



Inter Pulse Interval analysis of Sperm Whale (*Physeter macrocephalus*) "clicks" recorded in Mediterranean Sea

Population structure and distribution of sizes

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Abstract

- The size of adult males in the Atlantic and Pacific Ocean is reported to reach 17-18 m
- In the Mediterranean Sea no animals longer than 14 m have been acoustically measured, but the number of investigated whales is limited
- This study aims to analyse all recordings made by C.I.B.R.A (Interdisciplinary Center for Bioacoustics and Environmental Research, University of Pavia) from 1999-2011 that meet the quality standards (Fig. 1) in order to study the size structure of the sperm whale populations in the Mediterranean Sea

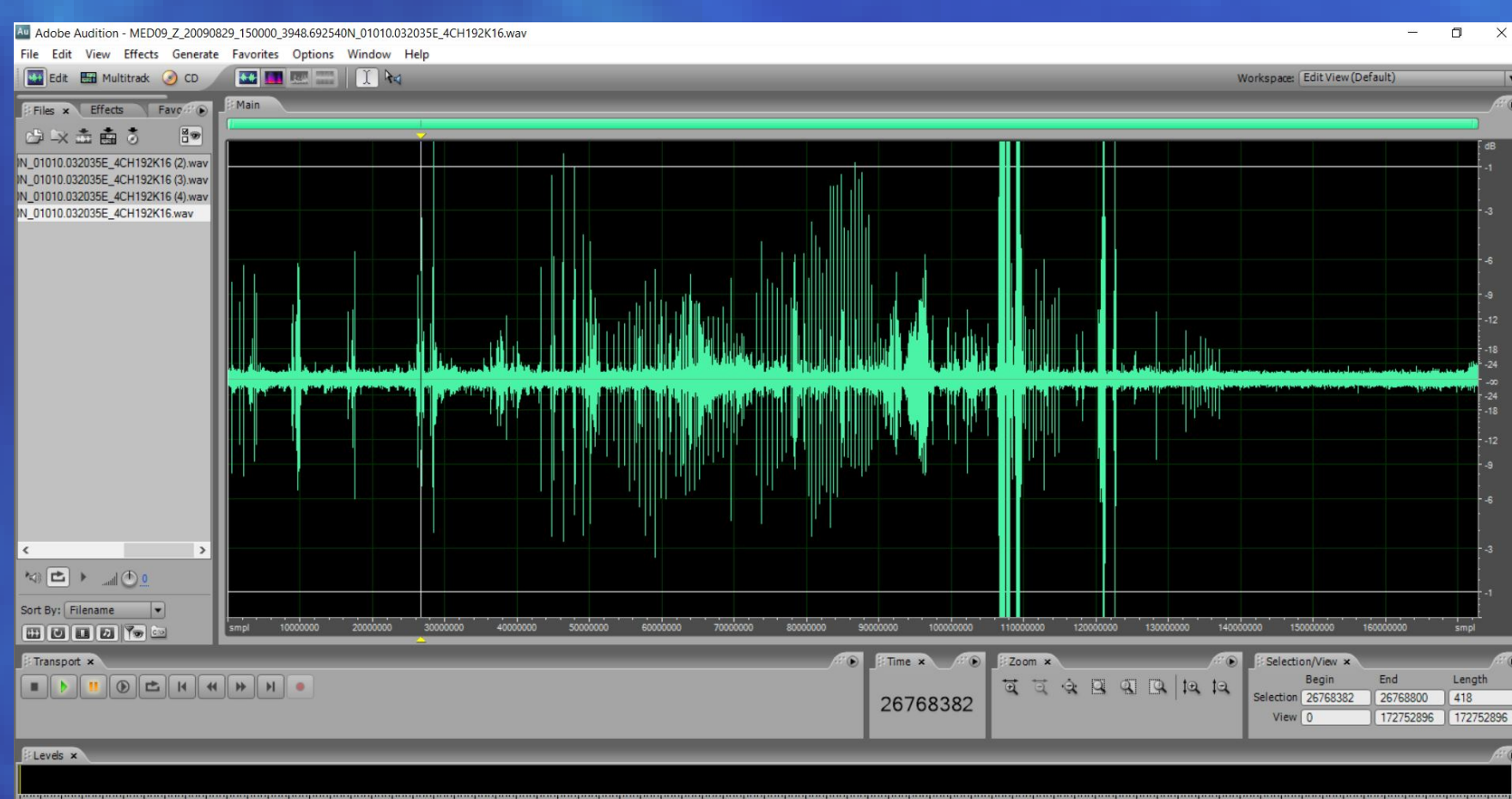


Fig.1 Screenshot from Adobe Audition® of a Sound Wave of 15 minutes "clicks" recordings made in the Mediterranean Sea in 2009 (C.I.B.R.A)

Introduction and Objectives

- The sperm whale (*Physeter macrocephalus*) emits typical short acoustic "click" signals to acoustically explore the environment and communicate with conspecifics
- Each emitted click has a multi-pulse structure (Fig. 2), resulting from the production of an initial pulse within the nose of the whale that then bounces several times within the spermaceti (Fig.3)

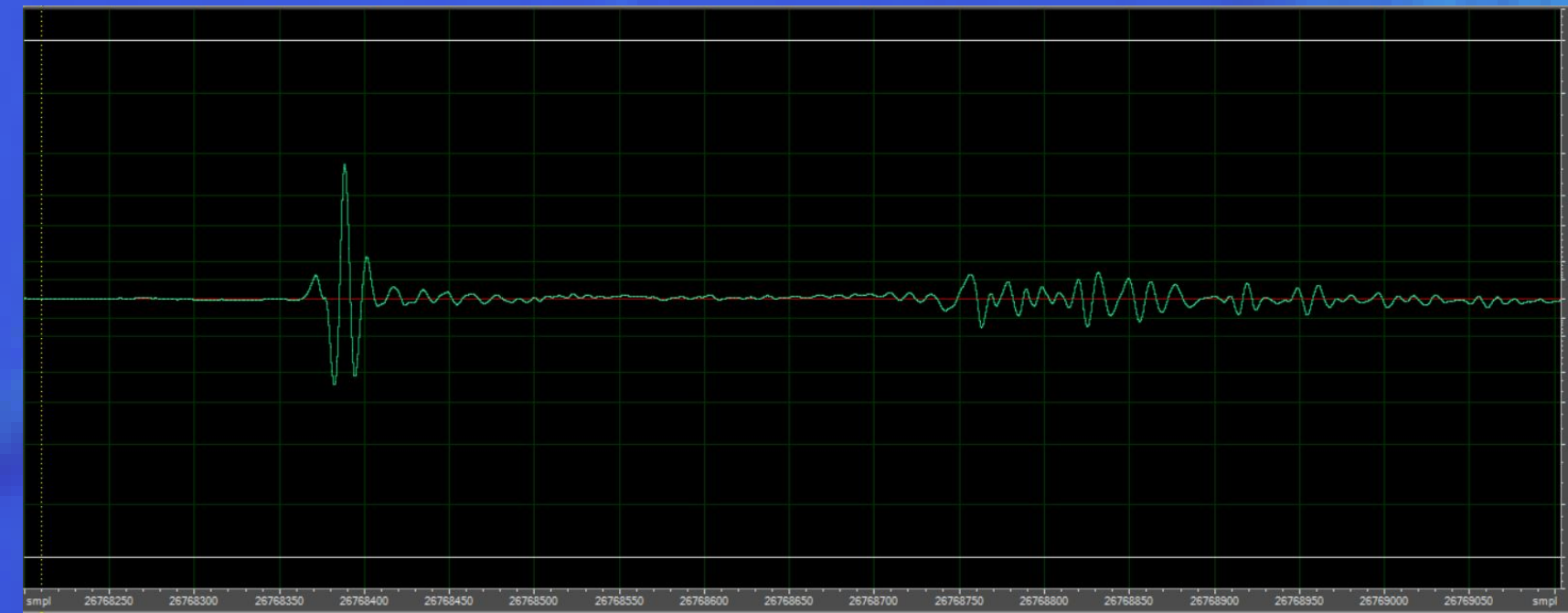


Fig.2 Sound Wave of a singular multi-pulse click taken from a recording made in 2011 (C.I.B.R.A).

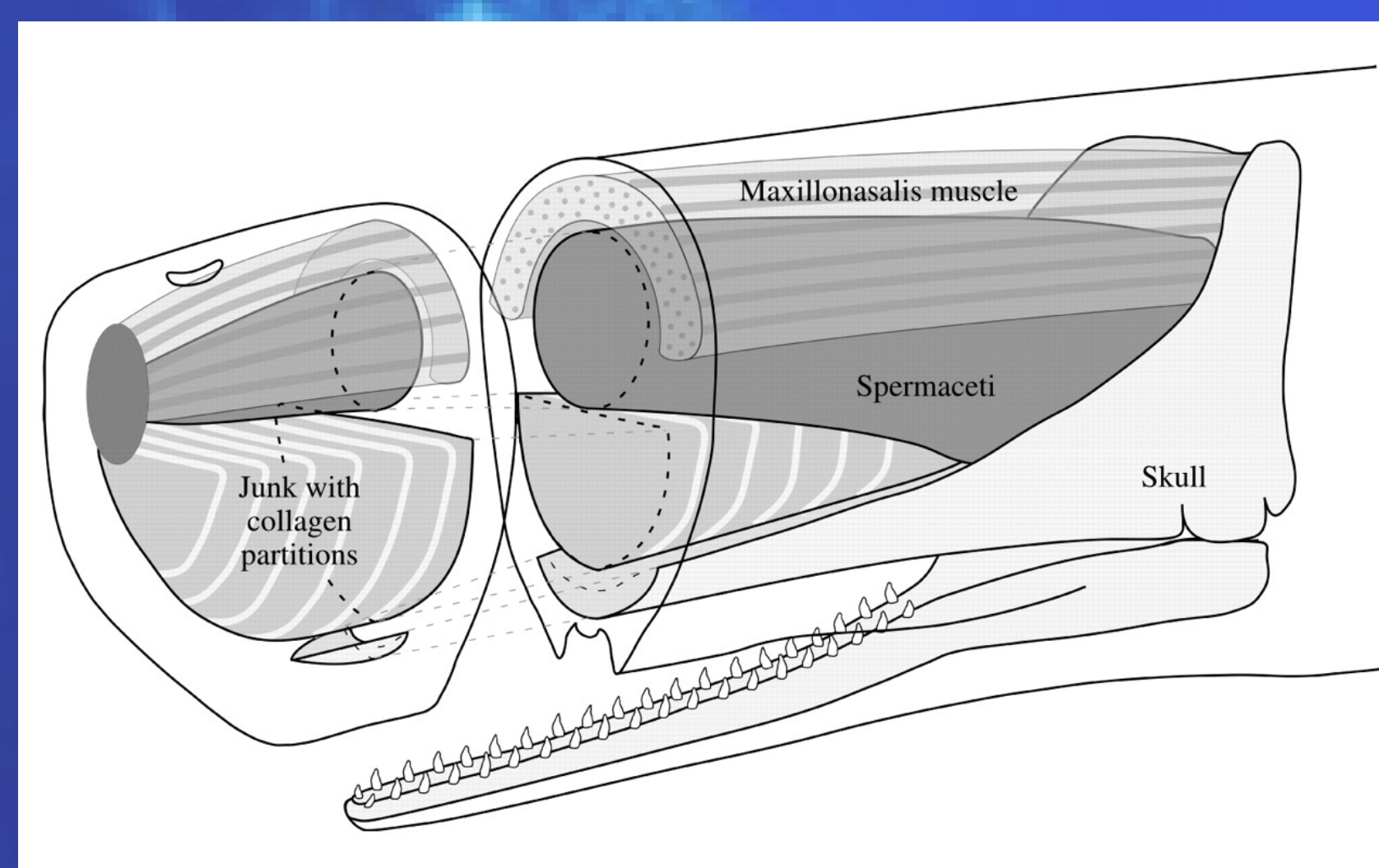


Fig.3 Diagram of the anatomy of the head of the sperm whale *Physeter macrocephalus* (Carrier et al., 2002).

- The click (Fig. 4) emitted by the whale is thus characterised by multiple pulses whose time spacing depends on the spermaceti size, which can be estimated based on a Stable Inter Pulse Interval (stable IPI)

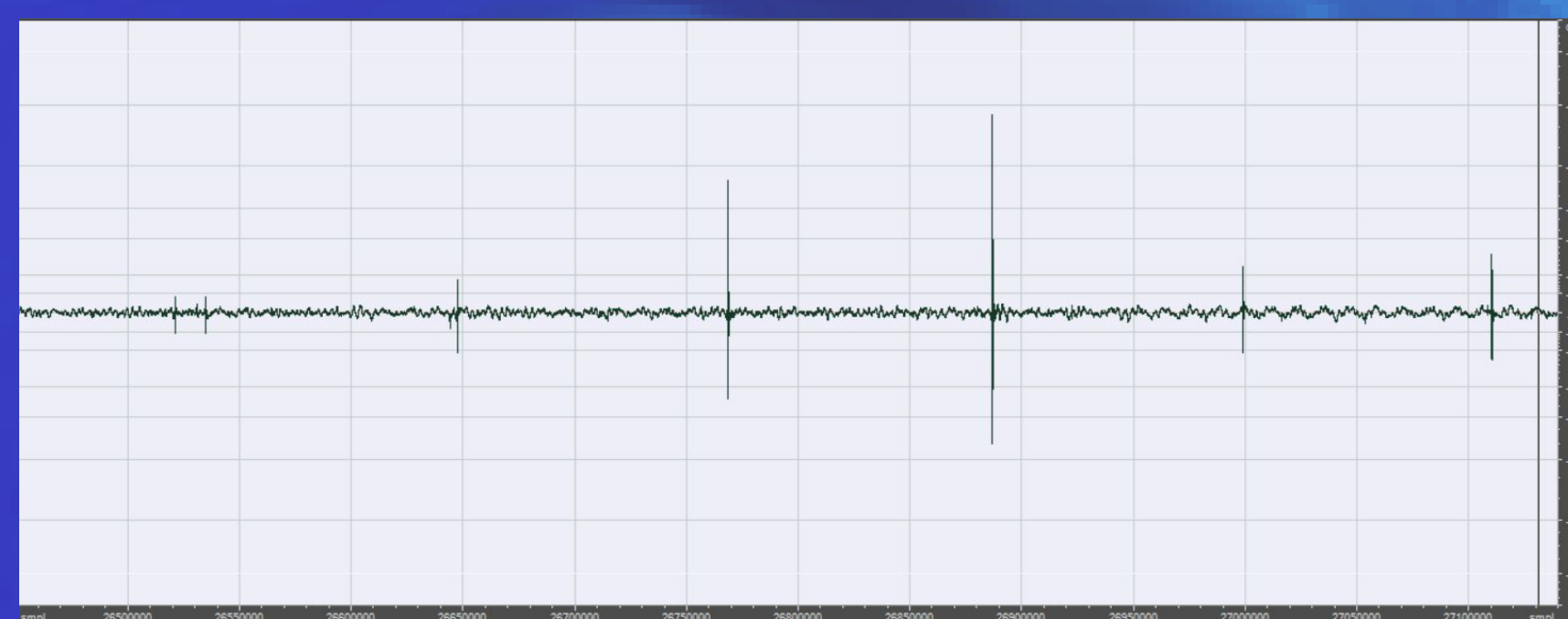


Fig.4 Sound wave of regular clicks recorded in 2010 (C.I.B.R.A)

- This can be used to estimate the size of the whale
- The sperm whale is characterised by a sexual dimorphism, mature males reach 17-18 meters in length, mature females rarely exceed 11 meters, and the data can also be used to determine the sex

Materials & Methods

- Analysis requires pre-selection of suitable recordings (presence of sperm whale sounds with good quality and Signal to Noise Ratio)
- The programs Adobe Audition® and Sea Pro® will be used for manual analysis (Fig.5), but automatic verification has to be done with Matlab (Cepstrum analysis)
- In optimal cases the automatic analysis provides good data and requires minimal time to perform IPI verification
- In a minimal part of recordings, it is almost impossible to get good data; this fact may occur when the hydrophone depth is less than 15 meters
- Equations available in literature will be applied to assess whale sizes

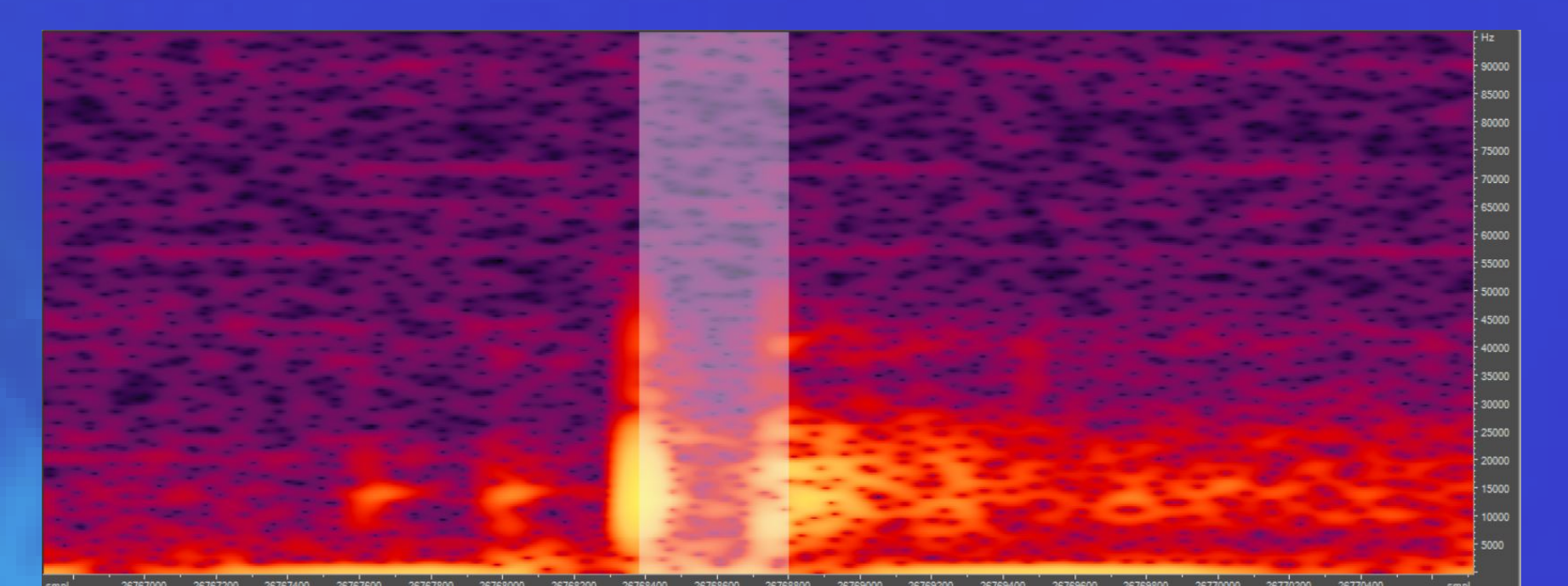


Fig.5 High resolution spectrogram of a click. Here is evidenced the Inter Pulse Interval between two peaks of the click. With the measure is possible to estimate the spermaceti size (2011, C.I.B.R.A)