

Assessing movement patterns of fin whales from ocean-bottom seismometer data

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ABSTRACT:

Passive acoustic monitoring (PAM) is a powerful tool to acquire data about the distribution and movements of vocal animals that are otherwise difficult to observe, such as baleen whales. Ocean-bottom seismometers (OBS) are excellent platforms for monitoring such animals because they can record acoustic data, typically at 100 Hz, and cover extensive geographical areas for extended periods. This study uses acoustic data recorded from OBS in the northeast North Atlantic Ocean to track fin whales and estimate several movement characteristics. Twenty-Hz fin whale notes were detected, filtered and then located using a single station method, and their locations were adjusted to obtain the most reliable estimates. This process resulted in a dataset of 116 tracks of fin whales for which the median swimming speed, track length, and directivity were calculated. The median track length contained 42 detections (range: 30-108), had 2.2 km (range: 0.4-4.6) and lasted 12 minutes (range: 7-24). The median swimming speed was 7.5 km/h (range: 3-17) and showed a small increase in the months of highest vocal activity. Most tracks followed a distinct path with a predominantly northward orientation. These results are valuable observations to assess the spatial dynamics of the fin whale populations in the area.

Study area & methodology

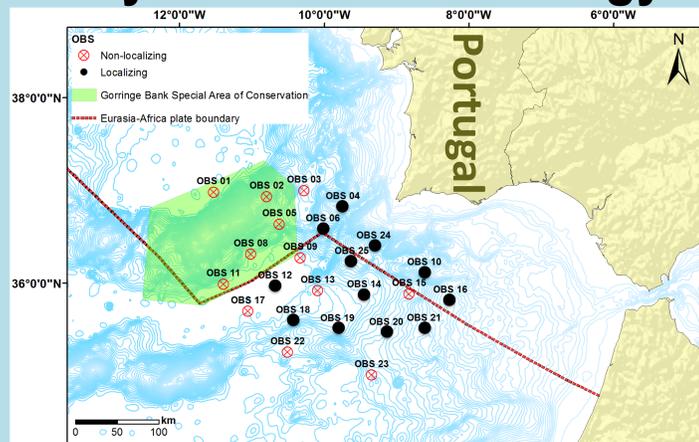
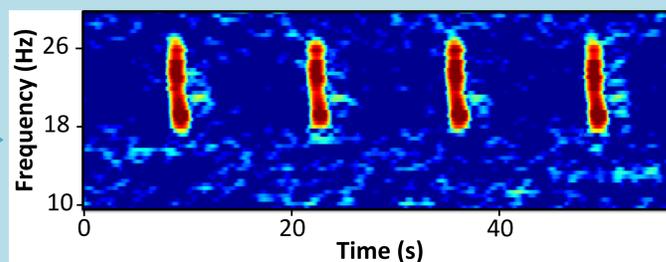


Fig. 1: Location of the ocean-bottom seismometers (OBS)

- 12 OBS

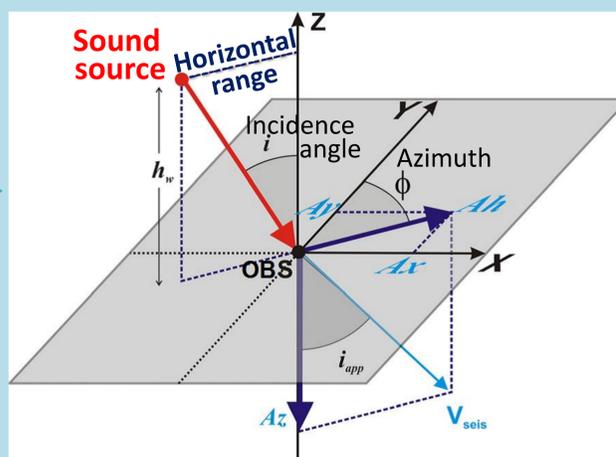
Three-component seismometer + Hydrophone
100 Hz sampling rate
September 2007 – August 2008



Acoustic signal & Detection:

- 20-Hz fin whale notes
 - Matched filter algorithm
- Harris *et al.* 2013, Pereira *et al.* 2020

Fig. 2: Spectrogram of 1 minute with 20-Hz fin whale notes



Location method:

- Single-station
- Three-component seismometer
- Horizontal range + Azimuth

Fig. 3: Geometry of the single-station location method

RESULTS

- A total of 116 fin whale tracks were used to calculate movement parameters.
- Location estimates had to be averaged by 3 points (moving average)

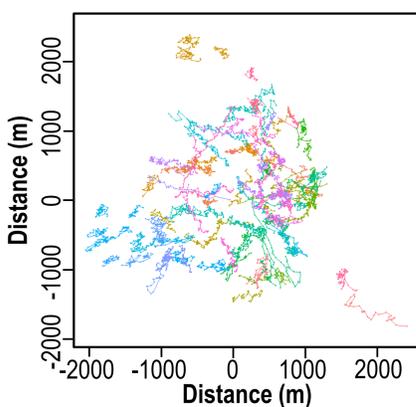


Fig. 4: Relative positions of the tracks plotted around several OBS instruments (all OBS are in the center of each plot at 0,0).

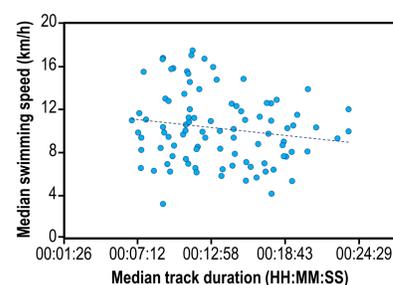


Fig. 5: Median swimming speed of 116 fin whale tracks located from 20-Hz fin whale notes with median track duration.

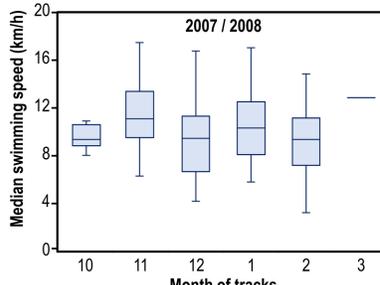


Fig. 6: Median swimming speed of 116 fin whale tracks located from 20-Hz fin whale notes with month.

Summary of movement patterns (median values of tracks)

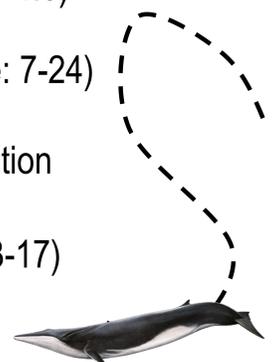
42 detections (range: 30-108)

2.2 km (range: 0.4-4.6)

12 minutes (range: 7-24)

Northward orientation

7.5 km/h (range: 3-17)



FINAL CONSIDERATIONS

Fin whales were tracked with three components of a seismometer (X,Y,Z) that measures ground motion

A set of processing rules were needed to obtain reliable estimates of movement parameters of fin whales

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- Matias, L., and Harris, D. (2015). "A single-station method for the detection, classification and location of fin whale calls using ocean-bottom seismic stations." *J. Acoust. Soc. Am.* 138, 504–520.
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