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Acoustic characteristics of *Delphinus delphis* and *Stenella coeruleoalba* based on behavior and vessel presence in the Eastern Aegean Sea, Greece

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INTRODUCTION

The anthropogenic noise level introduced into the marine environment has increased in the last decades and is shown as a potential impact on marine mammal ecology[1]. **The underwater noise** produced by vessels dominates the range of frequencies **between 20 Hz and 10 kHz**[2,3]. **Whistles** are continuous, narrowband and frequency-modulated signals used for tonal communication ranging between 5 and 20 kHz[4], which **may overlap with the frequencies of vessels**[5]. Whistle parameters can change amongst different dolphin species[6] and, within populations, during different behaviors[7].

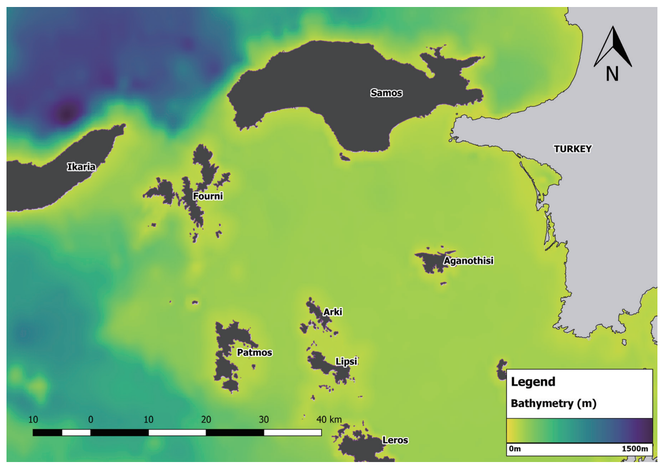

Fig. 1 - Study area map. Eastern Aegean Sea.

MATERIALS AND METHODS

Two resident species of the **eastern Aegean Sea**, Greece (Fig.1) were studied: the **Striped dolphin** (*Stenella coeruleoalba*), recorded in the Ikarian sea (Depth < 1500m); and the **Short-beaked Common dolphin** (*Delphinus delphis*), recorded in the south of Samos island (Depth < 100m). The whistles were recorded opportunistically by a stationary Aquarian H2a hydrophone with a Zoom H1 recorder system during boat-based surveys. The collected parameters were Low Frequency, High Frequency, Delta Time, Peak Power, Peak Frequency, Center Frequency and Shape. Data analysis was performed on Raven Pro V 1.5.0 37 build (1024 point FFT, hop size 128, Hann window, 50% overlap). In addition, dolphin behavioral data (Range < 550 m) and vessel presence (Range < 2 nm) were recorded during visual surveys.

RESULTS

A total number of 100 whistles were collected: 44 from *D. delphis* and 56 from *S. coeruleoalba*. The two species showed **differences in Low Frequency** (χ^2 = 12.3, df = 1, p-value < 0.01) (Fig.2) and **Shape** (χ^2 = 52.854, df = 21, p-value < 0.01) (Fig.3).

D. delphis showed a significantly **higher Peak Frequency** (χ^2 = 5.7412, df = 1, p-value < 0.01) during **No-Travel movements** (diving and milling) compared to Travel movements (travelling and swimming) (Fig.4).

S. coeruleoalba showed a significantly **higher Peak Power** in the **presence of vessels** (χ^2 = 8.5453, df = 1, p-value < 0.01) (Fig.5).

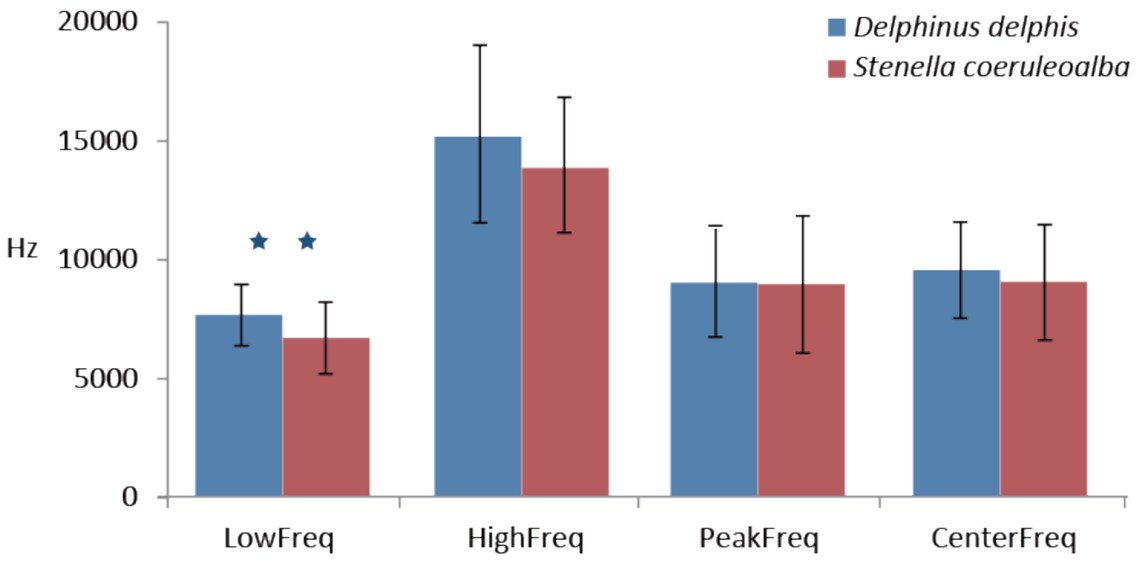

Fig. 2 - Whistle parameters of *D. delphis* and *S. coeruleoalba*.

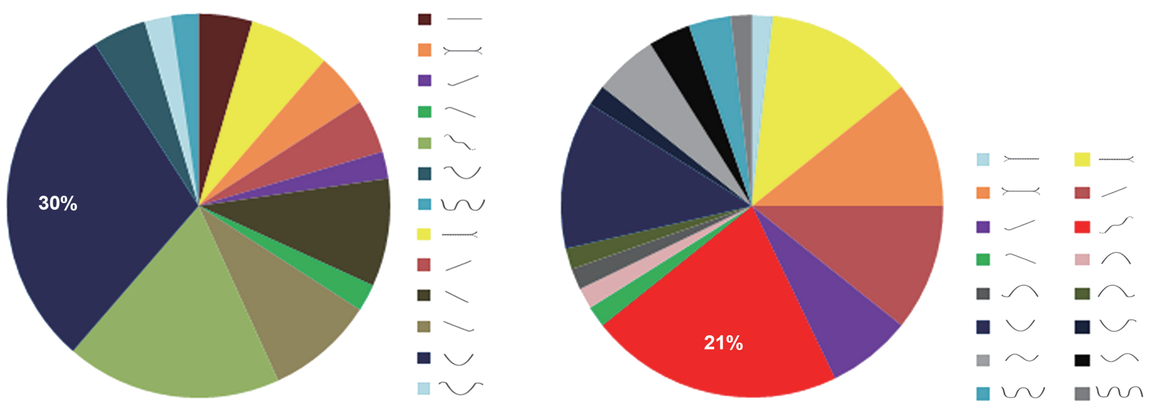

Fig. 3 - Percentage of whistle shape in *D.delphis* (left) and in *S. coeruleoalba* (right).

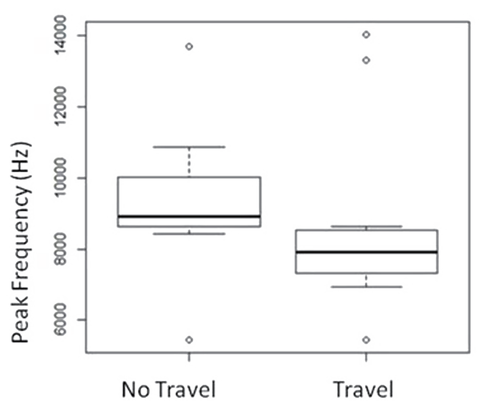

Fig. 4 - Whistle Peak Frequency during Travel and No Travel movements in *D. delphis*.

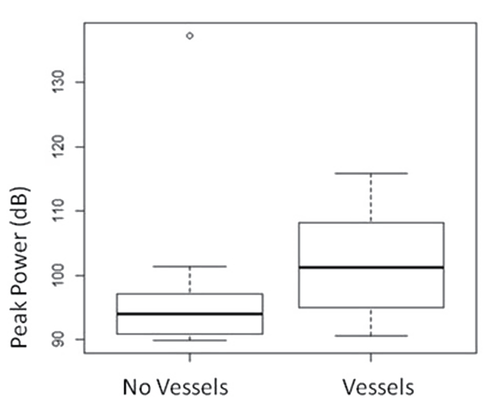

Fig. 5 - Whistle Peak Power in presence and absence of vessels in *S. coerueoalba*.

DISCUSSION

Different vocal repertoires are recorded in two significantly different habitats of residence.

Peak Frequency is higher during No-Travel for *D. delphis*. This result **hypothesizes that the variation in its communication repertoire correlates to a specific pod structure**.

Many animal species change the frequency content or source level of their sounds to decrease the masking effects of anthropogenic noise whenever possible[8]. In a noisy environment, variations in whistle parameters allow dolphins to facilitate the transmission of their signals[9].

To avoid masking, Peak Power increases in presence of vessels for *S. coeruleoalba*, showing the **adaptability of the specimens to high-amplitude underwater noise levels**.

CONCLUSION

This preliminary study can be considered a **first contribution** to the acoustics research on ***D. delphis*** in a data-deficient area within the Mediterranean Sea. Further research and policy development are necessary in order to improve conservation strategies of cetaceans species and mitigate anthropogenic noise impacts in the Aegean Sea, as well as throughout the Mediterranean Sea.

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