# Monitoring density and abundance of cetaceans in the seas around Italy through aerial surveys: a summary contribution to conservation and the future ACCOBAMS survey

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## INTRODUCTION

Systematic monitoring of absolute density and abundance of cetacean species is essential to inform conservation measures. These activities are among the highest priorities for the Pelagos Sanctuary, ACCOBAMS, the Specially Protected Areas and Biodiversity Protocol (Barcelona Convention), the EU Habitat Directive and the Convention on biological diversity (CBD).

Although some abundance estimates have been provided in the past (e.g. South Tyrrhenian sea - *Stenella coeruleoalba* – Fortuna et al., 2007; West Pelagos – Forcada et al., 1995; Lauriano et al., 2011), these were limited especially in terms of study area and effort coverage.

Mediterranean striped dolphins have suffered from high levels of mortality due to incidental capture in fishing gear and subject to mortality from morbillivirus (e.g. see summary in Aguilar, 2000). High bycatch rates were reported in all the Mediterranean Sea in the 1990s. Currently the extent of bycatch is unknown, however, despite the European Union large driftnets ban (over 2.5 km length) since 2002, illegal driftnetting was recently reported (Cornax et al., 2006; 2007). In the Mediterranean Sea, fin whales are exposed to anthropogenic source of mortality such as ship strikes (Panigada et al., 2006), which represent the main source of direct mortality. All these elements, coupled with coastal run off and sewage, chemical pollution, ferries and merchant traffic may represent important threats for cetaceans in the Mediterranean Basin (Fossi and Lauriano, 2008; Fossi et al., 2003; Panigada et al., 2008; Panigada et al., 2006). A proper evaluation of the effect of any of these potential threats at the population level requires a fair knowledge on abundance and stock structure of concerned species and populations. Obtaining baseline information on cetacean distribution, density and abundances in the seas around Italy is a priority for the Italian Ministry of the Environment that in 2009 started to fund a series of aerial surveys. Furthermore, considering Adriatic sea is well defined and relatively closed basin shared among several nations, an effort was made to cover the entire Adriatic sea and in cooperation with national authorities.

Distance sampling methods were applied to estimate the number of fin whales, striped dolphins and common bottlenose dolphin.
The study areas included: the Pelagos Sanctuary (winter 2009, summer 2009 and 2010), a portion the Ionian Sea, including the Gulf of Taranto (spring 2010), the Central and Southern Tyrrhenian, the Corsica and Sardinia Seas, and the Adriatic Sea (summer 2010).

## MATERIAL AND METHODS

The survey design and subsequent data analyses were in accordance with line transect distance sampling methodology (Buckland et al. 2001). The platform used was a two engine high-wing aircraft (*Partenavia* P-68) equipped with bubble windows (to allow direct observation of the trackline below the plane) flying at a constant altitude of either 650 (Adriatic Sea) and 750 feet (all other areas), and a ground speed of about 100 knots (185km/h). The observers team was made of three experienced researchers: two searching for animals through the bubble windows and the third observer recording the data directly onto a laptop. Effort and sightings data (Beaufort state three or less) were recorded onto a lap top with dedicated *ad hoc* data logging programme.

The aircraft flew along parallel transects, equally spaced (space varied in different surveys), designed using the software Distance 5.0 and 6.0[1] (Thomas et al. 2009) to provide equal coverage probability. All the study areas were subdivided into strata following a bathymetric criterion and the available knowledge of cetacean presence and distribution. This allowed to deal with change in cetacean density across the study area. Distance analyses for estimating absolute abundance and density were also performed using Distance 6.0. Both Conventional distance sampling (CDS) and Multi Covariate Distance Sampling methods (MCDS) were applied (Thomas et al. 2007, 2010; Buckland et al. 2001). In MCDS, additional explanatory variables (z) are considered along with perpendicular distance in the estimation of the detection function and hence the effective strip width or *esw* tested were 'observer', 'Beaufort sea state' and 'glare' (all as factor variables with 3 levels each). The best model fit was selected using the minimum value of the Akaike Information Criterion (AIC; Akaike 1979; Buckland et al. 2001). Details of the analyses are not presented here but can be obtained from the authors.

## RESULTS AND DISCUSSION

All estimates presented here are uncorrected for availability or perception bias and, therefore, represent underestimates.

### 2009 surveys (Pelagos Sanctuary – GL, SP)

In 2009 two aerial surveys have been conducted within the borders of the Pelagos Sanctuary in winter (the first time the full Sanctuary area has been covered) and summer 2009. The survey comprised 82 parallel transects, 10km apart, covering an area of 88,267 km$^2$. A total of 467 (131 in winter, 336 in summer) cetacean sightings were made: striped dolphins (n=114, n=280), common bottlenose dolphins (7, 8), fin whales (1, 24), sperm whales (1, 5), pilot whales (0, 5), Cuvier's beaked whales (1, 4), Risso's dolphins (0, 4), unidentified small dolphins (7, 5), and unidentified large whales (0, 1). Distribution of the striped dolphins in winter and summer 2009 are in figure 1.

The abundance estimate of striped dolphins in the area was some 19,600 specimens (CV=19.2%; 95% CI=12,300 – 27,000) in winter and 39,000 (CV=16.9%; 95% CI=28,000 – 54,300) in summer.

The sample sizes obtained allowed a reliable abundance estimate of the number of fin whales in summer only. The estimated abundance was some 150 individuals (CV=27.04%; 95% CI=86-250).

### 2010 - (Pelagos Sanctuary, Central Tyrrhenian, Corsican and Sardinian Sea, Ionian Sea – GL, SP)

Some 171 parallel transects 15km apart were flown in spring and summer 2010, in a total area of 333,598 km$^2$. A total of 515 cetacean sightings were made: striped dolphins (n=414), fin whales (59), common bottlenose dolphins (16), Risso's dolphins (13), sperm whales (5), pilot whales (5), Cuvier's beaked whales (3). The resultant best estimates of abundance of striped dolphins were 88,650 (CV=14%; 95% CI=67,022–117,301) in the Tyrrhenian, Corsica and Sardinia Seas, and 30,500 (CV=21%; 95% CI=20,215–45,866) in the Ionian Sea and the Gulf of Taranto. The estimated abundance of fin whales was 426 (CV=18%; 95% CI=298–609) in the former area; no fin whales were sighted in the latter. A crude comparison with data from past shipboard surveys (Forcada et al., 1995) suggests an appreciable decrease in fin whale density in the Pelagos Sanctuary area over the last decade (Lauriano et al., 2011).

### 2010-2011 - (South Tyrrhenian Sea – GL, SP)

In the autumn 2010 and winter 2011 an additional aerial survey took place in the south Tyrrhenian Sea. Forty-seven parallel transect were flown over a surface of 111,146.5 km$^2$.
A total of 153 cetacean sighting were made: striped dolphin (145), common bottlenose dolphin (3), Risso's dolphin (3), Cuvier's beaked whale (1) and fin whale (1).
From the sample size obtained, it was possible to produce an abundance estimate for striped dolphins only, with 40,554 individuals estimated (CV=18,19%; 95% CI= 28.240 - 58.237).

### 2010 - (Adriatic Sea – CMF, DH)

During the survey in the Adriatic Sea (July-August 2010) about 8,800 km were covered on effort along 63 parallel transects. Cetacean sightings, recoded in all weather conditions and research effort, were 124 of common bottlenose dolphin (Fig. 2), 82 of striped dolphins (Fig. 2), 11 of Risso's dolphin, 1 of Cuvier's beaked whale and 1 of fin whale (Fig. 2).

[1] http://www.ruwpa.st-and.ac.uk/distance/

The CDS abundance estimate of common bottlenose dolphins for the entire Adriatic Sea (about 133,200 km$^2$) was 5,237 dolphins (CV=25%; 95% CI=3,205-8,559). Whereas the abundance estimates of striped dolphins and Risso's dolphin in the southern Adriatic Sea were 20,221 dolphins (CV=31%; 95% CI=11,040-37,037;) and 807 dolphins (CV=76%; 95% CI=198-3,285), respectively.

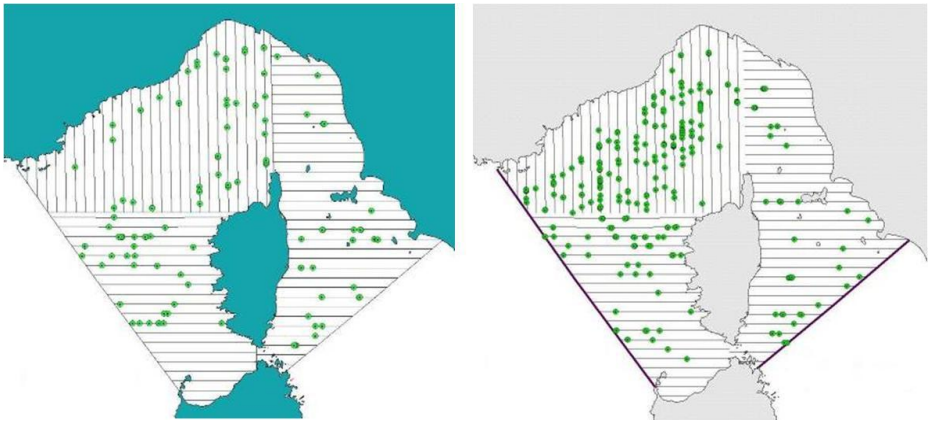

Fig. 1 – The Pelagos Sanctuary showing winter and summer 2009 striped dolphin sightings (left winter, right summer).

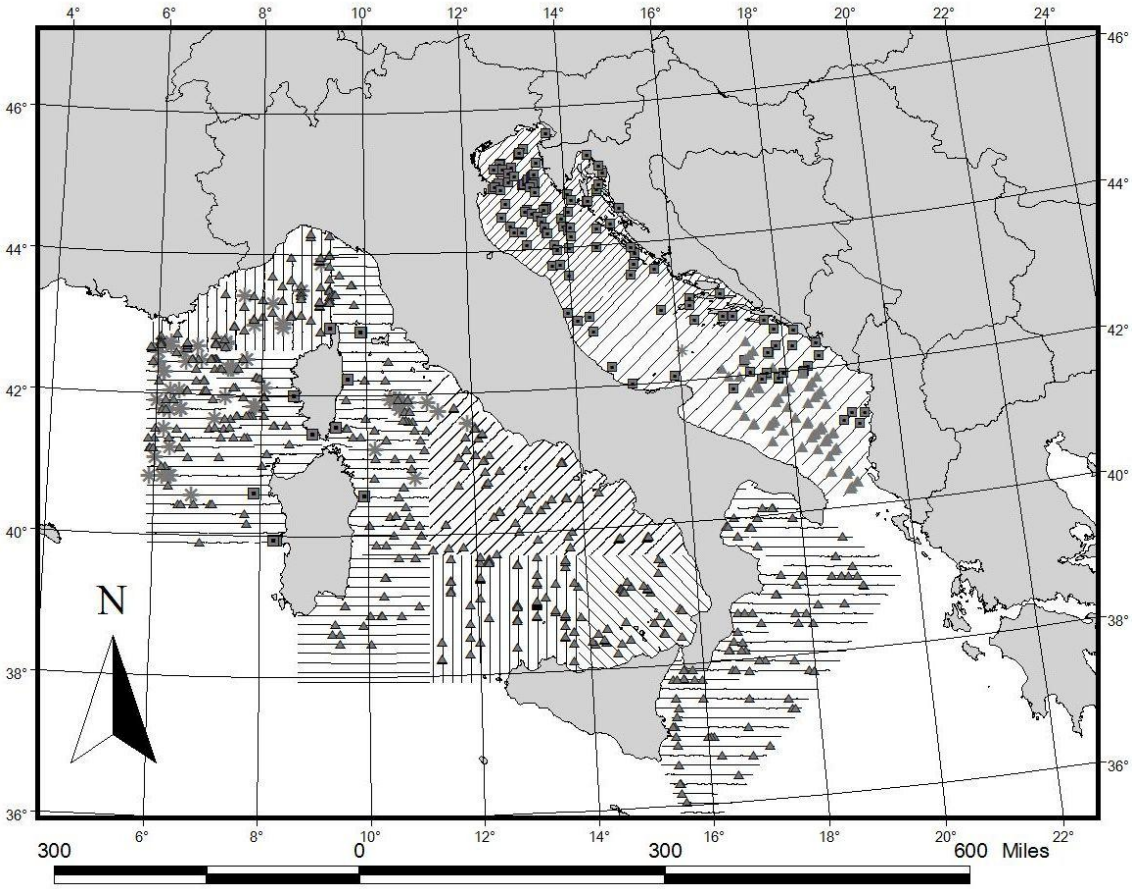


Fig. 2 – The study area showing spring and summer 2010 sightings of fin whale (star), striped dolphin (small triangle) and common bottlenose dolphin (square).

## CONCLUSION

This represents the first large scale systematic effort, aimed to provide data on presence, distribution and absolute density and abundance estimates of cetaceans, around the Italian peninsula . Robust estimates for striped dolphins, common bottlenose dolphins and fin whales where obtained.

Nevertheless, in order to fully understand the distribution of cetacean species that can range widely in relation to the prey availability, as well as to obtain a complete figure of their abundance at the Mediterranean basin level – including, for example, those of the proposed Vulnerable common bottlenose and striped dolphin (Reeves & Notarbartolo, 2006) - an expansion of the surveyed region is necessary. Moreover, given that change in oceanographic conditions can determine drastic cetaceans presence and distribution changes from one year to the next, replicates of the surveys are equally needed as they can provide data on potential differences across years. All these considerations reiterate the need for the ACCOBAMS Survey Initiative (ASI), as well as regular monitoring surveys and additional specific work on population structure and movements.

These surveys have illustrated the effectiveness of aerial surveys in estimating abundance of certain cetacean species in suitable areas/circumstances and may provide a model for other areas within the ACCOBAMS area (Mediterranean, Black Sea and adjacent Atlantic waters).

Aerial surveys have a number of advantage if compared to ship-based surveys. Particularly in winter when the weather is poorer, aerial survey increase the chance to optimise the working time in favourable conditions and in general aerial survey let to cover a wide region in great detail, allowing high coverage of the area (total transect length x width observed on both sides of the plane/total area). Moreover less uncertainty in both distance measurements and group size estimation, and little (if any) problem with responsive movement or avoidance - due to survey altitude used (which are known to cause significant bias with vessel surveys for some species - allow the determination of more robust estimates with lower CVs and CIs, than would have been possible with more traditional ship based surveys.

These surveys provide baseline data to develop efficient long-term systematic monitoring programmes, as required by a number of national and international frameworks and provide valuable input into the design of the ASI. Table 1 summarises the experience gained during the aerial surveys conducted in the Central Mediterranean Sea (2009-2010) in terms of correction for g(0) and possibility of producing robust estimates, in light of the forecasted ASI.

Table 1 - Summary of experience gained during aerial surveys in the Mediterranean Sea (2009-2010)

| **Species** | **G(0)** | | **Qualitative summary of likely 'robustness' of estimate**[2] |
|---|---|---|---|
| | Perception bias [1] | Availability bias | |
| *Stenella coeruleoalba* | ?low | No data to correct<br>Correction could be derived from comparable data or collected experimentally | good |
| *Tursiops truncatus* | ?low | Correction available [4] | Good/medium |
| *Delphinus delphis*[3] | ?low | No data to correct | Medium/poor |
| *Grampus griseus*[5] | ?low | No data to correct | Medium/poor |
| *Globicephala melas* | ?low | Data available to correct* | Poor |
| *Physeter macrocephalus* | ?low | Data available to correct* | Poor |
| *Ziphius cavirostris* | ?low | Data available to correct* | Poor |
| *Balaenoptera physalus* | ?low | Data available to correct* | Good |

[1]Perception bias can be reduced to low levels with experienced personnel, although it will vary from species to species; ideally it can be estimated using double platform procedures.

[2] A primary component of this relates to sample size.

[3] Options to study common dolphins by aerial survey are limited to the restricted area where the species is still present. Given the low encounter rates, CV may be quite high. May also be difficult to identify in mixed groups with striped dolphins.

[4] Forcada J., Fernández-Contreras M., Gazo M., Aguilar A., Gonzalvo J.2004. Bottlenose dolphin abundance in the NW Mediterranean: addressing heterogeneity in distribution. Marine ecology progress series. Vol. 275: 275–287, 2004

[5] Patchiness of Risso's dolphin distribution may create difficulties in obtaining good abundance estimates; this is not related to the survey platform but is also a question of effort and design.

* Telemetry data (TDR, D-TAG) available for surfacing intervals from the Ligurian Sea.

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