Buzz rates comparison between two sperm whale feeding grounds.

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INTRODUCTION

Canyons are known to be high **productive areas** and therefore favorable **feeding grounds** for sperm whales. **Male sperm whales**, after leaving their maternal group, are thought to move to high latitude feeding grounds where they find richer and colder waters with bigger amount of preys (Lettevall *et al.*, 2002). The aim of this study is to use the **buzz rate** as index of attempted prey capture in order to determine eventual individual or geographical variation.

MATERIALS AND METHODS – Norwegian waters

During summer 2009, from June to the end of July, **sperm whale acoustic data** were collected onboard *M/S Reine*, the whale-watching vessel of Whalesafari Ltd., in the **Bleikdjupet Canyon** (Bleik Canyon), Norway. After the visual detection, records started when the sperm whale fluked-up, with the boat acoustic detection system (see specifics in Nielsen *et al.*, 2006). The system has been designed to monitor and track vocally active cetaceans as sperm whales. It consists in 2 hull mounted hydrophones placed on both sides of the keel, allowing to estimate the bearing of the clicking whale while maneuvering the vessel.

During June, sighting locations were manually quoted while during July, both boat tracks and sighting locations were constantly registered with GPS. Pictures of animals were taken at each emersion; and in particular, details of the fluke.

Photo-identification

Acoustic data were analyzed only for 3 individuals that were identified by our photo-identifications. Three animals were selected for the study as they presented, from a rough visual estimation, different size and different fluke patterns (smooth or marked flukes).

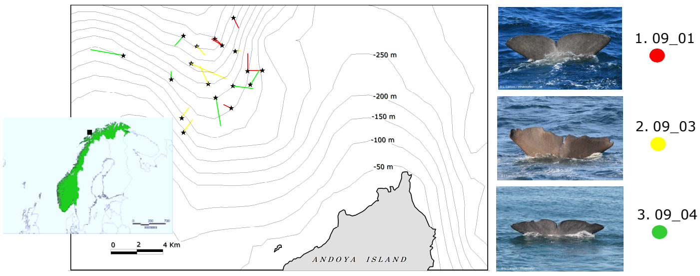

Fig. 1. Bleik Canyon with immersion positions (*) and movement directions of the 3 studied whales

Mediterranean waters

The recordings were collected during the ISHMAEL project campaigns in 2009 and 2010 in the Pelagos Sanctuary (northwestern Mediterranean sea). Data were recorded using an omnidirectional hydrophone or using the instrument C.L.I.C.S (Cetacean Localisation Integrated Customized System). Sperm whale recordings are collected on a regular acoustic grid, therefore they are not always linked to a sperm whale visual sighting

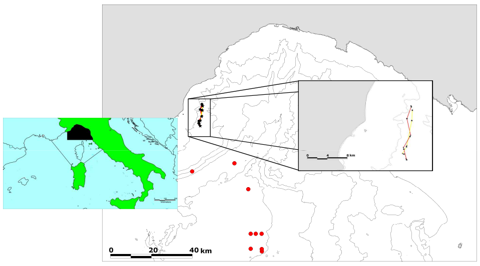

Fig. 2. Sperm whale recordings positions ( ) in the Mediterranean area.

In the detail: immersion positions (*) and movement directions of two distinct individuals followed during an entire day.

Inter Pulse Interval (IPI) analysis

The class of length of the studied individuals was estimated using the IPI considering the following equations (Gordon, 1991):

(1) *Body length 1 = 4.833 + 1.453 IPI – 0.001 IPI2*

(2) *Body length 2 = 9.75 – 0.521 SL + 0.068 SL2 + 0,057 SL3*

where SL is the spermaceti organ length, calculated as

SL = IPI x Sound speed in spermaceti / 2

where the sound velocity used was 1430 m.s-1 (Goold et al.,1996)

RESULTS

Two sets of good quality recordings were analyzed:

- the Bleik Canyon dataset: 9 hours (552 min) from 3 photo identified individuals
- the Ligurian Sea dataset: about 2 hours (172 min) from several individuals

Inter Pulse Interval (IPI) analysis

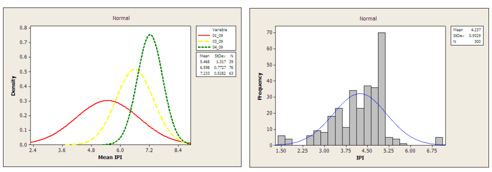

Fig. 3. On the left: fitted lines of the IPIs from the 3 Norwegian individuals; on the right : histogram regarding the frequencies of IPIs in Mediterranean sperm whales.

Ind. ID	(1)	(2)
09_01	12.7 m	12.2 m
09_03	14.4 m	14.8 m
09_04	15.3 m	16.8 m
MED Ind.	from 9 m to 12 m	

Tab. 1. Length estimation using the two Gordon's equations for all the analyzed sperm whales.

A part of the analysis was dedicated to underline differences between the individuals in the Norwegian waters (6 complete dives per individual $N_{\{3\ ind\}}=18$).

Diving pattern analysis

The **diving time seems to change significantly** between the 3 individuals (ANOVA test, $P_{value}=0.018$; *t*-test with the 2 samples between Ind09_04 and Ind09_03, $P_{value}=0.004$). Ind09_04 have the mean diving time greater than the others.

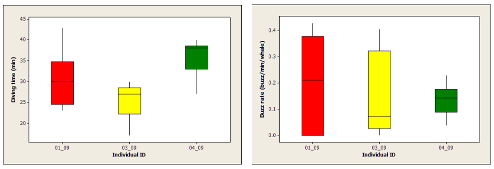

Fig. 4.
On the left the boxplot regarding the diving time in the 3 individuals.

On the right the box plot of buzz rate in the 3 animals studied.

Buzz rate analysis

The buzz rate doesn't vary significantly among the three individuals (ANOVA test, $P_{value}=0.702$). The buzz rate variance seems to decrease with the increase of body length; the longest individual (Ind. ID 09_04) has a more constant buzz rate through all the recorded dives.

Correlation between dive time and buzz rate

The observed differences of diving pattern do not imply different buzz rates so there isn't a significative correlation between these two parameters.

Comparison between the two study areas

The **Mediterranean buzz rate is significantly higher than the Norwegian one** (*t*-test, $P_{value}=0.004$).

The two data sets used in the study are very different in accuracy and dimension. We compared our results to the literature in order to assess whether differences in sampling protocol could have affected the analysis. The buzz rate (0.458, SD=0.312) measured for the Mediterranean area is similar to the one calculated by Drouot *et al.*, 2004 (about 0.5). The buzz rate calculated in the Bleik Canyon (0.161, SD=0.139) is partially consistent with Teloni et *al.*, 2008 in a study performed in the same area with tagged animals.

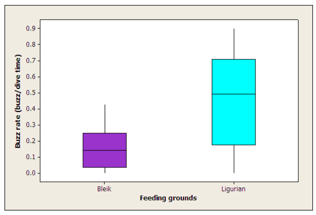

Fig. 5. Box plot regarding the comparison between Norwegian and Mediterranean buzz rate.

CONCLUSIONS AND FURTHER INVESTIGATIONS

In Norway no significant difference was found among the 3 individuals in the buzz rate, probably due to a restrict dataset, however a negative correlation between buzz rate and animal length is shown. If this trend will be confirmed in future analysis one possible hypothesis may be found in the greater skills that older males can use during the foraging dives.

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