adi.ayoub1993@gmail.com

ID N: 93

Foraging behavior of Chilean blue whales (*Balaenoptera musculus chilensis*)

Adi Ayoub[1], Francesco Caruso[1,*], Paolo Segre[2], Leigh Hickmott[3], Joseph D. Warren[4], Gustavo Chiang[5], Alessandro Bocconcelli[1,6,7,*]

[1]Stazione Zoologica Anton Dohrn, Naples, Italy. [2]Stanford University, Pacific Grove, California, USA. [3]Open Ocean Consulting, Hampshire, UK. [4]Stony Brook University, Southampton, New York, USA. [5]Melimoyu Ecosystem Research Institute, Santiago de Chile, Chile. [6]Woods Hole Oceanographic Institution, Woods Hole, Massachusetts, USA. [7]Centinela Patagonia Foundation, Chile.

* Corresponding authors (francesco.caruso@szn.it ; abocconcelli@whoi.edu)

INTRODUCTION

The northern Chilean Patagonia region belongs to the Chiloense Ecoregion (CER), one of the most extensive fjord regions in the world. It is a key feeding ground and a nursery area for blue whales (*Balaenoptera musculus*). Primary production in the CER is high and strongly seasonal, peaking in Austral spring/summer. In this region, growing salmon aquaculture and passenger ship industry have boosted marine traffic with the peak in abundance during austral summer coinciding with the highest density of large baleen whales feeding in the area, placing whales at significant risk of vessel strikes (Caruso et al., 2021).

In 2014, we began a project focusing on the ecology, foraging and acoustic behavior of blue whales (*Balaenoptera musculus*) in Northern Chilean Patagonia. Our study area includes the Moraleda Channel, the Corcovado Gulf and the Ancud Gulf (Fig. 1). We deployed suction-cup attached digital acoustic tags (DTAGs) on blue whales, combined with prey sampling data acquired using active acoustics and morphometric sampling. More than 190 hours (28 tags) of tag data from six separate research cruises were acquired (Fig. 1) . Here, we examined day and night foraging behavior of blue whales in order to study their kinematics, energetics, and how it is related to the density and distribution of their prey (euphausiids).

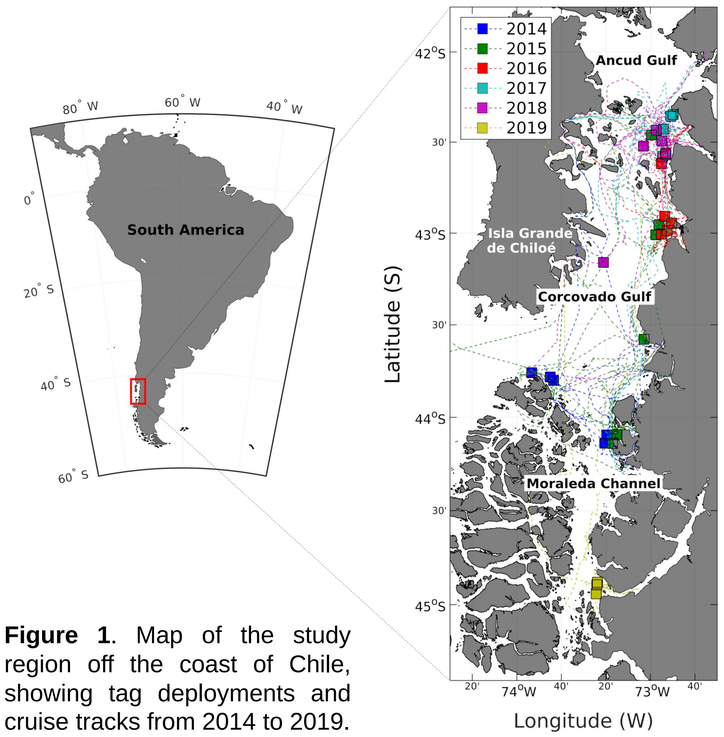

Figure 1. Map of the study region off the coast of Chile, showing tag deployments and cruise tracks from 2014 to 2019.

METHODS

Field efforts were carried out from 2014 to 2019 during February and March. DTAGs are sound and movement recording tags equipped with two hydrophones, a depth sensor, and 3-axis accelerometers and magnetometers (Fig. 2; Johnson and Tyack 2003). Accelerometer data were sampled at frequencies of 200-500 Hz and used to detect blue whale foraging events (Fig. 3).

DTAGs are attached with four suction cups using a hand-held 8 m carbon fiber pole (Fig. 2) and can be programmed to release after durations of up to 24 hours. The tags contain a VHF transmitter to track the tagged whales during deployment and retrieve the tag after release. Prey mapping was carried out using a two-frequency (38 and 200 kHz) scientific echosounder.

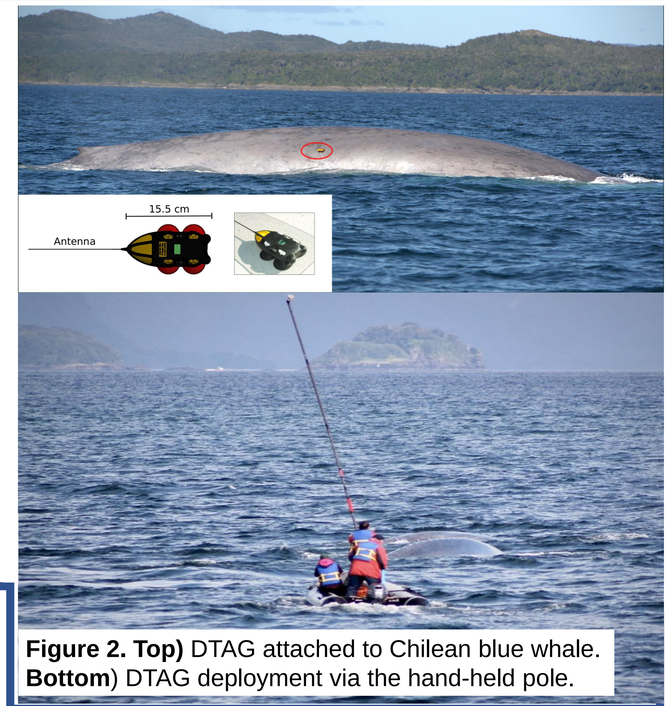

Figure 2. Top) DTAG attached to Chilean blue whale. **Bottom**) DTAG deployment via the hand-held pole.

RESULTS

Chilean blue whales showed a higher feeding rate during night-time on shallow and dispersed krill patches rather than feeding on dense and deeper krill aggregations (Fig. 3). The results showed less energetically costly manoeuvres when foraging near the surface, with lower values of pitch and speed during feeding events (Fig. 4). The whales preferred waiting for the migration of krill to shallow waters, and this behavior increases the risk of ship collision during nighttime.

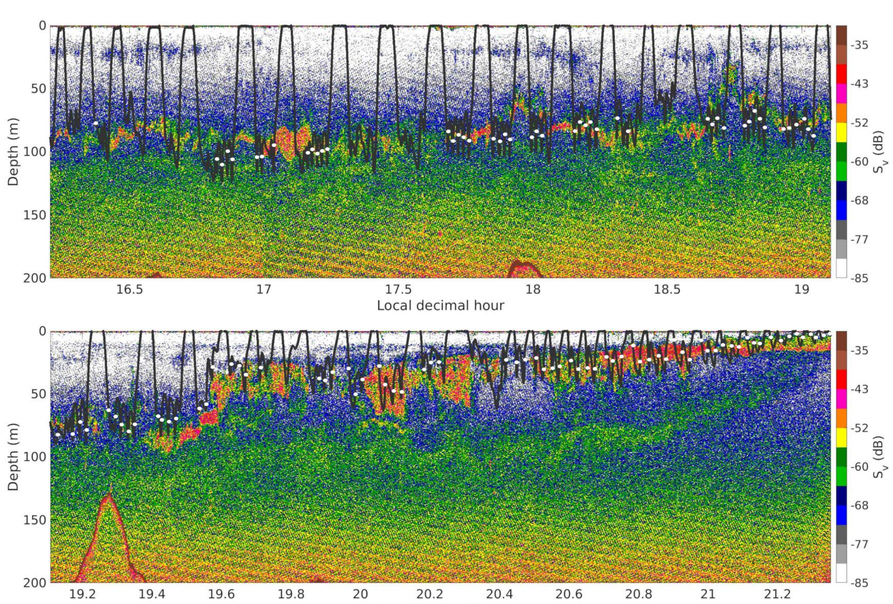

Figure 3. 200 kHz echogram shows the distribution of krill, with the dive profile of a tagged blue whale (bm18_055a, black line) and feeding events (white dots). Whale dive patterns and maximum depth varied as the krill migrated shallower at dusk.

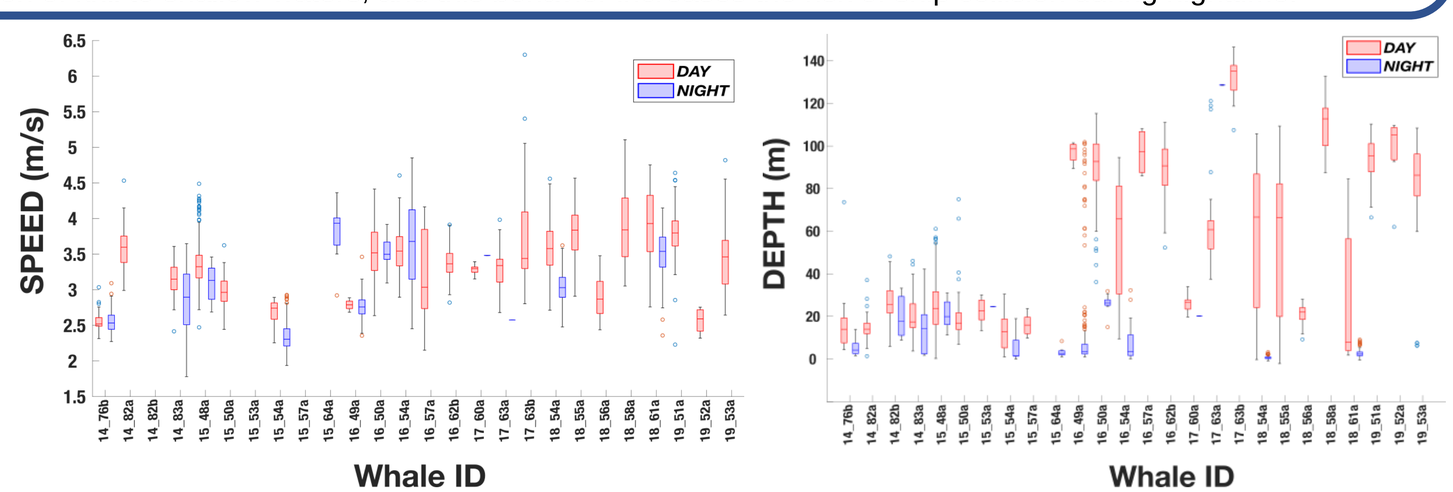

Figure 4. Boxplots of whales' speed (left) and depth (right) during feeding events at daytime (red) and nighttime (blue) of all the DTAG deployments.

CONCLUSIONS

The increased risk of vessel strike is a dramatic threat since blue whales concentrate their energies during nighttime shallow feeding. This study provides valuable information for policy decisions regarding conservation plans of the species in northern Chilean Patagonia.

REFERENCES:

- Caruso, F., 2021. Diel differences in blue whale (*Balaenoptera musculus*) dive behavior increase nighttime risk of ship strikes in northern Chilean Patagonia. Integr. Zool. 16, 594– 611. https://doi.org/10.1111/1749-4877.12501
- Johnson, M.P., Tyack, P.L., 2003. A digital acoustic recording tag for measuring the response of wild marine mammals to sound. IEEE J. Oceanic Eng. 28, 3–12. https://doi.org/10.1109/JOE.2002.808212