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TS measurements and simulations of Mediterranean sea turtles

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Abstract

The development of a method for detecting sea turtles distributed along the water column using side scan sonar devices and the first detection registered in open sea is presented. Backscattering directivity of the animal, and also the dependence of target strength with turtle size, is investigated through measurements in indoor tanks.

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Introduction

Sea turtles are protected species. The main threats are from anthropogenic origin: bycath in longline and trawl fisheries, collisions and plastics ingestions, between others. To know the state of the species and the effectivity of protection actions is essential to count individuals and estimate populations and their evolution. In the Mediterranean Sea, this estimation is obtained, at the present moment, from extrapolation from bycath data and direct sighting at sea campaigns or airplane observations. In this work we propose an acoustical method for detecting sea turtles in the water column. Some attempts in this direction had been addressed in the last years, most of them using side-scan sonars (SSS) for detecting turtles lying on the floor, but with not very successful results [1,2]. We suggest a different disposition and processing of side scan sonars adapted to turtle behaviour. Some preliminary measurements in open sea show that sea turtles can be detected along the water column by SSS measurements. To consider the variability of the target strength with the turtle size and also with the orientation of the animal respect to the acoustic beam (directivity) we have performed measurements also in controlled conditions in tanks. To develop the present research we are working in collaboration with a turtle rescue centre, where turtles recover after being injured by longline and trawl fisheries, collisions and others.

Material and methods

Sound speed in carapace material

First step was to characterize the sound velocity in the carapace material. To the best of our knowledge, there are not previous studies in this matter, and we consider it necessary to perform numerical simulations to compare with the experimental results. We used an echo-impulse scheme with an Piezoelectric transducer Olympus with 7,5 MHz for measuring the longitudinal sound speed through carapace thickness dimension. The experimental setup is shown in Fig. 1.

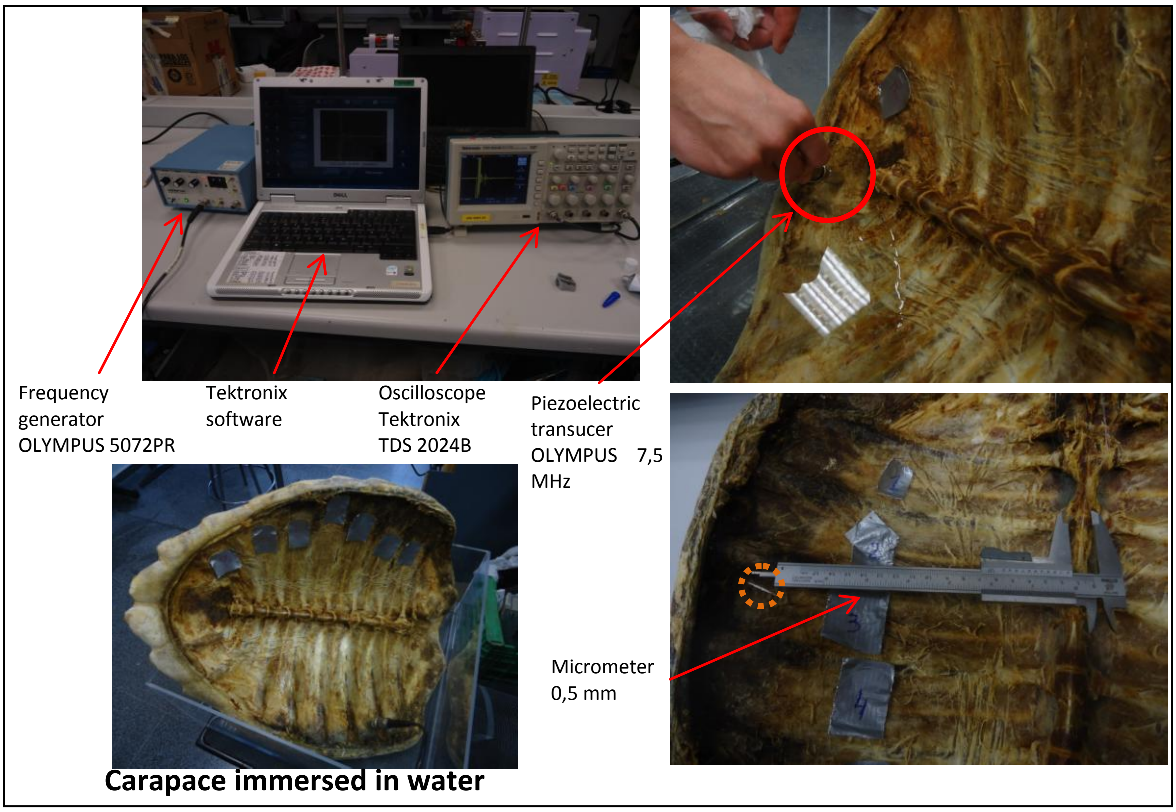

Fig. 1. Experimental setup for longitudinal sound speed measurement in sea turtle carapace.

TS measurement in tanks

TS value from sea turtles is highly dependent on the size of the animal, but also on the relative angle between the acoustic beam and the animal due to the anatomic structure of sea turtles and the particular existence of the carapace and lungs. This study has been addressed using a 200 KHz composite single beam transducer with a Simrad EK60 echosounder synchronized to a Sony IP videocamera (Fig. 2a, 2). In indoor tanks, we turtles are recovered before to be released to the sea, we monitored the acoustical echoes for different turtle sizes and orientation when turtles swim freely along the tank. Related work was addressed by [3]. The echosounder measurements can be related to the aspect shown by the turtle. The transducer (with a wide aperture, 30 degrees to completely insonify the animals at short the ranges) was chosen considering the limits of the tanks we could work and the far field distance of the transducer.

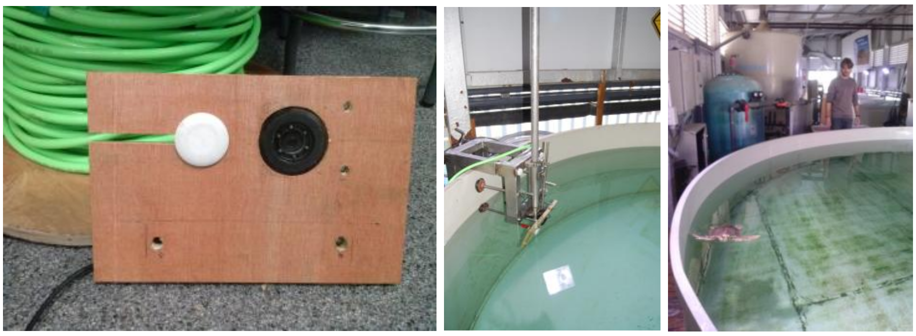

Fig.2. (a) Transducer and syncronyzed IP videocamera, (b) system mounted hunging on the tank, (c) turtle swimming in the tank.

TS measurements in open sea

Sea turtles that can be found, but not only, in the Mediterranean Sea, swimming along the water column, more than resting on the sea bottom. We suggest and test a method for detecting them when they are along the column using SSS because of the resulting wide coverage. The measurement scheme is shown in Fig. 3

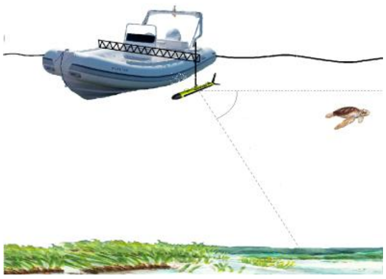

Fig. 3. SSS detecting sea turtle swimming along the water column.

The system have been tested in turtle releasing from the rescuer centre, using a 200 kHZ SSS with EA400 Simrad echosounder. The system was mounted on a rubber boat, that moved covering transects to intersect the turtle way with the acoustic beam. The complete scheme used in these measurements is shown in Fig. 4.

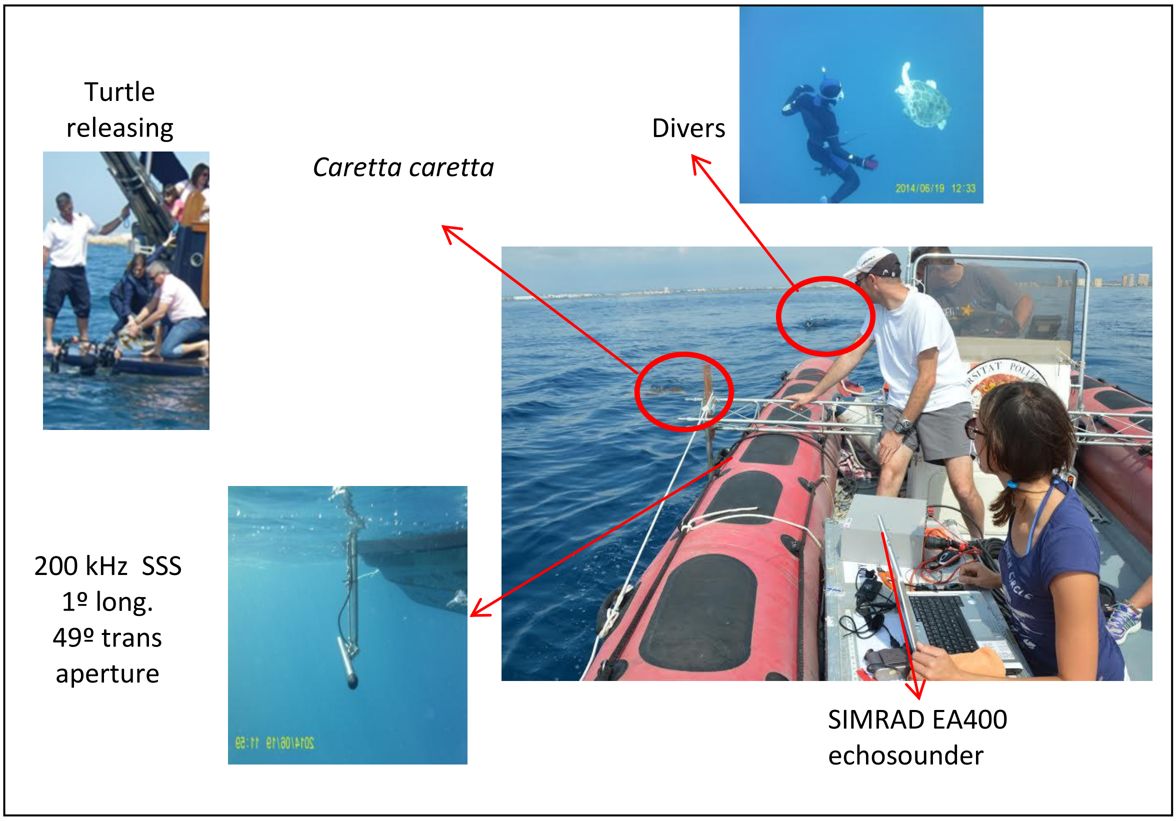

Fig. 4. Experimental scheme in open sea measurements.

Results

Sound speed in carapace material

We obtained a sound velocity across the turtle carapace, $c_{carapace} = 2930 \pm 110$ m/s. Fig. 5 shows the corresponding adjustment

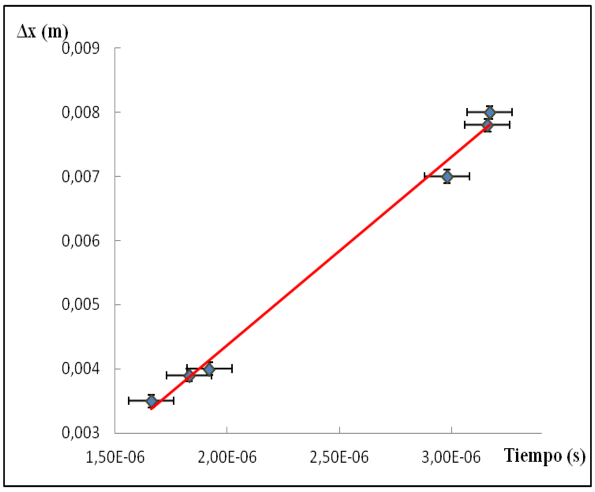

Fig. 5. Adjustment for obtaining $c_{carapace}$. Parameters of the adjustment is x=2930 t-0,0015 with R=0,994.

TS measurement in tanks

Typical echogram and image video obtained in recovery tanks are shown in Fig. 6.

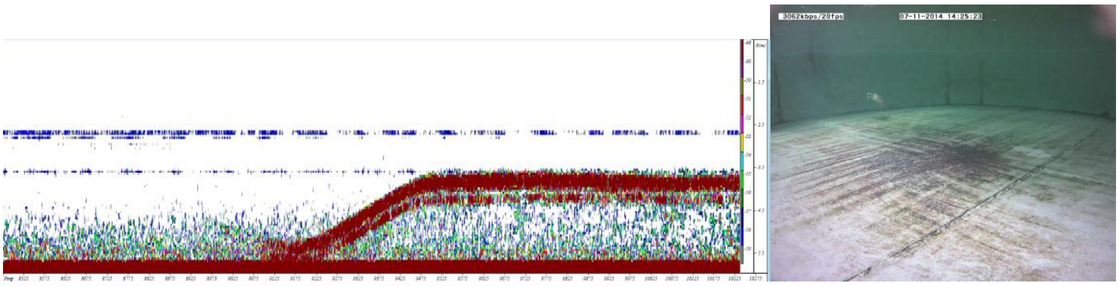

Fig. 6 Echogram showing a long track of quasistationary turtle and corresponding video frame.

TS measurements in open sea

Fig. 7 shows characteristic echograms corresponding to sea turtle detection in open sea.

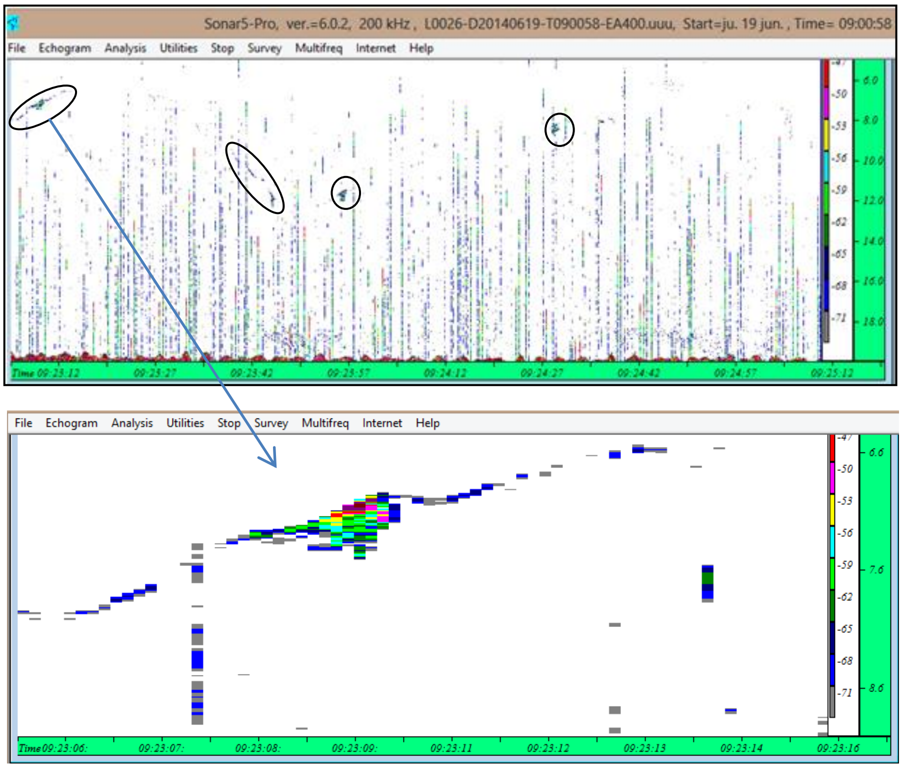

Fig. 7. Echograms corresponding to turtle detection in open sea. Vertical lines correspond to reflections of the beam side lobes on sea surface.

Discussion

The obtained results confirm the hypothesis of detection and identification of sea turtles in the water column through quantitative measurements with wide aperture transducers used for SSS imaging. The TS characterisation performed in tanks have some limitations due to the size of the animals (beam aperture, near field of the transducer and scattterer, TS measurements in near range associated errors, etc) together with reverberation and wall reflections. Nevertheless, smaller animals have been measured with consistent results in the TS vs. size and orientation relationships. Administrative permissions are in progress to measure sea turtles in bigger tanks, even with split-beam transducers of smaller apertures.

Conclusions

The viability of sea detection and characterisation in open sea through SSS echosounding has been demonstrated. Sound speed in turtle carapace has been measured to perform numerical simulations of TS. Single beam measurements with sinchronized video recordings in tanks allow to characterize TS dependence with turtle orientation and size, for small/medium size turtles.

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