# Abundance estimates for sperm whales in the south western and eastern Mediterranean Sea from acoustic line-transect surveys

TIM LEWIS*, JUSTIN MATTHEWS*, OLIVER BOISSEAU*, MAGNUS DANBOLT*, DOUGLAS GILLESPIE†, CLAIRE LACEY†, RUSSELL LEAPER*, RICHARD MCLANAGHAN* AND ANNA MOSCROP*

*Song of the Whale Team, International Fund for Animal Welfare, c/o Marine Conservation Research Ltd, 1 High Street, Kelvedon, CO5 9AG, UK.

†Sea Mammal Research Unit, Scottish Oceans Institute, University of St. Andrews, KY16 8LB, UK

Contact: tim.p.lewis@gmail.com

**www.ifaw.org**

## Introduction

Mediterranean Sperm whales are a sub population, essentially isolated from animals in the Atlantic. They are impacted by a variety of anthropogenic threats especially drift-netting and ship strikes. There is evidence of population decline and Mediterranean sperm whales are classified as Endangered by IUCN. Therefore there is an urgent need for data to assess the Mediterranean population distribution and size to inform conservation actions.

Surveys were conducted in 2003 (Ionian Sea), 2004 (SW Med) & 2007 (E Med). Sperm whales are ideally suited for survey by passive acoustics due to distinctive loud clicks which are produced almost continually during the time that animals are submerged. These clicks are easily detected, distinguished from other species, and can be localised in order to provide precise locations of individual whales, even when encountered in large groups. Intervals between bouts of clicking are short leading to low availability bias.
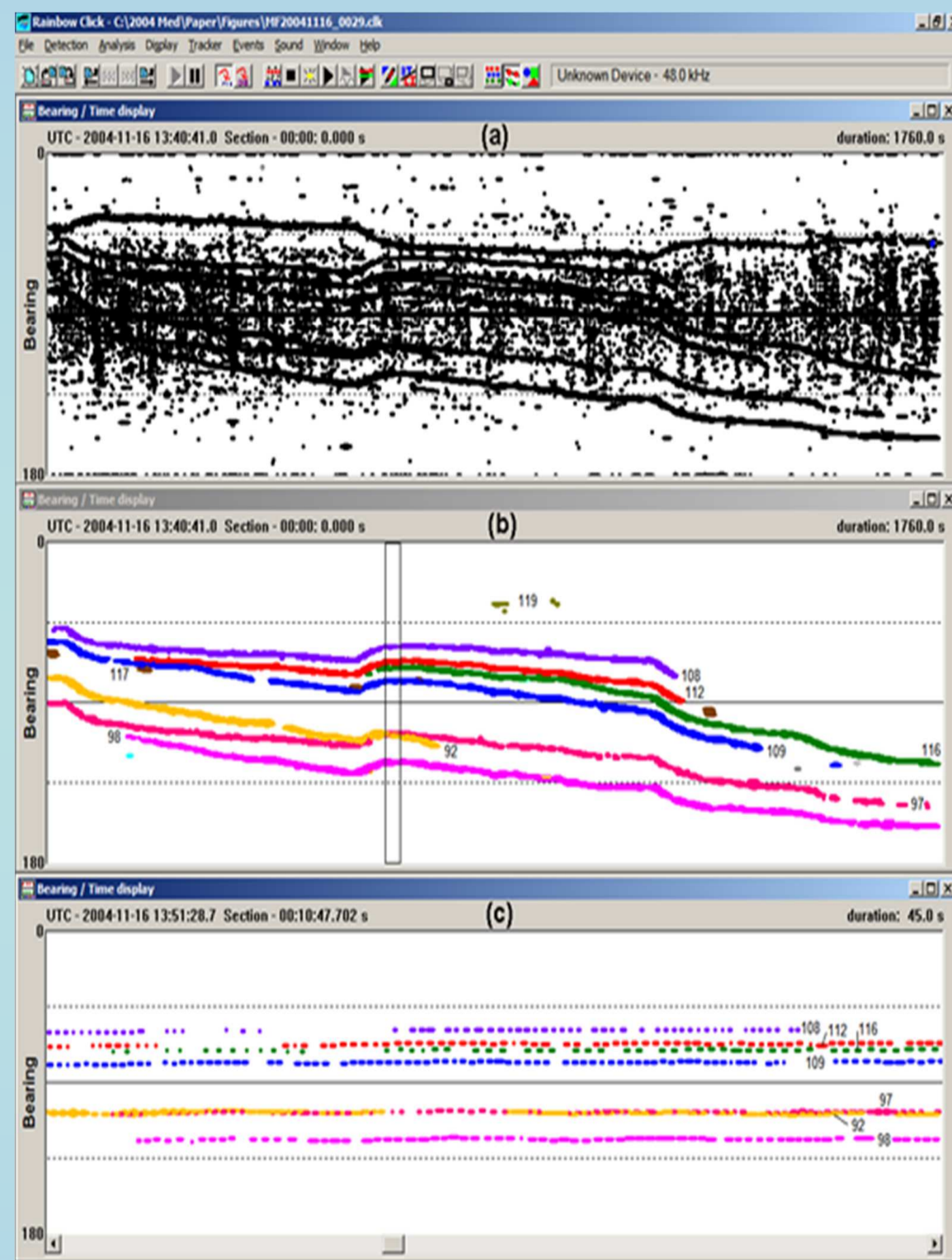
## Methodology

### Acoustic data collection

Acoustic surveys were conducted 24 hours a day at ≈7 knots (≈ 3 x speed of sperm whale) from a quiet vessel towing at two-element hydrophone. Continuous WAV recording were made and In-field detections of sperm whales using Rainbow Click and headphones so that 10° zigzagging could be initiated when whales were detected to resolve left/right ambiguity.

For photo-ID, we broke from survey track only when last whale >6.5 km behind vessel – avoids breaking before whole group passed which would give a negative bias to abundance.

### Offline acoustic data analysis

Click detection parameters in Rainbow Click were optimised post-survey and then used to generate a uniform set of files of candidate sperm whale clicks. An analyst manually assigned sperm whale clicks to click trains (using bearing, ICI, spectral characteristics, etc.). The analyst linked trains across gaps to form chains of trains, each chain having been produced by an individual whale. The gaps between trains can be due to surfacing (gaps of approximately 18 minutes), clicks falling temporarily below the acoustic detection threshold (variable length gaps) and post-feeding buzzes (short gaps of a few seconds).
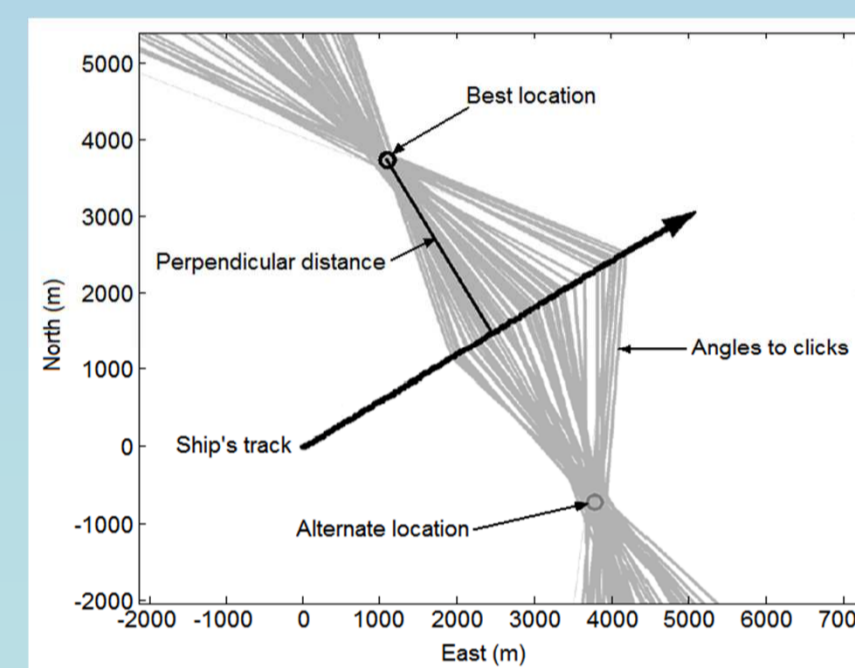


Example screen images from the click analysis program Rainbow Click. All windows show plots of clicks on time versus click angle axes. Clicks at the top of the plot are directly ahead of the hydrophone, Clicks plotted along the central horizontal line are perpendicular to the hydrophone and those at the bottom are directly astern.
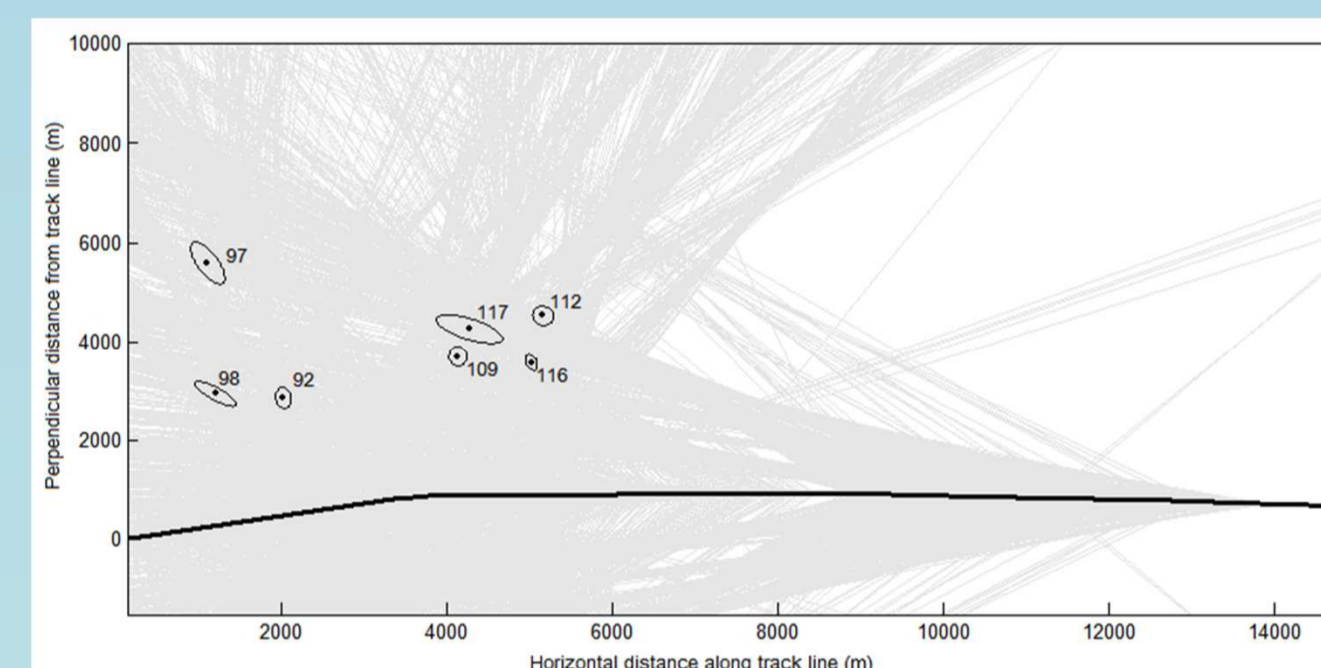
(a) All candidate sperm whale clicks for a 30 minute period.

(b) Analysed sperm whale clicks for same period (non-sperm whale clicks and echoes of sperm whale clicks have been removed), clicks are assigned to click trains and click trains are then assigned to individual whales and coloured by individual whale.
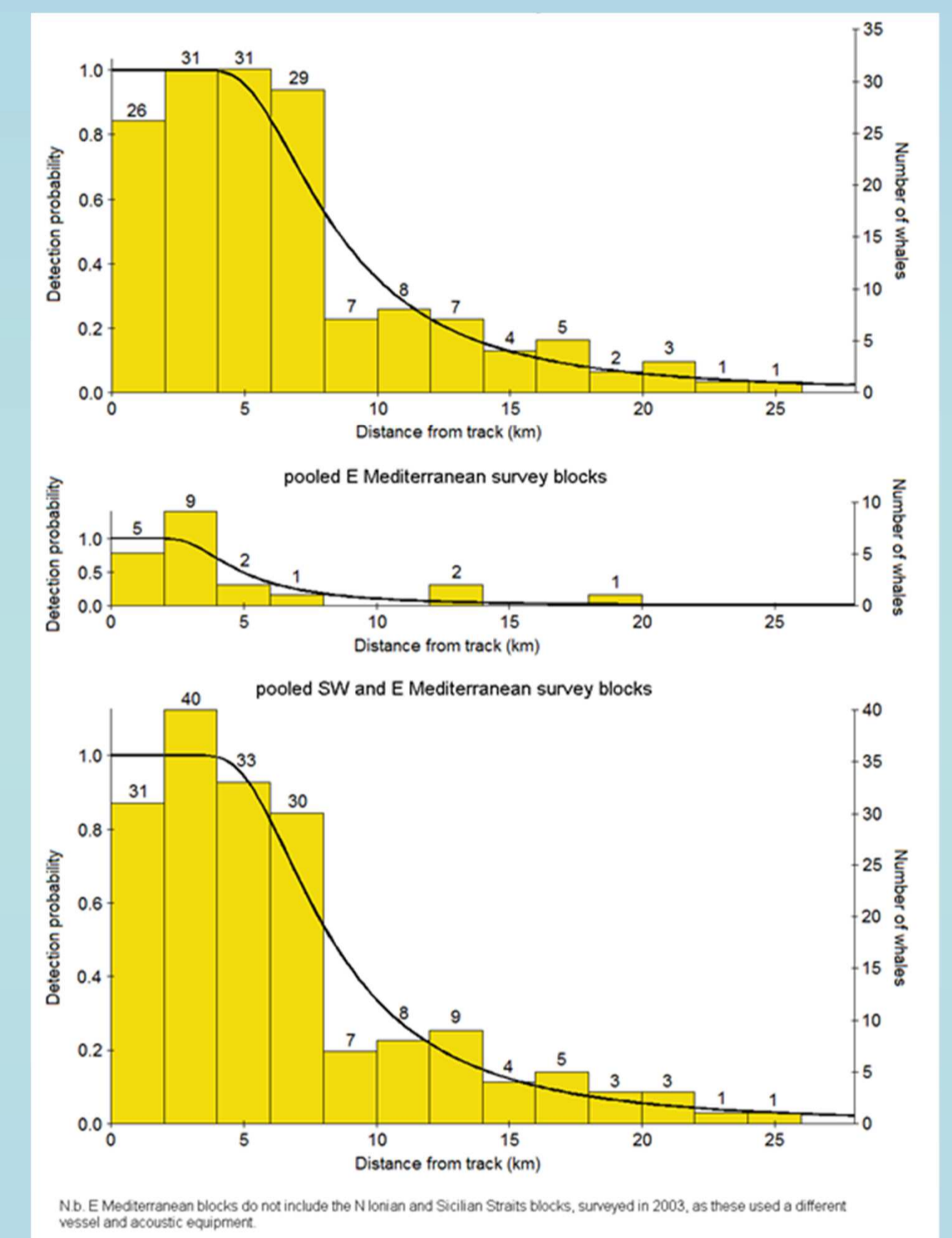
(c) Zoomed in 30s section of plot (b) individual clicks can be seen for seven sperm whales, notice individual whales can be identified even though click trains are coincident in time-bearing space.



Crossing of angles to clicks at the sea surface in order to estimate the whale's position and perpendicular distance from the survey track.
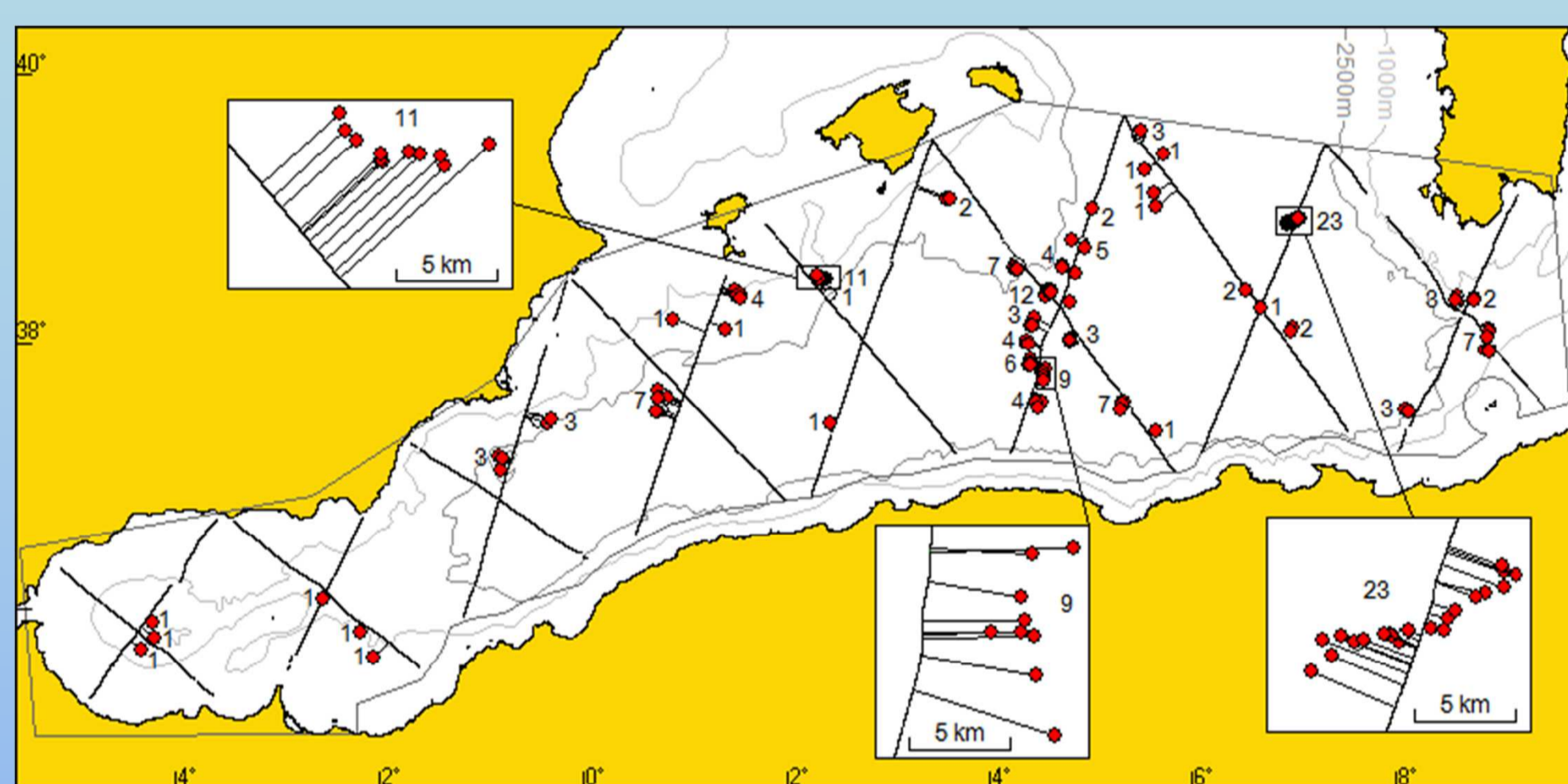


Output from the Matlab perpendicular distance routine for the event starting at 16/11/2004 12:53 - this is the plot of whale positions derived from the click sequences shown in the Rainbow Click screen grab, and shows an aggregation of seven whales to the left of the survey track. Whale positions are marked as black dots, whale IDs and error ellipses in black, surface angles to clicks in grey and the survey track in black.
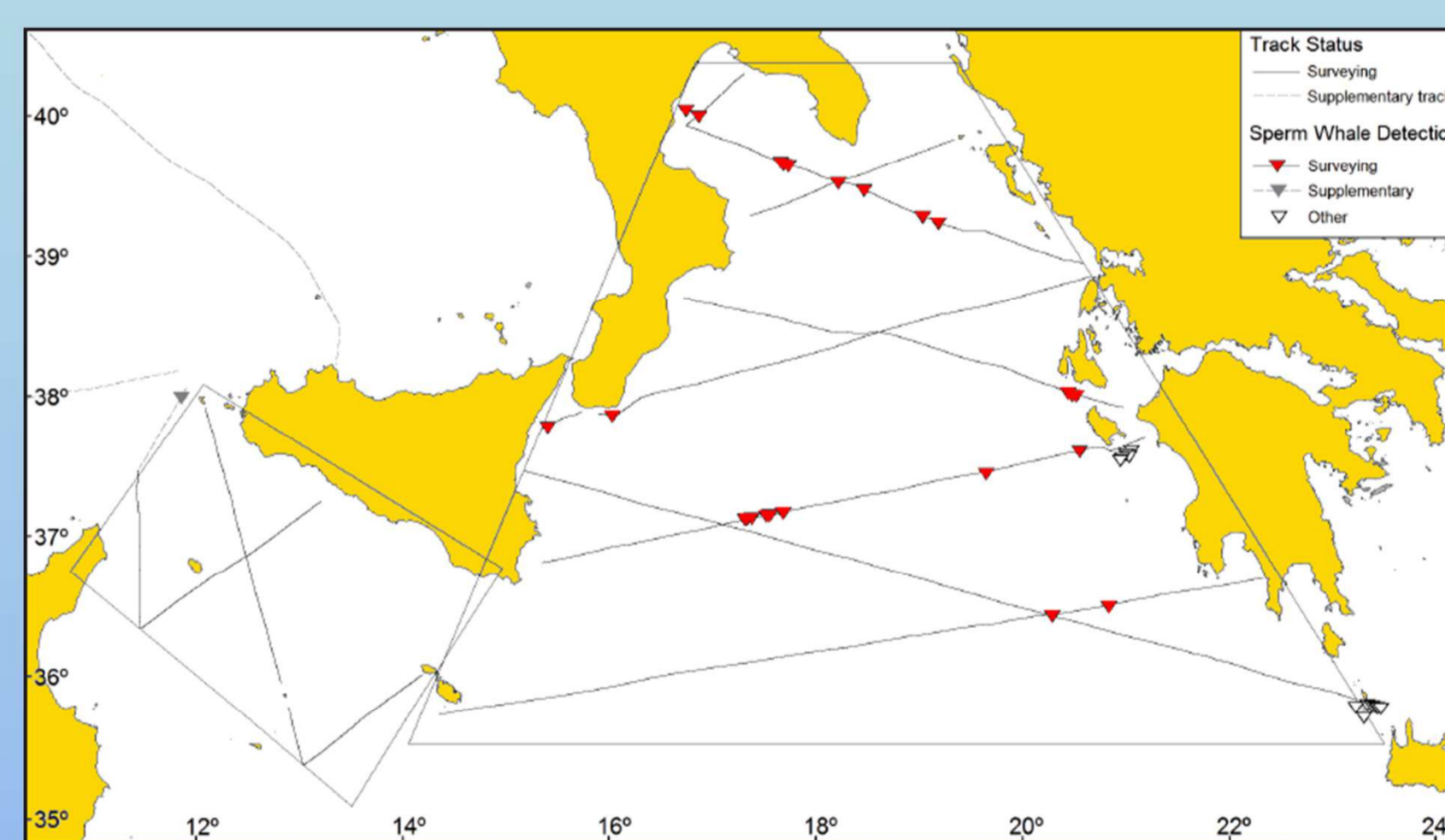
Detection functions fitted to perpendicular distance data with the Distance software. Fits use a Hazard Rate probability function with no adjustment terms.
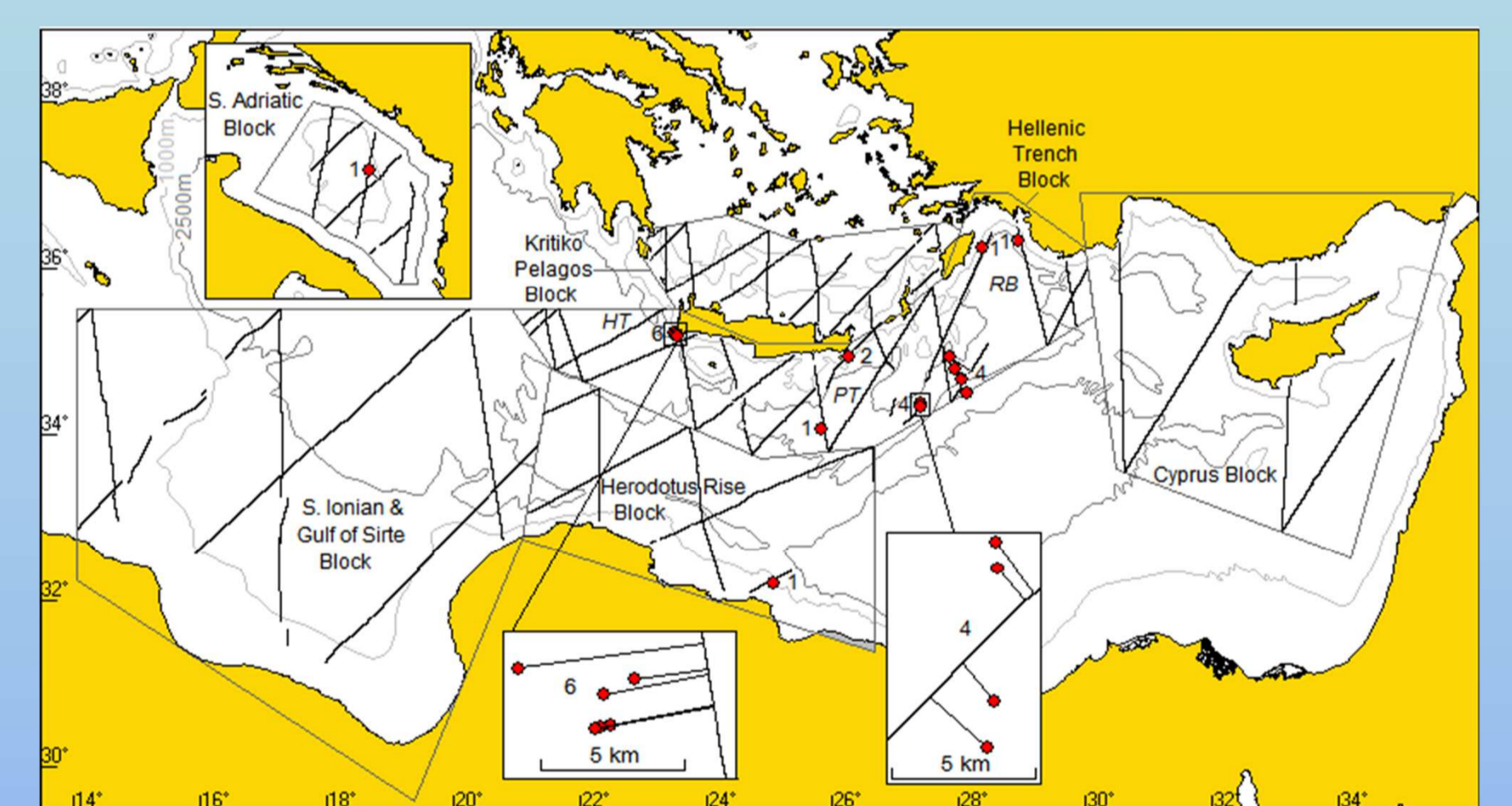


## Results



### SW Mediterranean

Locations of detected sperm whales (black circles with red fill) in the SW Mediterranean survey block linked to acoustically surveyed tracks (black) by perpendicular lines. The number of detected sperm whales is given for each encounter. Zoomed in examples of aggregations are shown in the inset boxes.



### Ionian Sea and Sicilian Channel

Locations of detected sperm whales (black triangles with red fill) in the Ionian Sea and Sicilian Channel survey blocks. Black triangles with white fill are detections made off transect and not included in the abundance estimates.



### Eastern Mediterranean and S Adriatic

Locations of sperm whales detected whilst on track and on effort (black circles with red fill) in the eastern Mediterranean linked to acoustically surveyed tracks (black) by perpendicular lines. The number of detected sperm whales is given for each encounter. Zoomed in examples of aggregations are shown in the inset boxes. HT – Hellenic Trench, PT – Pliny Trench and RB – Rhodes Basin.
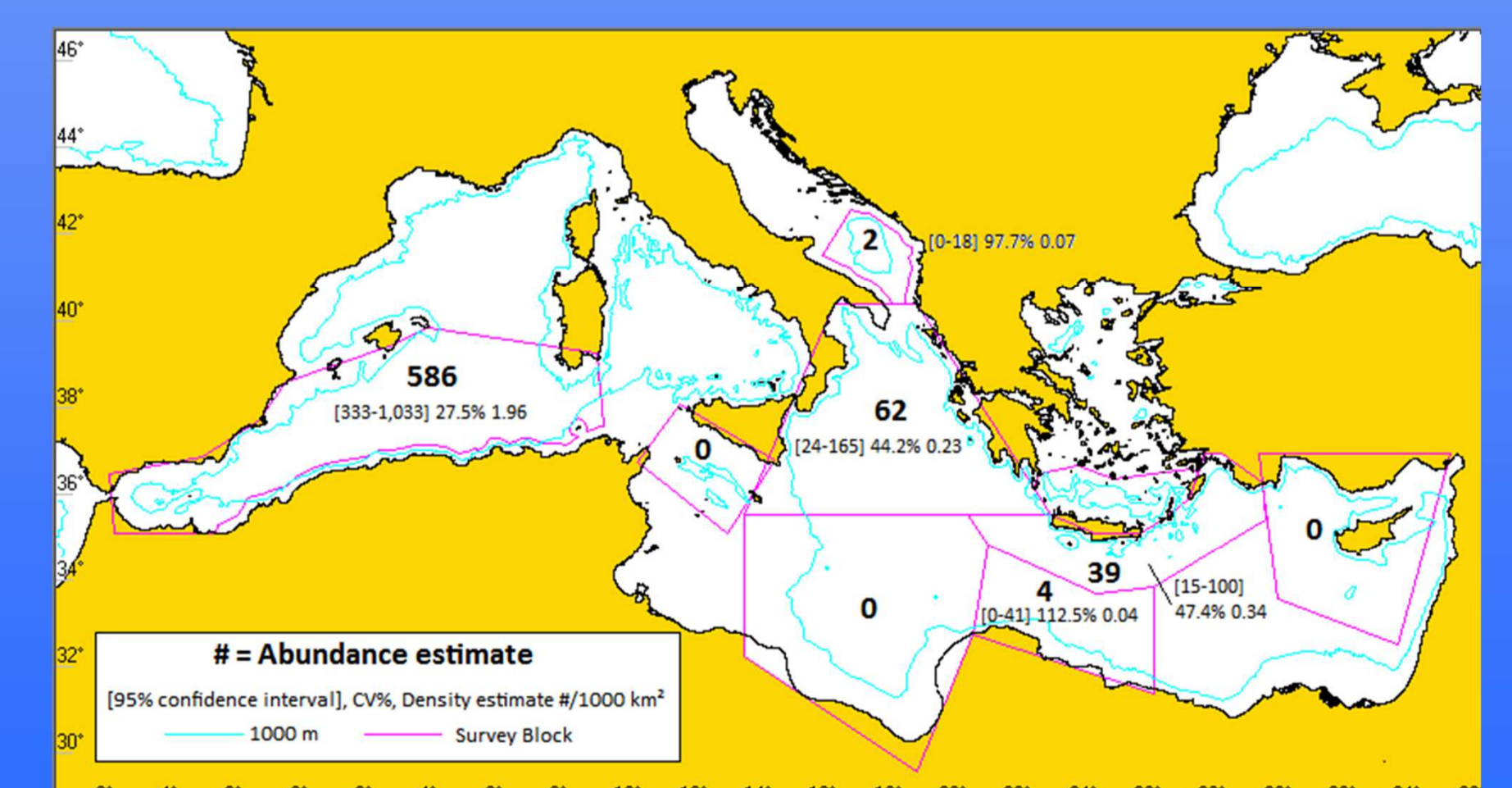
## Summary

### Detection function parameters

| Region | Selected truncation distance (km) | Number of whales (after truncation) | Effective strip half-width (ESW) (km) | ESW coefficient of variation | ESW 95% log-normal confidence interval (km) |
|---|---|---|---|---|---|
| SW Mediterranean | 28 | 155 | 10 | 8.5% | 8.5 - 11.8 |
| E Mediterranean (pooled blocks for detection function | 28 | 20 | 6.2 | 28.2% | 3.5 - 11.1 |
| SW & E Mediterranean (pooled blocks for detection function) | 28 | 175 | 9.8 | 8.0% | 8.4 - 11.5 |

➢ South western Mediterranean sperm whale density: 1.96 whales per 1,000 km².

➢ Eastern Mediterranean sperm whale density: 0.10 whales per 1,000 km².

➢ Density in south western Mediterranean block is 20x density of surveyed eastern Mediterranean.

➢ Within eastern Mediterranean, the Hellenic Trench block has highest density with 0.34 whales per 1,000 km² while Ionian Sea block has second highest density with 0.23 whales per 1,000 km².

➢ Very low numbers of animals outside these two areas.

**Abundance estimates for surveyed areas:**

| | |
|---|---|
| SW Mediterranean: | 586 |
| Eastern Mediterranean: | 107 |
| Total for surveyed areas: | 691 |



## Acknowledgments