALME acoustic surveillance network.

We monitor various species of dolphins in collaboration with Fisheries and Oceans Canada (Ocean Protection Program).

We participate in programs for the conservation of bottlenose dolphins with the GIS Marine Mammals of the Mediterranean and the French Agency for Biodiversity.

We participate in programs for the conservation of the Saint Lawrence beluga whales and North Atlantic right whales in collaboration with Fisheries and Oceans Canada (Ocean Protection Program).

We map and monitor ocean noise levels and assess their impact on marine fauna with the Water Agency Rhône Méditerrannée Corse within the scope of the European Marine Strategy Framework Directive (MSFD).
Some numbers

Research
- 6 publications
- 12 conferences per year
- > 70% of our profits reinvested every year for research and conservation
- Co-financing of research programs and the acoustic surveillance network of the Western Mediterranean together with the Water Agency RMC.

Team
- 3 permanent positions
- 2 PhD fellows
- 5 members
- 2 post-doc fellows
- 2 professional divers
- 4 experts with PhD degree in underwater acoustics
- A policy of collaboration with the academic realm, private and public sector.

Our fieldwork
- 3000 days of recordings since January 2016
- Over 300 recording sites studied since January 2016 across 4 oceans

Equipment and infrastructure
- 8 autonomous acoustic recorders
- 32 hydrophones
- 2 transducers
- 150 m² premises
- 5 power computers

AMP Tavolara
Data acquisition

We own a range of instruments, including a dozen of autonomous acoustic recorders and around thirty hydrophones. We can equip all kinds of study sites and adapt data acquisition to the environment and the study questions. The recorders are either fixed on bottom structures to acquire long-term data or on drifting devices to map soundscapes. Some of the recorders are connected, allowing real-time data transmission. We also analyze data collected by ocean gliders to explore soundscapes at the basin level.

Our tools and competences

In the field

We have two professional divers in our team (CERN Classe 1B) and several boat driving licenses. We acquire 24 000 hours of data every year.

- We propose experimental protocols and request the necessary permits.
- We have competences in GIS.
- We deploy instruments.

Processing knowhow

In Grenoble, known for the research conducted in signal processing applied to natural environments, we have 150m² premises with 5 power computers and a storage capacity of 200 To. We developed our own processing and simulation tools, validated by the scientific community via peer-reviewed publications.

24 000 hours of acoustic data per year

Laboratory facility of 150 m²

Real-time communication and transmission

Processing and simulation toolboxes
Our processing and analytical skills

We develop our own algorithms and constantly adapt them, along with our innovations, to process large amounts of acoustic data, model sound propagation and assess anthropogenic impact.

**BIOSOUND**

**BIOSOUND** integrates all our routines dedicated to soundscape processing, including soundscape quantification tools, sound detection, classification and localization of underwater sounds (biophony: invertebrates, fish & marine mammals, geophony, and anthrophony sources).

**RAMDAM**

**RAMDAM** is a modeling tool dedicated to efficiently map marine traffic noise at an ocean basin scale and identify acoustic hot-spots, where intense noise overlaps with sensitive marine habitats or areas. **RAMDAM** allows to predict effects of increasing shipping on marine organisms and provides important information for decision-makers attempting to reduce the negative effects of anthropogenic noise in the ocean.

**Ecological interpretation**

Because of the interdisciplinarity of our team, combined to over 15 years of research experience in acoustics and marine biology and ecology, we can provide an ecological and environmental interpretation to the results obtained from the different analyses processes. This allows to study the structure, functioning, and dynamics of marine ecosystems and to establish metrics to monitor and diagnose marine environments for management purposes.


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Our professions

Our activity in research and innovation is at the best international level. We put our unique skills at the benefit of acoustic observatories, innovating systems for environmental monitoring and diagnostics, impact studies, consulting and teaching.

**RESEARCH**

**ENVIROMENTAL MONITORING AND DIAGNOSTICS**

**CONSULTING AND TRAINING**
Research and scientific excellence are priorities for our qualified team (all with at least a PhD degree). Interdisciplinary synergy is the core of our work. The combination of ocean physics, signal processing, biology and ecology provides an ecosystemic view of marine soundscapes for the study of the state, functioning and dynamics of marine environments and the anthropogenic pressures they are exposed to.

CHORUS participates in the working group «Acoustic Measurement of Ocean Biodiversity Hotspots» of the «International Quiet Ocean Experiment» scientific program that aims at promoting research, observations, and modelling to improve understanding of ocean soundscapes, and effects of sound on marine organisms. The aim of the working group is to suggest directives to measure and monitor marine biodiversity and changes based on passive acoustics.

- Vulnerable sound-producing species
- Acoustic indices of marine biodiversity
- Acoustic indices of the ecological state of marine habitats (natural or artificial)
- Ecosystem functioning (reproduction, nurseries, ...)
- Organism-environment relationships through the biophony
- Link between soundscape dynamics and environmental changes (natural and human-induced)

Research in eco-acoustics
Anthropogenic noise & impact

- Quantification of man-made noise
- Description of human activities based on the sounds they emit
- Impact of traffic noise on marine organisms
- Modelling and mapping of noise impact


Some projects

- A project funded by the National Agency for Research: ANR France Energie Marines «Benthoscope2» (2016-2019).
- A project funded by the national program for research and scientific innovation: ANR Astrid «GAAP, Glace arctique par acoustique passive» (2015-2019).
- European project LIFE: PIAQUO «Practical Implementation to Achieve Quiet Oceans» (2019-2023); a consortium of 12 members with Naval Group as project leader.

Collaborate with CHORUS if you can enrich our work with complementary competences in engineering, signal processing, marine biology or ecology.

Join CHORUS (internship, Master degree, PhD, post-doc fellowship).

Become a donor.

Become a major actor in eco-acoustic research!

SEACOUSTICS

In a research program co-funded by the Water Agency RMC and CHORUS, we study two protected key habitats of the Mediterranean Sea, seagrass meadows and coralligenous reefs. We describe, and quantify the bio-acoustic potential emitted by fish and benthic invertebrates, and develop acoustic monitoring indicators of these two habitats. The CALME network with over 30 recording sites per habitat allows to validate and test the hypotheses raised as well as the descriptors and acoustic indices to easily monitor and monitor the state and changes of those habitats. At the same time, we measure and quantify anthropogenic noise and its acoustic impact on the fauna.

Quantification of man-made noise

Description of human activities based on the sounds they emit

Impact of traffic noise on marine organisms

Modelling and mapping of noise impact

Acoustic data

Analysis

Models of acoustic indices

Become a major actor in eco-acoustic research!
ENVIRONMENTAL PASSIVE ACOUSTIC MONITORING AND DIAGNOSTICS

With our BIOPAM service we propose passive acoustic monitoring solutions to diagnose and follow ecosystem health, anthropocentric pressures and links between state and pressure:

- Monitoring of target species
- Biodiversity appraisal and monitoring
- Monitoring of functional sites (nurseries, spawning areas)
- Monitoring ecological restoration actions
- Monitoring human activities and their impacts at sea

These services are addressed to:

- Environmental managers, including marine protected areas, marine parks and reserves, inter-regional marine managers, territorial and local agencies, water agencies, Agencies for biodiversity, etc.
- The private sector involved in ecosystem monitoring, noise impact studies, and measuring the efficiency of compensatory measures.

BIOPAM CORB-oscope

Development of a easy-to-use, replicable and standardized solution based on passive acoustics to acquire biological key information (spatio-temporal distribution, seasonality, reproduction) on the brown meagre, a protected species in the Mediterranean Sea, and other Sciaenidae, for environmental managing and conservation.


Typical vocalizations emitted by males of the brown meagre between May and September.

BIOPAM and ecological restoration

We assess the efficiency of ecological restoration programs with BIOPAM and are involved in various projects with ECOCEAN, such as the installation of artificial nurseries (Biohuts©) in front of water treatment plants (Amphitra of Véolia, Cap Sicil), installation of artificial reefs (SEABOOST, water treatment plant of Marseille, Calanques national park) and installation of artificial nurseries Architeuthis at Stella Mare (Cap Corse).

A few projects
Together with the Water Agency Rhône Méditerrannée Corse, we monitor the Western Mediterranean basin via our passive acoustic network CALME. The eco-acoustic state of ecosystems, sensitive species as well as noise levels and their impact on marine fauna are measured and quantified since 2015.

The CALME network is built on a unique sampling scheme that includes long-term fixed measurements, punctually sampled sites along the coast and offshore exploration using gliders.
CONSULTING AND TRAINING

Thanks to our skills, constantly updated by our research activities and our presence in the field to the nearest stakes, we are able to offer consulting services and training programs with strong scientific and technical added value.

Consulting & Impact Studies

- Acoustic database processing (detection, classification, counts, acoustic indices, for any kind of marine signals)
- Consulting in design and sizing of data acquisition systems and acoustic observatories.

Training

- Training programs
- Summer school

We offer a unique training program on noise impacts in the ocean addressed to managers, and stakeholders in the marine realm. «Understand and predict anthropogenic noise emissions on marine organisms».

These services are addressed to:

- Environmental managers, including marine protected areas, marine parks and reserves, inter-regional marine managers, territorial and local agencies, water agencies, Agencies for biodiversity, etc.
- To companies that carry out work at sea, install marine renewable energy devices, or conduct port development.
- To private environmental firms that follow the acoustic impacts of human activities
- To Master, PhD and post-doc fellows and senior researchers studying marine soundscapes.

Since 2016, we consulted: Balineau, Dreyfus-TravOcean, Bouygues, BRL, Conservatoire du Littoral, Sedna, RTSYS, Pêches et Océans, Canada, France Energies Marines, Écosse, Suez, Veolia, Veolia, Bauxites, Alseamar, SHOM, Quiet Oceans, Naval Group, Parc National des Calanques, Parc National Marin du Golfe du Lion, Stella Mare, Biotope ...
OUR COLLABORATIONS

• Acquario Di Cala Gonone
• Agence de l’eau- Rhône Méditerranée Corse
• Agence française pour la biodiversité
• Andromede Océanologie
• Aire Marine Protégée - Côte Agathoise
• Alseamar Alcen
• Area Marina Protetta - Tavolara Punta coda Cavallo
• Biotope
• CEFREM
• Creoecean
• Ecocean
• Ecosys, Université Nice Sophia Antipolis
• Fondation Grenoble INP
• France Energies Marines
• GIPSA-lab
• GIS 3M
• Liège université - Laboratoire de morphologie fonctionnelle et évolutive
• Océanopolis Brest
• Parc Marin de la Côte Bleue
• Parc National des Calanques
• Parc Naturel marin du Golfe du Lion
• Pêche et Océans Canada
• Pôle Mer Méditerranée
• Quiet Oceans
• Réserve Naturelle Marine de Cerbère Banyuls
• RTSYS
• SEABOOST
• Semantic ts
• SHOM
• SINAY - Maritime Data Solution
• STARESO, Recherches Sous-Marines et Océanographiques
• UQAR ISMER

Let’s understand and protect the ocean of tomorrow!