Abundance of dolphins in the southern Egyptian Red Sea

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Abstract

Cetaceans in the Red Sea are poorly known and the lack of information on species presence and abundance is precluding assessments of population status. This work reports the first abundance estimates for delphinids in the southern Egyptian Red Sea based on vessel surveys. Three surveys were conducted in summers 2010, 2011 and 2012 using conventional distance sampling techniques covering a study area of 10,651 km^2. A total of 3,702 km were searched on transects (sea conditions Beaufort ≤ 5) resulting in 81 sightings of five species. The following abundance estimates and coefficient of variation were obtained for these species: *S. attenuata* 8,146 (0.26), *S. longirostris* 6,609 (0.24), *T. truncatus* 407 (0.36), *T. aduncus* 497 (0.49) and *G. griseus* 303 (0.34). Detection probabilities were estimated for groups of combined species due to limited sample sizes (*S. attenuata* + *S. longirostris*; *Tursiops* sp.; *Stenella* sp. + *G. griseus*) and as function of covariates likely influencing the detectability. The abundance estimations obtained are the essential first step in developing conservation measures for cetaceans in the area as recommended by the Regional Master Plan developed by the countries of the Red Sea region in 2002.

Introduction

Cetaceans in the Red Sea are still poorly known (Notarbartolo di Sciara *et. al.*, presented at this scientific committee) and dedicated monitoring studies of their presence, distribution and abundance have been carried out in limited number and localized areas across the basin (Alling 1986, Beadon 1991, Feingold 2006, Gladstone and Fisher 2000, Notarbartolo di Sciara *et al.* 2009, Preen 1989, Smeenk *et al.* 1996). Although the Red Sea could be considered as a still relatively pristine environment (PERSGA 1998), the increase in marine pollution (oil, solid waste, sewage) as well as the degradation of the coastal habitats from urban, tourism and industrial developments represent recognized threats for top predators such as cetaceans in particular in a semi-closed basin such the Red Sea (PERSGA 2002). Obtaining quantitative information about cetacean populations in the Red Sea was listed as a priority by the Regional Organization for the Conservation of the Environment of the Red Sea and Gulf of Aden (PERSGA) (PERSGA 2004) which in 2004 identified as main objectives (a) the need of an updated list of species present, (b) their broad distribution and (c) the best possible abundance estimation (PERSGA 2004).

To address these requirements the Red Sea Dolphin Project (RSDP) was initiated in 2010 focusing in the southern Egyptian Red Sea, an area where coastal developments still are at their early stages and that encompasses the waters of two existing protected areas: Wadi Gemal National Park and the Gabel-Elba Conservation Area. Here we report the first results from three seasons of vessel-based surveys. The present document is an extract from a chapter of the first author PhD thesis.

Material and Methods

The study area encompassed 10,651 km^2 of Egyptian waters in the Red Sea and was delimited by Marsa Alam city (25°05’ N, 34°53’ E) in the North and the border with Sudan to the South and, from West to East, by the Egyptian coast and a line running parallel to the coast at a distance ranging from 24 to 55 km (**Figure 1**). Surveys were carried out on board of different “Safari” boats with lengths ranging from 28 to 38m, observation height above the sea surface of 7m and average speed of 9knots (~17km/h). Three surveys were conducted in the summers of 2010, 2011 and 2012 using conventional distance sampling techniques (Buckland *et al.* 2001) and closing mode (Dawson *et al.* 2008) during sightings allowing for positive species identification and a precise estimation of group size.

Density for each species encountered on transect was estimated using the formula suggested by Buckland et al. (2001):

$$\widehat{D} = \frac{n\,\widehat{E}(cs)}{a\,\widehat{P}_a g(0)}$$

Where:

n = number of clusters encountered

$\widehat{E}(cs)$ = estimated cluster size

a = area covered by the survey
$\hat{P}_a$ = probability of detection
$g(0)$ = probability of detecting school on the trackline

$g(0)$ was considered unity as number of sightings from a second observation platform (Buckland and Turnock 1992) were not sufficient to estimate the correction factor. Estimates of abundance $(\widehat{N})$ were obtained by scaling the density estimates to the entire area (A) using $\widehat{N} = \widehat{D}A$.
In order to reach a sample size for robust use of the methods (Buckland et al. 2001), the detection probability $\hat{P}_a$ was obtained by pooling together species with similar characteristics such as body size, cluster size, behaviour at surface and association among species (Wade and Gerrodette 1992). Combined groups included: (a) *S. longirostris* and *S. attenuata*; (b) *Tursiops truncatus* and *T. aduncus*; (c) *Stenella* species and *Grampus griseus*. Sightings made outside the designed transects but during navigation with dedicated observer effort were also included in the estimation of the detection probability to increase sample size. Detectability was estimated using the Multiple Covariate Distance Sampling (MCDS) engine available in the software Distance version 6.1 (Thomas *et al.* 2006). MCDS allows modelling data heterogeneity, incorporating the covariates affecting the detectability (in this study: sea state and different survey vessels) in the detection function. The Akaike Information Criterion (AIC) (Akaike, 1973) was used to select the model with the best fit to the data. Effort considered for the analysis included sea state conditions of Beaufort≤5.

Results
A total of 119 days were spent at sea in the summers of 2010, 2011 and 2012. Three surveys were carried out over the 10,651 km^2 of the study area and a total of 3,702 km were navigated on designed transects (**Figure 1)**. A total of 81 sightings occurred on transect of which 77 included five species of dolphins: *S. longirostris*, *S. attenuata*, *T. truncatus*, *T. aduncus* and *G. griseus*; for the other four sightings, the species was not identified.

Distribution of the sightings for the five target species is shown in **Figures 2-5**. In summary:

- *S. longirostris* and *S. attenuata*: spinner and pantropical dolphins were encountered throughout the entire study area (**Figure 2**) with similar number of sightings obtained each year. Out of the 51 sightings of *Stenella* species, 15 (29%) sightings were of single species groups of *S. attenuata*, 16 (31%) of single species groups of *S. longirostris* and 20 (39%) of both species associated in the same schools.
- *T. truncatus*: the 10 sightings of common bottlenose dolphins occurred throughout most of the study area with an apparent concentration north of the Ras Banas peninsula (**Figure 3**).
- *T. aduncus*: only six sightings of Indo-Pacific bottlenose dolphins occurred in the study area. Sightings appear to be concentrated near the coast in the most southern

part of the study area (**Figure 4**). Small sample size limits further interpretation of these observations.

- *G. griseus*: all but one of the 10 sightings of Risso's dolphins occurred in the southern part of the study area, south of 23° N (**Figure 5**). Only one sighing occurred north of 23° N and included three individuals encountered together with seven individuals of *T. truncatus*.

Abundance: *Stenella* species were the most abundant species sighted with several thousands of individuals (Table 1). The other three species were an order of magnitude less abundant with abundance estimates of several hundreds of individuals.

Discussion

The main reason why this research was carried out was to provide baseline information about cetacean presence and abundance in the southern Egyptian Red Sea. This information is essential for the management of the protected areas included in the region and will contribute to the development of the regional strategy for cetacean conservation required by the Strategic Action Programme and implemented by PERSGA in 1998 (PERSGA 1998).

The results presented here set a reference point for future monitoring programmes of cetaceans in Egyptian waters as well as in other countries around the basin. Although set up in a logistically challenging environment, this study also demonstrated that vessel-based surveys and distance sampling methods could be used successfully to monitor cetacean populations as they were relatively cheap to organize respect European/American standards and could benefit of a well developed and efficient sector for leisure navigation.

The survey area monitored constituted only 12% of the Egyptian EEZ waters and 2% of the entire Red Sea basin. Thus, the vast majority of the Red Sea area remains unsurveyed and an extension of the survey effort is needed to assess the status of cetacean populations and threats to them in the entire basin and to develop adequate conservation strategies.

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M., Siddiqui S., Markula A., Maude J., Lambert R., Paynter I., Sanchez V., Szegedi A., Veneruso G., Walsh D., Weilermann D., Weller T., Warwick-Evans V., Ziltener A. Huge thanks are due to all the crews, video-operators, marine guides, volunteers and friends that, with their enthusiasm and experience, made this project possible and unforgettable.

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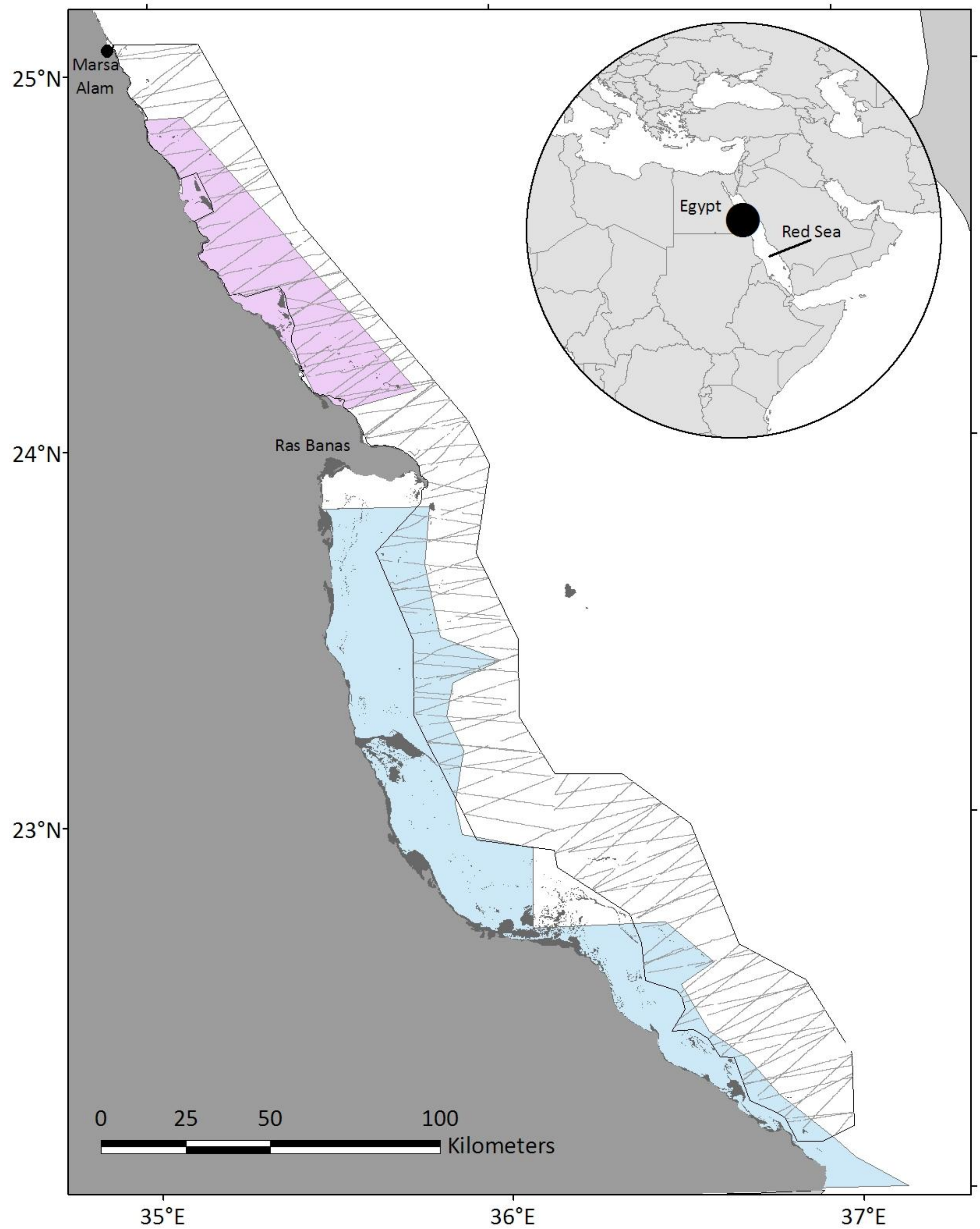

Figure 1 – Survey area (continuous line) in the southern Egyptian Red Sea with survey effort (grey lines) carried out in the summers of 2010, 2011 and 2012 with sea states of Beaufort ≤5. The colourful areas represent the marine portion of Wadi Gemal National Park (pink) and Gabel-Elba Conservation Area (azure). In the circular insertion, the black dot represents the location of the study area.

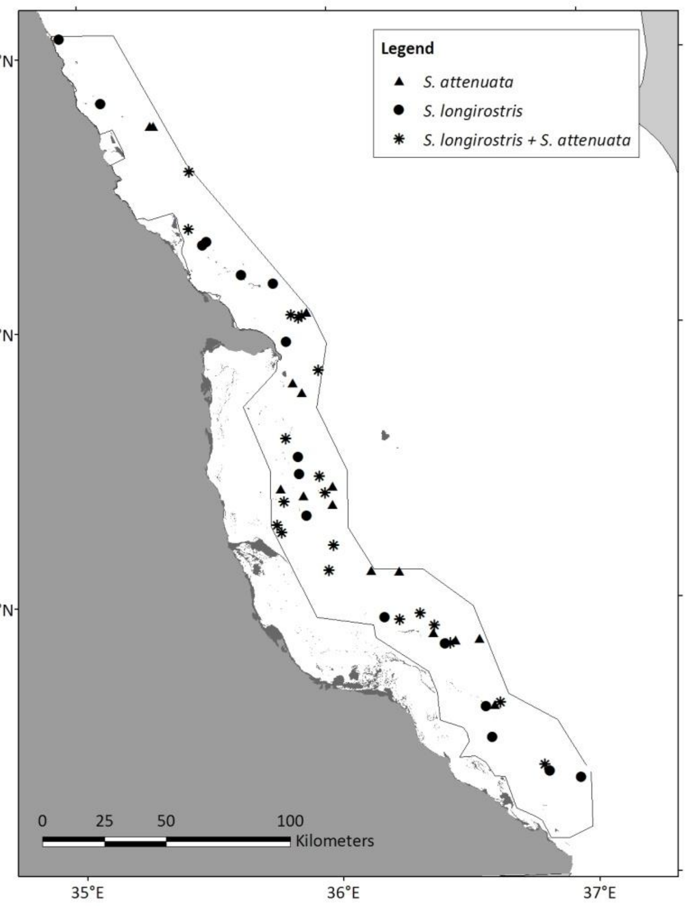

Figure 2 – Sightings of *S. attenuata* (black triangle), *S. longirostris* (black circle) and of the two species together (black asterisk) made on transects in the summers of 2010, 2011 and 2012 in sea states of Beaufort ≤5.

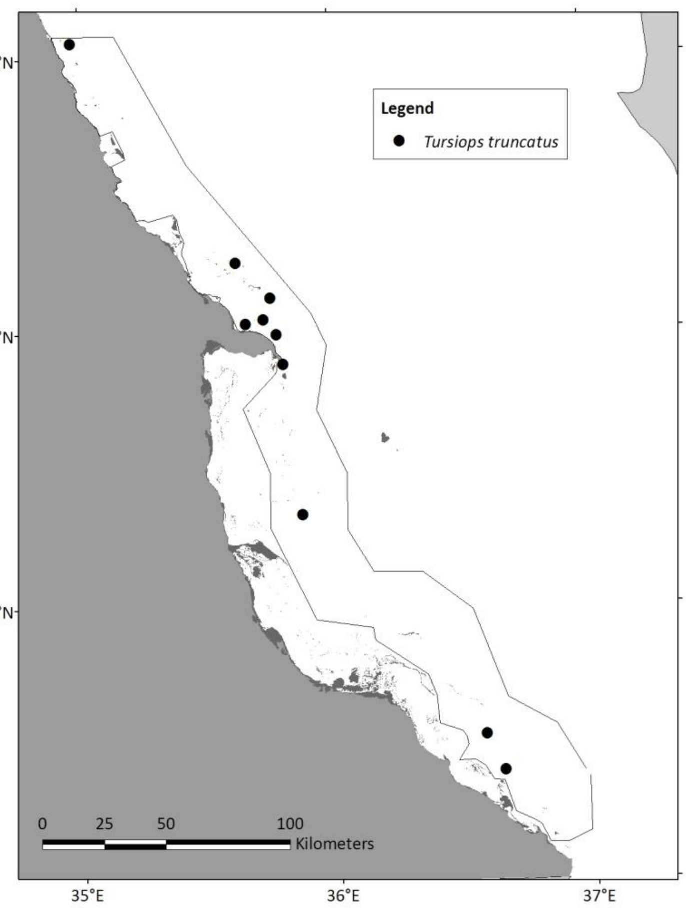

Figure 3 - Sightings of *Tursiops truncatus* (black circle) made on transects in the summers of 2010, 2011 and 2012 in sea states of Beaufort ≤5.

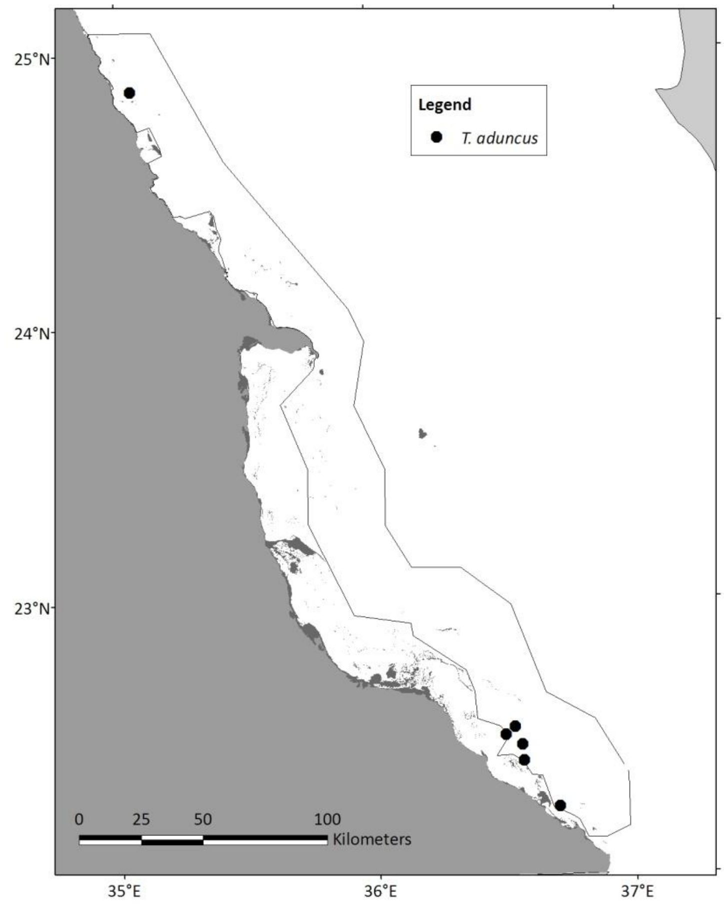

Figure 4 - Sightings of *Tursiops aduncus* (black octagon) made on transects in the summers of 2010, 2011 and 2012 in sea states of Beaufort ≤5.

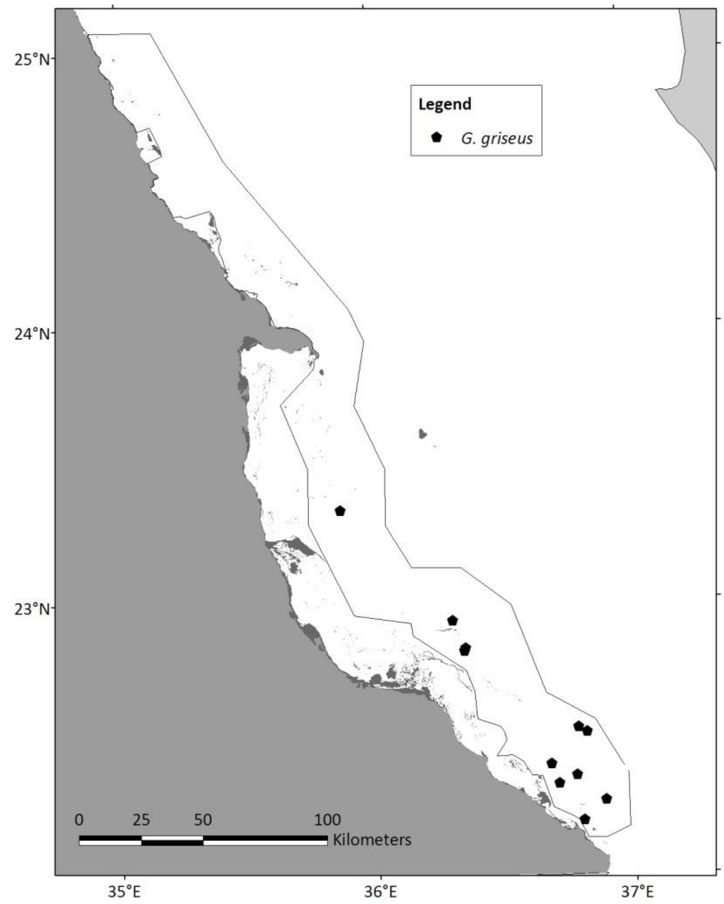

Figure 5 - Sightings of *Grampus griseus* (black pentagon) made on transects in the summers of 2010, 2011 and 2012 in sea states of Beaufort ≤5.

Table 1 - Estimates of density (dolphins per km^2) and abundance (N) for each species encountered on transects in the study area during the summers of 2010, 2011 and 2012. CV: coefficient of variation; 95% LCI/UCL: lower and upper 95% confidence intervals; $\hat{P}_a$ detection probability used. Sl: *S. longirostris*; Sa: *S. attenuata*; Tt: *T. truncatus*; Ta: *T. aduncus*; Gg: *G. griseus*.

Species	**D** ind/km^2	**N**	**CV(D/N)**	**95%**		$\hat{P}_a$
				LCI	**UCI**	
Sl	0.621	6,609	0.24	4,121	10,600	0.31
Sa	0.765	8,146	0.26	4,951	1,402	
Tt	0.038	407	0.36	203	816	0.23
Ta	0.047	497	0.49	199	1,238	
Gg	0.028	303	0.34	159	576	0.37