Presentation of Binning-Based Inter-Click Interval Data from Passive Acoustic Monitoring of Free-Ranging Harbour Porpoises (*Phocoena Phocoena*)

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(Received 13 December 2018; accepted 26 April 2019)

C-PODs are used for Passive Acoustic Monitoring (PAM) of harbour porpoises (*Phocoena phocoena*) at an offshore open sea location in the German North Sea.

Diel patterns of echolocation click trains are extracted from minimum inter-click interval (minICI) data by binning. The aim of this study is to reassess and refine minICI ranges of click train data with particular consideration to the binning widths. Emphasis is also placed on choosing an appropriate visualisation of these binned data.

Key ecological results include presence of higher train rates during the day with intermediate minICI values defined by the range 6–28 ms and a higher train rate with short minICI values 1.25–2.00 ms at night. This indicates an increase in porpoise feeding behaviour, or change of style, at night. Click trains with long minICI values > 35 ms occur at an equal rate throughout both diel phases, suggesting a more routine behaviour, such as navigation.

Results could be revealed only by judicious choice of binning widths, e.g. previously overlooked patterns within historical echolocation data. The classification methodology can be used to analyse echolocation trains from a variety of species and can be applied to any PAM data with the relevant click parameters.

1. INTRODUCTION

1.1. Measurement of Animal Echolocation Sounds

Echolocation is the deliberate production of sounds to generate echoes off biotic and abiotic features in the environment, and has evolved independently in several taxa including toothed cetaceans, bats, shrews, tenrecs and cave-dwelling birds (see Thomas for a review). Harbour porpoises (*Phocoena phocoena*) are small toothed cetaceans that emit Narrow Band High Frequency (NBHF) communication and echolocation clicks almost constantly, and can be collected with a range of underwater Passive Acoustic Monitoring (PAM) systems. C-POD click-train recognition algorithms filter out non-cetacean clicks and give reliable data on cetacean presence and echolocation behaviour by using digital waveform characterisation to select and log time of cetacean tonal ultrasonic sounds from 120-160 kHz. In addition, they also log centre frequency, intensity, and bandwidth of each cetacean click.

One of several data parameters readily exportable from C-POD software is the inter-click interval (ICI), also sometimes referred to as inter-pulse interval. The ICI is a numerical value measured in seconds (s) or milliseconds (ms), defined as “the temporal separation of clicks emitted by the same vocalising animal”.

For an informative review on ICIs used by odontocete species, see Dunn. Harbour porpoise ICIs vary between 1.5–200 ms.

C-PODs are described in the available literature. C-POD click-train recognition algorithms filter out non-cetacean clicks and give reliable data on cetacean presence and echolocation behaviour by using digital waveform characterisation to select and log time of cetacean tonal ultrasonic sounds from 120-160 kHz. In addition, they also log centre frequency, intensity, and bandwidth of each cetacean click.

For technical and practical extraction of minICI, refer to the C-POD manual. A description is given in Carlström. For brevity, key procedures are summarised here. The C-POD logs data for every click detected, including time, duration, frequency, and sound pressure level. These individual clicks are collected into separate trains. Each train can be analysed and classified, e.g. probable species class and quality of data. Time