

## **A note on the use of aerial surveys to estimate large whales' density and abundance in the central Mediterranean Sea: baseline data to begin to assess population level effects of anthropogenic mortality, including ship strikes**

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### **INTRODUCTION**

Ship strikes are one of the main non-natural causes of death for fin whales (*Balaenoptera physalus*) in the Mediterranean Sea (Panigada et al., 2006) and a proper evaluation of the conservation implications of this anthropogenic mortality requires at least an understanding of (a) the abundance (and trends) of the population<sup>1</sup> and (b) estimates of the anthropogenic mortality. Information on temporal and geographical distribution and movements of animals can assist with both (a, b) and with the development of mitigation measures when linked with similar information on information.

While there is direct evidence of ship strikes of fin whales in the Mediterranean Sea, the degree to which this may pose a population level threat is unknown. Baseline information on abundance and trends of fin whales (and other cetaceans) in the Mediterranean Sea is poor and as a result a proposal for a basinwide cetacean survey has been developed in the context of ACCOBAMS and endorsed by the IWC Scientific Committee.

In order to assist in this process, systematic monitoring of density and abundance of the most common cetacean species of the Pelagos Sanctuary and the seas surrounding Italy to inform conservation measures throughout the Basin is one of the current priorities of the Italian Ministry of the Environment (as well as being priority actions in a number of other international bodies (e.g. the Sanctuary Management Plan, ACCOBAMS, the Specially Protected Areas and Biodiversity Protocol under the Barcelona Convention, by the EU Habitat Directive and Marine Strategy Framework Directive, and by the Convention on Biological Diversity).

The Italian Ministry of the Environment has started a series of aerial surveys to provide significant baseline information on cetaceans distribution and abundance in the seas around Italy: Pelagos Sanctuary, winter and summer 2009; Ionian Sea, Gulf of Taranto, spring 2010; Central Tyrrhenian Sea, summer 2010; Pelagos Sanctuary, summer 2010; Sardinia and Corsica Seas, summer 2010; Adriatic Sea, summer 2010; Southern Tyrrhenian Sea, winter 2010-2011. The results of recent relevant surveys with respect to fin whales are summarised here.

### **SUMMARY OF METHODS**

Where possible, the abundance of fin whales in the surveyed areas was estimated using both conventional distance sampling or CDS (Buckland et al., 2001) and multiple covariate distance sampling or MCDS (Marques and Buckland, 2004) approaches. The minimum value of the Akaike Information Criterion or AIC (Akaike 1974; Buckland et al. 2001) was used to choose between models and select which covariates to include in the detection function. Details of the analysis are available from the authors.

The estimates are underestimates as the data are not yet available to correct for availability or perception bias.

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<sup>1</sup> Use of the word population means that knowledge of stock structure is required.

## RESULTS

### Winter 2009

A total of 8,144 km (92%) of the planned trackline effort was surveyed. There were not sufficient data in order to proceed with analysis (just one fin whale sighting) and no abundance estimates have been provided.

### Summer 2009 (Fig. 1)

A total of 8494 km (97%) of the planned trackline effort was completed, covering 79 parallel transects, 10km apart, over an area of 90.000 Km<sup>2</sup>. Of the 24 fin whale sightings, 16 were primary sightings - all of single animals - and thus used in the analysis. The meagre number of sightings precluded the use of the MCDS approach and no truncation was used (the largest perpendicular distance was 1000m). The CDS estimated of l abundance of fin whales within the surveyed area was 148 animals (CV=27%; 95% CI 87 – 254), with a density of 0.00168 individuals km<sup>2</sup> (CV=27%).

### Summer 2010 (Fig. 2)

Some 210 parallel transects 15km apart were flown in spring and summer 2010, totaling 21,188 km, over a area of about 448,000 km<sup>2</sup>. Of the 60 fin whales sightings 59 were primary and has been used in the analysis. The CDS estimated abundance of fin whales in the Tyrrhenian, Corsica and Sardinia Seas was 625 (CV=25.83%; 95% CI= 378 - 1032); no fin whales were sighted in Ionian Sea and the Gulf of Taranto and only one sighting was reported from the Southern Tyrrhenian Sea.

## DISCUSSION

The programme thus far has illustrated the value of aerial (as opposed to shipboard) surveys for monitoring, particularly in winter when the weather is poorer. Aerial surveys can allow high coverage of the area and enable the determination of more robust estimates with lower CVs and CIs.

The results represent important baseline data for the seas around Italy but their value for management and eventual assessment of population trends also requires an understanding of stock structure.

Fin whales were not sighted during the winter survey, although previous acoustic data indicates some presence (Clark et al., 2002). This requires further consideration in terms of survey design and coverage.

Although differences in method and design preclude a valid quantitative comparison, a simple comparison of our results (or those from a shipboard survey carried out in 2008 - Lauriano et al., 2011) with published information from past shipboard surveys from either the whole Sanctuary area or parts of it (e.g. Forcada et al., 1995; Gannier, 2006) suggests an appreciable decrease in the summer density and abundance of fin whales in the Pelagos Sanctuary area since the early 1990s.

If this represents a real decline, either in the use of the Sanctuary by fin whales or in the total population of fin whales, it is important to investigate the possible explanations; if it is a true population decline then serious conservation actions would be required. As noted, the best known cause of direct mortality of fin whales in the Mediterranean is collisions with ships, although there are insufficient data on both whale abundance and numbers of deaths to determine whether this represents a population level threat. Efforts to collect better information on ship strikes (and to report this e.g. through the IWC database) are strongly encouraged.

Vessel traffic in summer within the Sanctuary is high and has been increasing – this may result in increased collisions (especially from high speed ferries) or increased overall disturbance (including from whale-watching vessels – Jahoda et al., 2003), causing the whales to move elsewhere. Other potential issues relate to more indirect threats such as effects of chemical pollutants on reproduction and survivorship (e.g. Fossi et al., 2003), effects of ocean acidification or climate change on prey (e.g. Gambaiani et al., 2009) and the synergistic effects of some or all of these factors.

Further monitoring of abundance (e.g. through this aerial survey programme) and anthropogenic factors is required to facilitate conservation of fin whales in the Mediterranean.

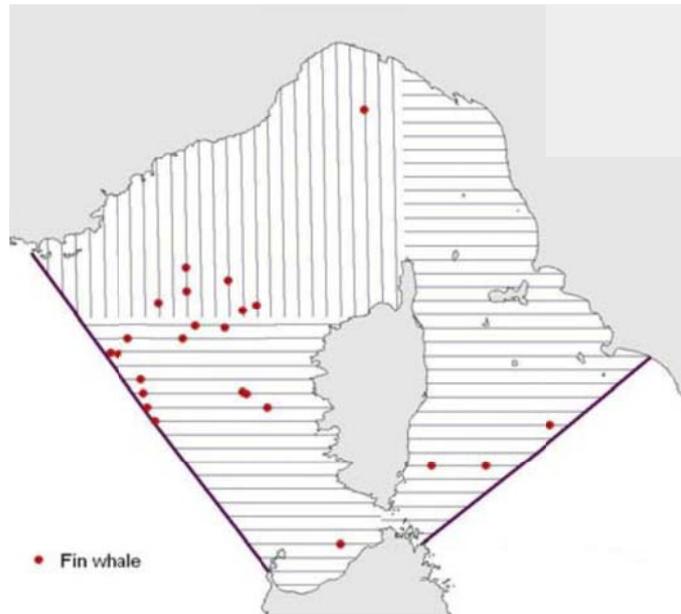


Fig. 1 – The Pelagos Sanctuary showing summer 2009 fin whales’ sightings

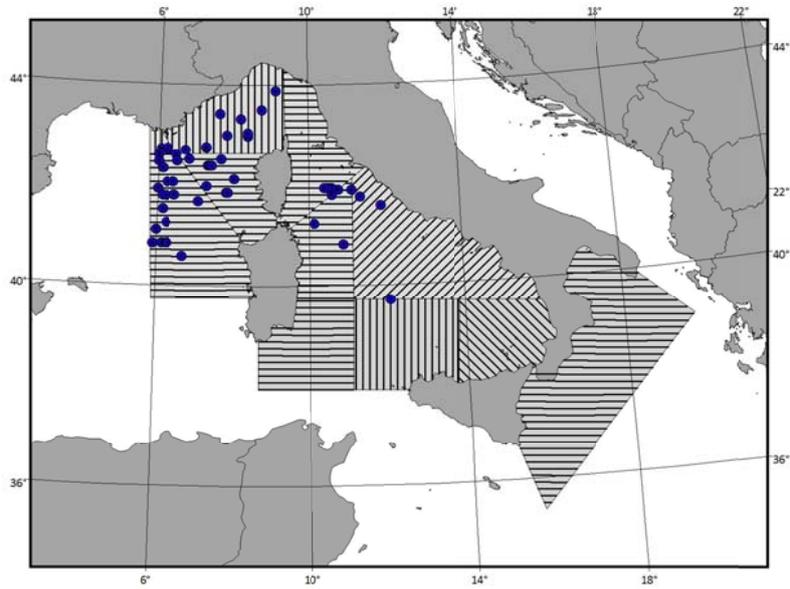


Fig. 2 – The 2010 study area and the fin whales sightings

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