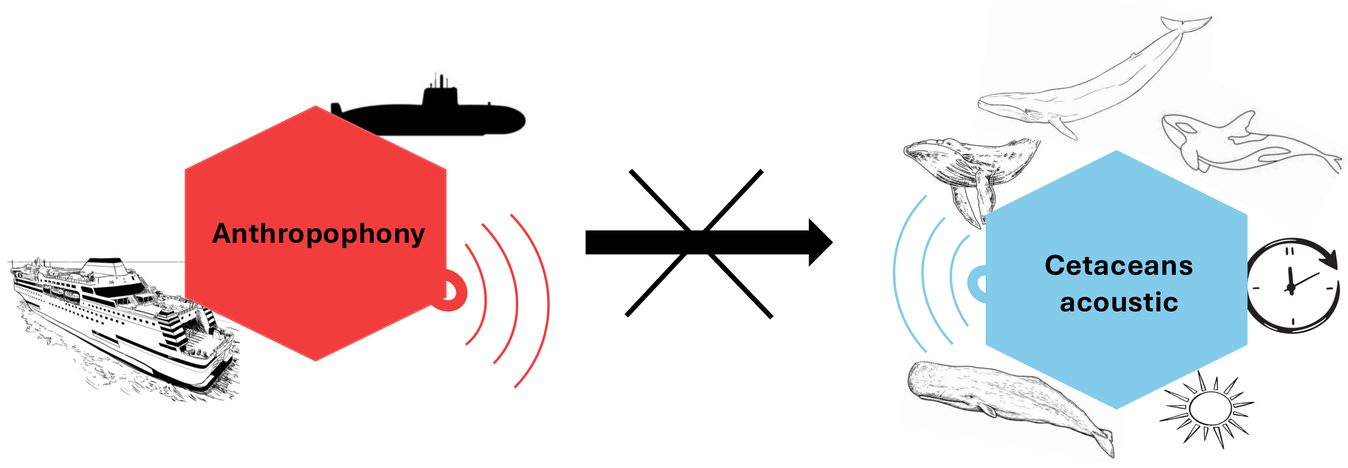
Circadian rhythms of cetaceans from Arctic and Mediterranean seas with controled anthropophony

Girardet J.[1,5], Sarano V.[2,5], Marchini A.[3,5], Chavin S.[1,5], Guiderdoni J.[4,5], Glotin H.[1,4,5]

[1]Univ. de Toulon, Aix Marseille Univ, CNRS, LIS, DYNI team, Marseille, France
[2]Longitude 181, Valence, France https://www.longitude181.org
[3]University of Pavia, Pavia, Italy [4]Valhallab, Seglvik, Norway
[5]CIAN, Centre internat. d'Intelligence Artificielle en Acoustique Naturelle, Toulon, France
justine.girardet@univ-tln.fr, herve.glotin@univ-tln.fr

OBJECTIVES

- **Assess** dial and solar acoustic patterns of cetaceans
- **Identify** anthropophony pressure
- **Compare** soundscape between different locations
- **Define** circadian rhythms in low ambient noise

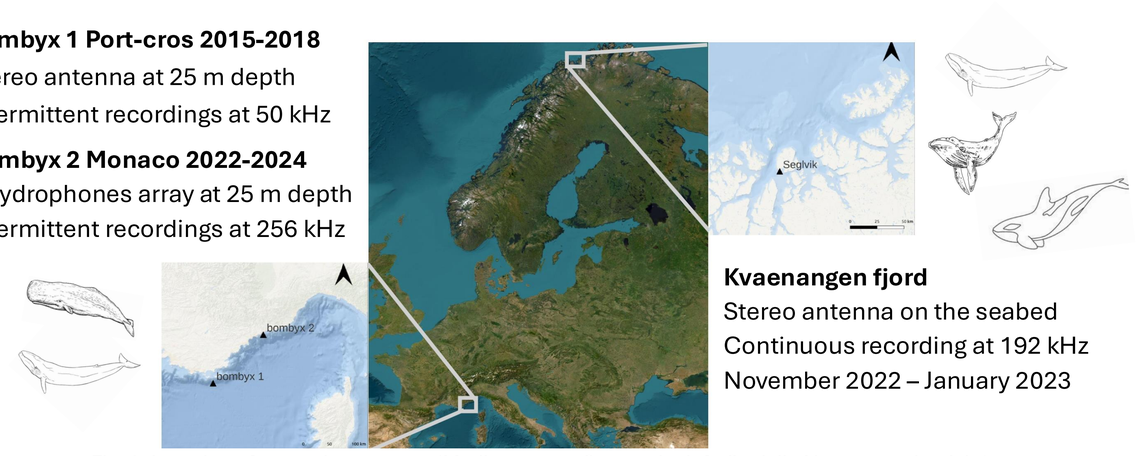


METHODS

Field recordings

Bombyx 1 Port-cros 2015-2018
Stereo antenna at 25 m depth
Intermittent recordings at 50 kHz

Bombyx 2 Monaco 2022-2024
5 hydrophones array at 25 m depth
Intermittent recordings at 256 kHz



Kvaenangen fjord
Stereo antenna on the seabed
Continuous recording at 192 kHz
November 2022 – January 2023

Fig. 1: Location of acoustic antennas (Mediterranean Sea on the left, Seglvik, Norway on the right).

Automatic detectors

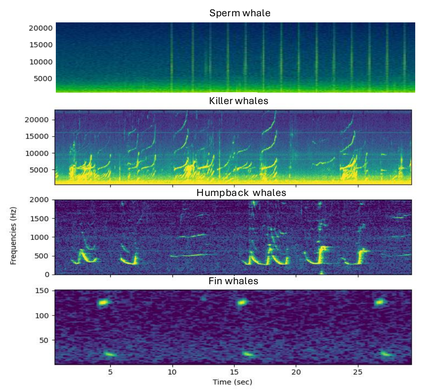


Fig. 2: spectrogram of vocalizations of the four studied species.

CNN on spectrogram in Mediterranean [1, 2]

Yolo v5 in Norway [3]

Recording selection

Power spectral density (PSD) for soundscape analysis: power of a signal for different frequencies, normalization with hydrophones parameters

Selection of recordings with less than the median ambient noise for each area:
238.5 hours in Mediterranean Sea
118 hours in Norway

RESULTS

Cetaceans rhythms in Mediterranean Sea

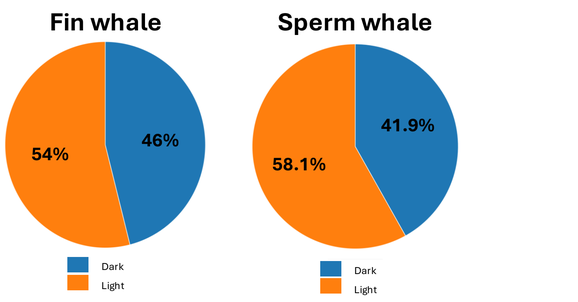


Fig. 3: The percentage of positive recordings according to the solar period (dark or light).

No link between **fin** and **sperm whale** acoustic activity and solar period

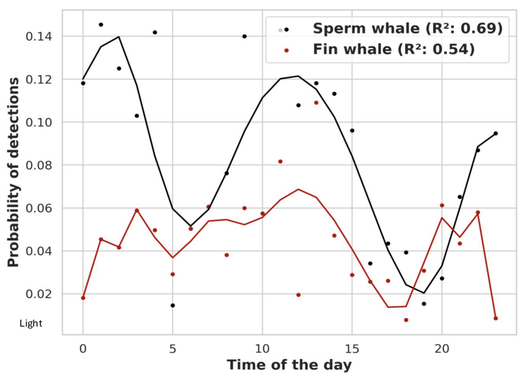


Fig. 4: Polynomial function (degree=10 for sperm whale, 14 for fin whale) of mean probability of detection throughout the day.

Maximum detection probability of **sperm whale** around 12a.m and 12p.m

Similar detection probability for **fin whale** along the day

Daily pattern of anthropophony

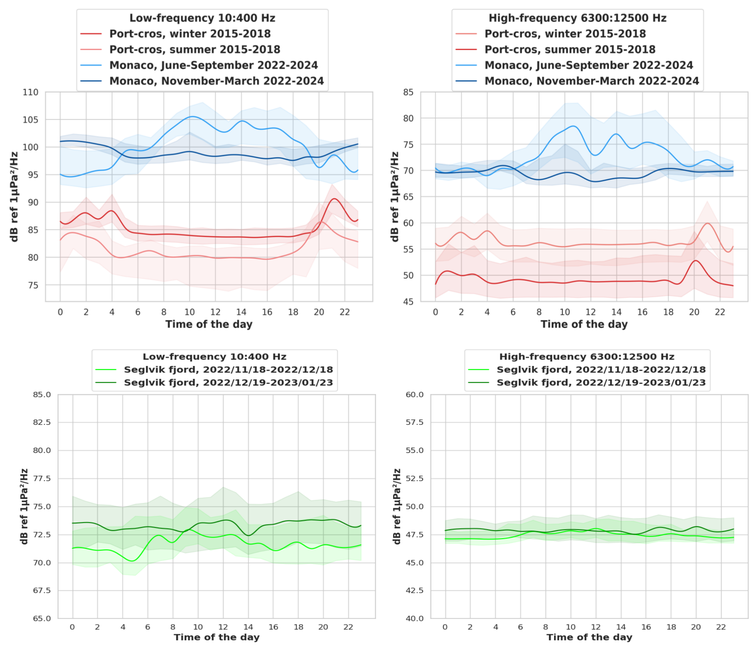


Fig. 7: Evolution of median ambient noise in low (10-400 Hz) and high frequencies (6500-12500 Hz) throughout the day in the three study sites.

Distinct pattern of ambient noise between two sites of Mediterranean Sea :

- Potential high **tourism pressure** in **Monaco** highlighted by the difference in ambient noise between summer and winter
- Noise peaks in **Port-cros** induced by **ferry routes** from Toulon/Marseille to Corsica
- **Relatively stable** daily ambient noise in **Arctic fjord**

Cetaceans rhythms in Seglvik, Norway

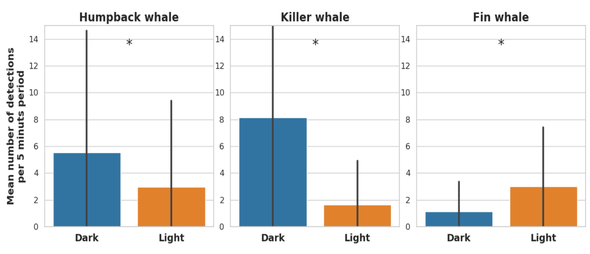


*Fig. 5: Acoustic activity according to solar period (excluded polar night period). * = p-value<0.05 for kruskall-wallis test.*

Solar period and time of the day significantly influenced **humpback** and **killer whale** acoustic activity

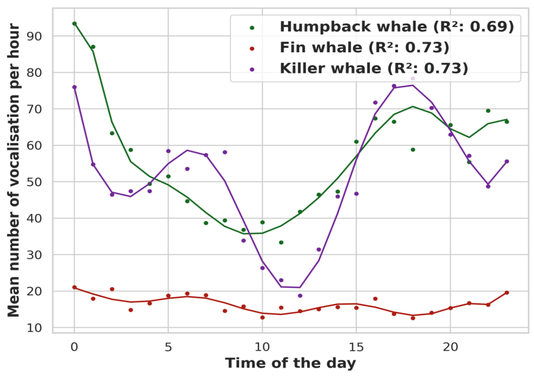


Fig. 6: Polynomial function (degree=10) of mean number of vocalization per hour for the three species.

The **three species** exhibited different acoustic activity on a daily basis

DISCUSSION & PERSPECTIVES

- A clear daily acoustic pattern was observed for cetaceans in Mediterranean Sea and Norway : does it reflect actual activity or movement within the detection range ?
- The high anthropophony pressure suspected will be confirmed using AIS data.
- Further research are needed to investigate long term effects of anthropophony on cetaceans acoustic behavior. To mitigate detection biases caused by high ambient noise, simulations will be conducted.

References
[1] Poupard M., Ferrari M., Best P., Glotin H., (2022), Passive acoustic monitoring of sperm whales and anthropogenic noise using stereophonic recordings in the Mediterranean Sea, North West Pelagos Sanctuary, in Scientific reports.
[2] Best, P., Marxer R., Paris S. and Glotin H, (2022), Temporal evolution of the Mediterranean fin whale song, Scientific reports.
[3] S. Chavin et al., (2024) Time-Frequency Exploration of the Repertoire and Evolution of Humpback Whale Songs in the Caribbean Sea, Poster Session, DCLDE 2024
[4] Glotin et al. (2022). Adapredat report. https://sabiod.lis-lab.fr/pub/ADAPREDAT/ADAPT-VIVANT-20230201_ADAPREDAT.pdf

Acknowledgements
This work would not have been possible without the financial support of MITI CNRS, TPM CG83 APRI, the projet Biodiversa Europam and ANR for grants ULPCochlea ANR-21-CE04-0020 for AI Chair ADSIL ANR-20-CHIA-0014. We are also grateful to Pelagos sanctuary for their technical support and scientific expertise. We thanks GIAS FEDER MARITTIMO for BX2 data set.