

Diversity and distribution of cetaceans off Mirissa in the southern coast of Sri Lanka I: Relationship with depth

E.P.D.N. Thilakarathne^{1*}, P.B.T. Pradeep Kumara and R.M.G.N. Thilakarathna

Department of Oceanography and Marine Geology, Faculty of Fisheries and Marine Sciences & Technology, University of Ruhuna, Matara, Sri Lanka.

*Corresponding author (E-mail: epdarshananuwan@yahoo.com)

Abstract

Dolphin and whale watching has become a blooming activity in the tourism industry in Sri Lanka. Proper scientific data is lacking for the understanding and management of dolphin and whale watching activities particularly in the Southern coast. Based from Mirissa, a shipboard survey was conducted for 43 days from January to May 2012 covering 940 km². The diversity and distribution of cetaceans inhabits in the continental shelf and slope were recorded from shipboard sighting data. Their species composition, pod size, behavioral pattern were observed and the distribution pattern was mapped.

Total of 8 species of cetaceans were recorded during the study period. They were spinner dolphin (*Stenella longirostris*), bottlenose dolphin (*Tursiops truncatus*), melon headed whale (*Peponocephala electra*), fin whale (*Balaenoptera physalus*), killer whale (*Orcinus orca*), short finned pilot whale (*Globicephala melas*), sperm whale (*Physeter macrocephalus*) and blue whale (*Balaenoptera musculus*). Distribution pattern and pod size varied with the species. Out of 6675 total sightings, 5382 were spinner dolphins and 843 were bottlenose dolphins. Depth levels showed a significant relationship with different cetacean species ($p < 0.05$). Spinner dolphins, bottlenose dolphins and melon headed whales were always observed near to the shore at relatively shallow areas around 100m depth contours. Fin whales, killer whales and short finned pilot whales were observed around 500 m to 650 m depth while sperm whales and blue whales were observed around 1000 m depth level located further away from the shoreline. Most of the dolphin groups were consisted with relatively large number of individuals about 160 while, most baleen whales were found solitary or small pods consisted with few individuals. Large toothed whales such as sperm whale pods were observed with intermediate number groups about 20 individuals. Those findings can be directly used to conserve and protect cetaceans and prepare a proper management plan to regulate whale watching industry.

Keywords: marine mammals; whale watching; dolphins; porpoises; southern Sri Lanka

Introduction

Due to their patchy distribution and low abundance, cetacean encounters at sea are very low but they remain charismatic species (Costa 1993). In the recent years, the whale sightings in Sri Lankan waters have attracted attention from both scientists and tourists. Point of Dondra, Kalpitiya and Tricomalee are popular sites for whale watching as these places have high sightings of whales and dolphins. With the rapid expansion of tourism, Mirissa has a growing demand for whale watching than other sites because blue whales (*Balaenoptera musculus*) (Vivekanandan and Jeyabaskaran 2012) can be very easily watched. Well-developed tourism infrastructural facilities overlapping of non monsoonal period with the tourism season, attract tourists to southern coastal areas of Sri Lanka. Many whale watching trips are daily organized during this period. However, most of these trips are non-scientific expeditions without proper regulations. Thus, this study was focused on the recording of the diversity and mapping the distribution of cetacean populations to provide baseline data to conserve cetacean populations and to develop a sustainable whale watching industry in the area.

Methodology

Mirissa harbour lies at 5° 56' 50" N and 80° 27' 04" E in Southern coast of Sri Lanka approximately 150 km away from capital city Colombo (Figure 1). The whale watching industry of southern province is mainly established at Mirissa targeting foreign tourists.

Data were collected during north east monsoon period for 43 days from January 2012 to May 2012 covering 940 Km² off Mirissa in the southern Sri Lanka during day light hours and favorable weather conditions.

The survey was conducted aboard a commercial whale watching boat constructed specially for whale watching by providing unobstructed 360 degree view. Six observers operated simultaneously keeping the eye level approximately 8 m above the sea level using binoculars (15 X 35) to observe water sprouts and fin flicks of cetaceans. Further, photographs and video clips captured were used to species identification and to estimate the number of individuals in each pod. The group sizes less than 100 individuals were accurate to ± 5 individuals, those of 100-200 individuals to about ± 10 individuals and those greater than 200 m to ± 20 individuals.

Once the cetaceans were detected, pod size and any associated species were recorded. The location data were recorded using a GPS (Garmin etrex) within 300 m circle of the identified individual or pod. Species were identified using Carwardine (2005).

Water depths for sighting were estimated from nautical charts published by National Aquatic Resource Research & Development Agency (NARA). Depths less than 300 m were accurate to ± 50 m, and those greater than 300 m to ± 200 m. All means are given with \pm standard deviation.

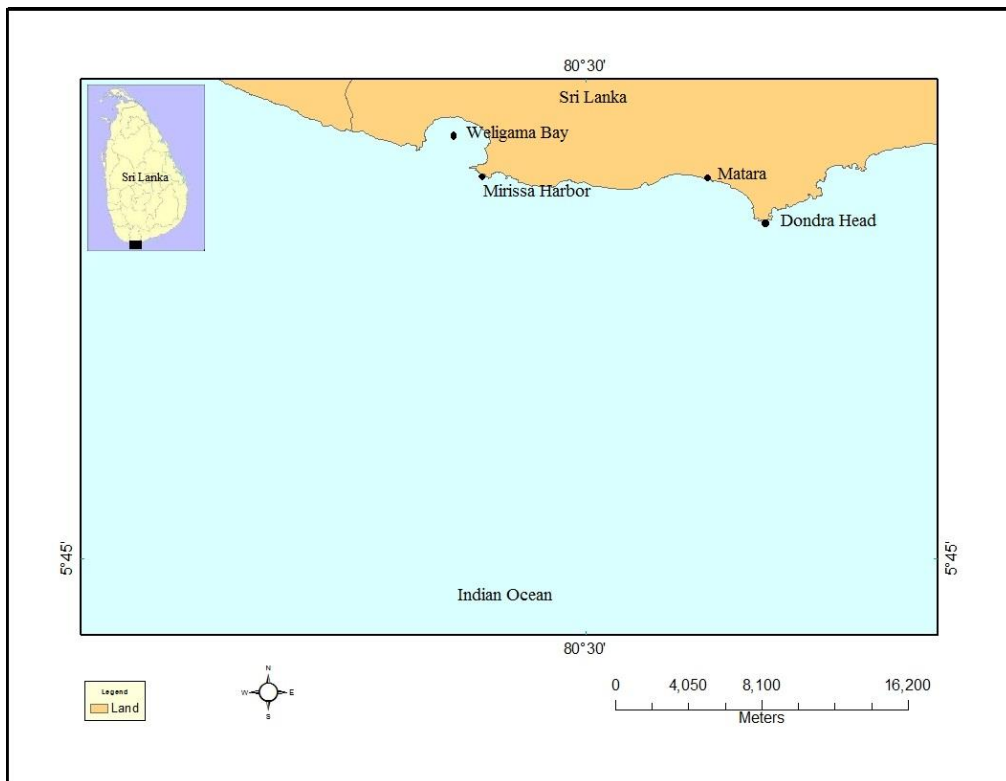


Figure 1. The study area off Mirissa in southern coast of Sri Lanka.

Arc GIS 10.1 software package was used to find out the relationship of the cetacean sighting to the water depth. The sighting data and depth measurements were converted into raster or vector maps (Aronoff 1989) as appropriate and analyzed.

Water depth data (mean, standard deviation and range) were recorded separately for each of the 6 most abundant cetacean species or species groups. To test whether species could be differentiated in relation to water depth, the species or species groups that had 10 or more sightings were analyzed using one way ANOVA (significance defined as $\alpha = 0.05$). Statistical analysis was carried out using SPSS software (SPSS v 16.0).

Results

During the present study, eight cetacean species or species categories were observed within the study area (Table 1). As largest baleen whales, 374 blue whale sightings and as largest toothed whales, 122 sperm whale sightings were recorded. Other toothed whales such as short-finned pilot whales and melon headed whales were also observed as groups with relatively small number of individuals. There were 6775 sightings of cetaceans during the study period. However, for *Orcinus orca*

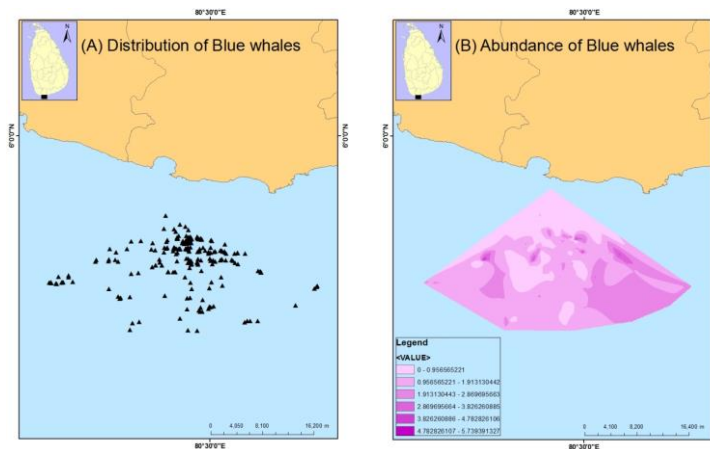
(killer whale) and *Balaenoptera physalus* (fin whale), there were less than ten sightings.

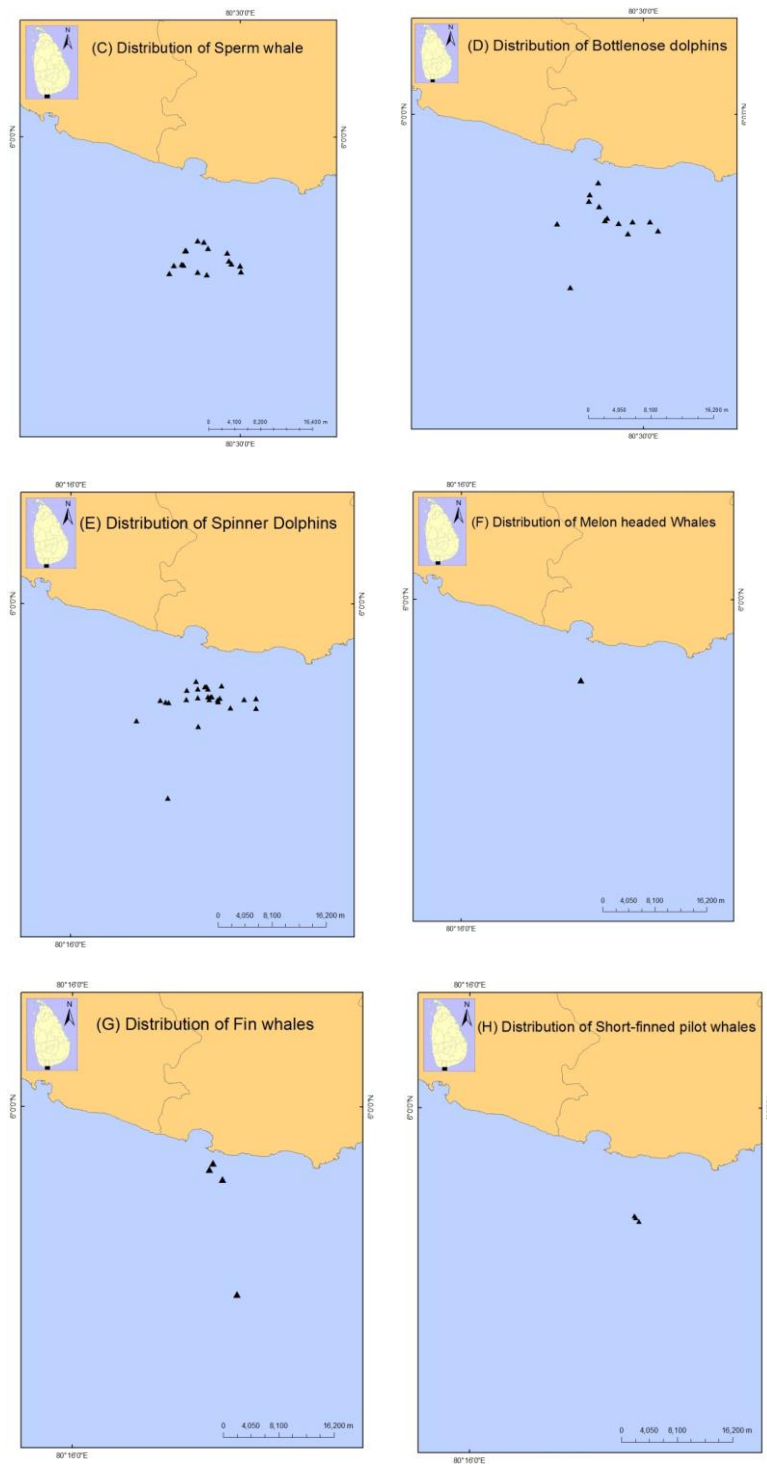
Table 1. Number of sightings of cetaceans during the study period.

Scientific Name	Common Name	No. of sightings	% Sighting	Probable number of Individuals
<i>Balaenoptera musculus</i>	Blue whale	374	5.52	30-40
<i>Physeter macrocephalus</i>	Sperm whale	122	1.80	70-80
<i>Globicephala melas</i>	Short finned pilot whale	24	0.35	24
<i>Balaenoptera physalus</i>	Fin whale	4	0.06	2-4
<i>Orcinus orca</i>	Killer whale	6	0.09	4
<i>Peponocephala electra</i>	Melon headed whale	20	0.30	20
<i>Tursiops truncatus</i>	Bottlenose dolphin	843	12.44	200-300
<i>Stenella longirostris</i>	Spinner dolphin	5382	79.44	1000-1500

Distribution patterns of cetaceans within the study area.

Distribution and abundance of blue whales in the study area are shown in Figures 2A and 2B. Distribution patterns of other cetacean species are indicated in Figures 2C to 2I.





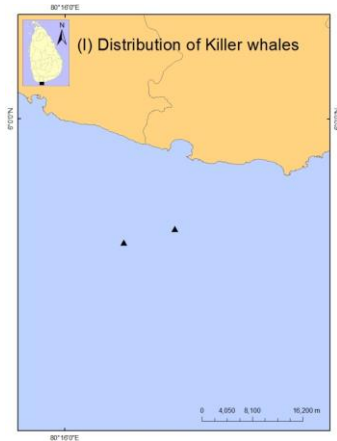


Figure 2. (A) Distribution and (B) abundance of Blue whales; Distribution of (C) Sperm whales, (D) Bottlenose dolphins, (E) Spinner dolphins, (F) Melon headed whales, (G) Fin whales, (H) Short-finned pilot whales and (I) Killer whales. Each point indicates an individual or a group.

Aggregation patterns of blue whales

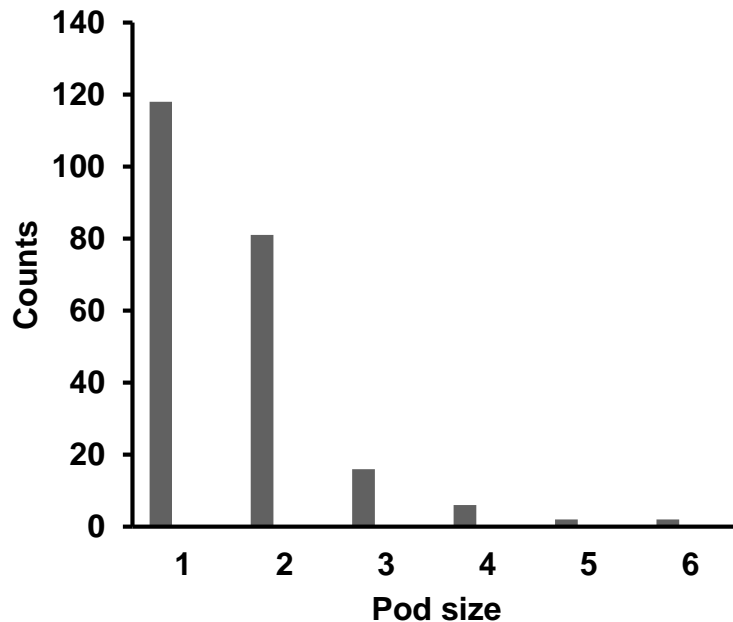


Figure 3. The differences of the aggregation pattern of Blue whales.

There were 374 blue whale sightings recorded in 227 occasions while 122 sperm whale sightings were recorded in 17 occasions. As shown in Figure 3, small

pod sizes could be frequently seen than larger pod sizes for blue whales. When they were aggregated as couples or small groups the rising up, spouting, surfacing and diving could be observed simultaneously. Because of aggregation as small or large groups, more than one cetacean sightings were recorded in the same locations. However, higher numbers of cetaceans of the Family Delphinidae were observed as large groups. Spinner dolphins and bottlenose dolphins were common in that area and of them, spinner dolphins were dominant. During the study period, 5382 of spinner dolphins were recorded in 26 occasions while 843 of bottlenose dolphins were observed in 13 occasions.

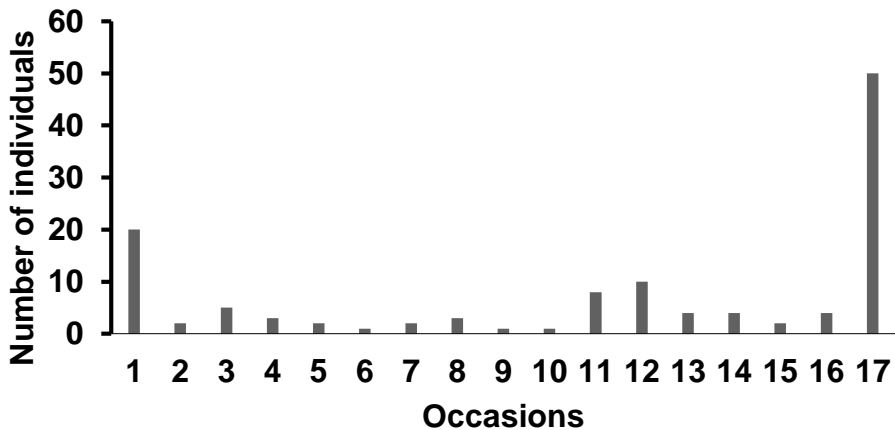


Figure 4. Number of individuals of sperm whales sighted in each occasion

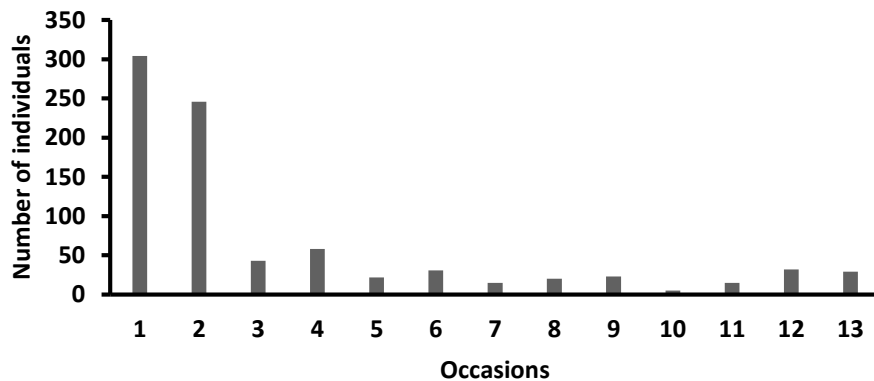


Figure 5. Number of individuals of Bottlenose dolphin sighted in each occasion

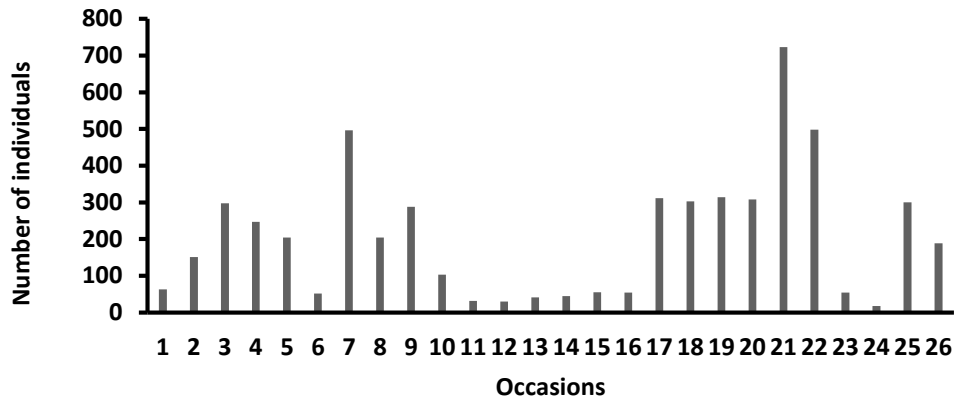


Figure 6. Number of individuals of Spinner dolphin sighted in each occasion

Depth variation

When the occurrence of cetaceans is related to bathymetric data, it can be seen that small toothed whales such as dolphins occur in shallow depth range. In contrast, large baleen whales and toothed whales occur in much deeper areas.

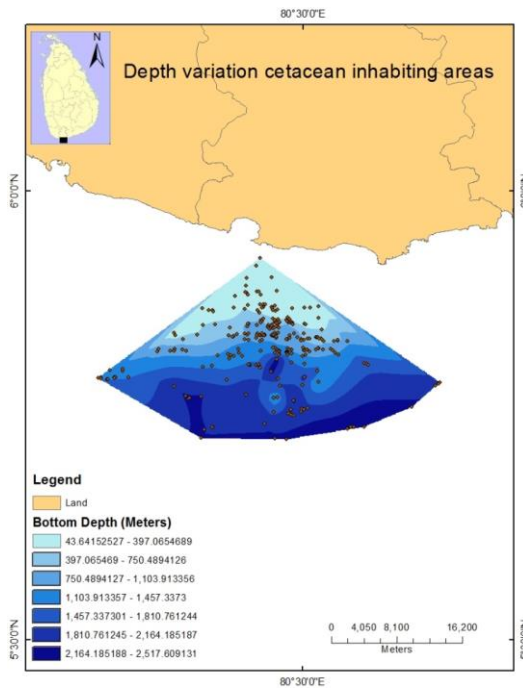


Figure 7. Depth of the sea in the study area.

The box plots (Figure 8) illustrate sightings of different species/species groups in relation to depth.

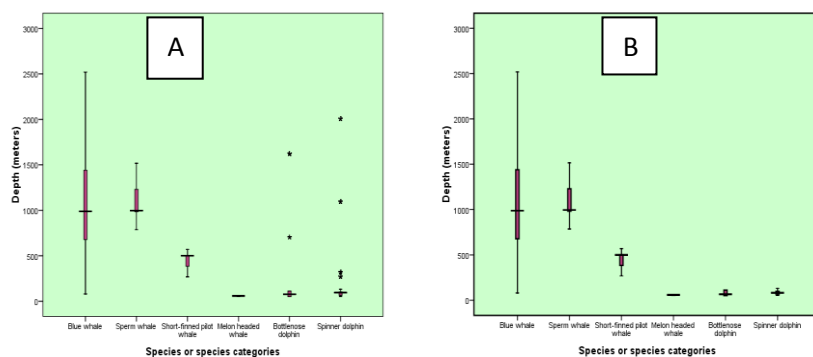


Figure 8. (A): Box plots of the bottom depth and (B): Box plots of the bottom depth after removing outliers, associated with the sightings of the 6 cetacean species. The mid-line is the median, the box encompasses the interquartile range, and the vertical lines are $1.5 \times$ the interquartile range. Outlier points are shown individually as horizontal bars.

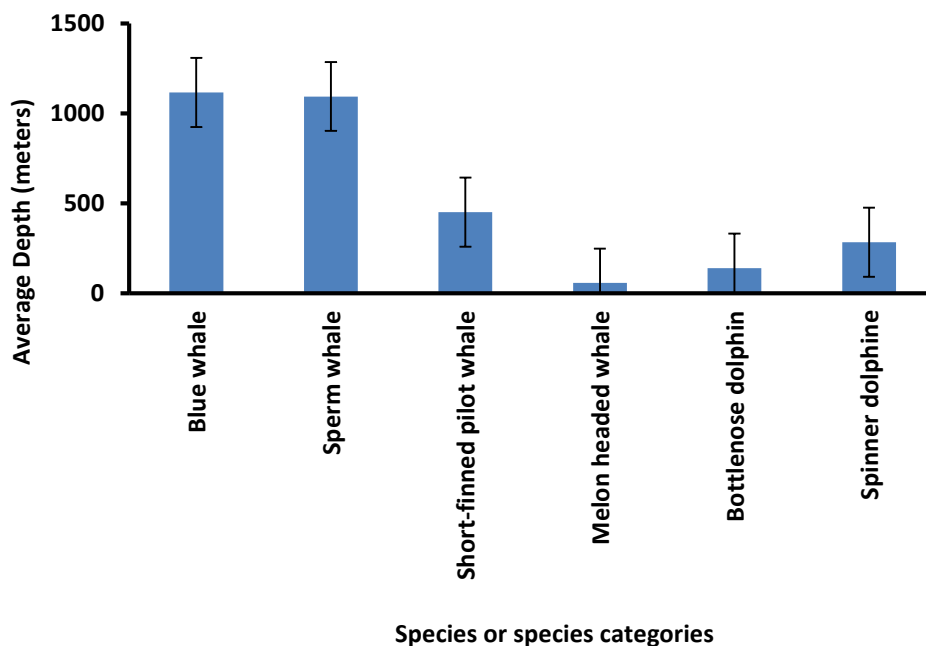


Figure 9. Mean depths of the areas where different cetacean species were present. Error bars are \pm SD.

After removing outliers following box plots for each parameter were taken for different cetacean species or species categories (Figure 9). There was a

significance difference ($p < 0.05$) among species or species categories with regard to bottom depth. However there were no significance relationships ($p > 0.05$) among sperm whales and blue whales and among melon headed whales, bottlenose dolphins and spinner dolphins.

Discussion

Spinner dolphins, bottlenose dolphins and melon headed whales were observed at relatively shallow areas near to the shore at about 100 m depth contours while fin whales, killer whales and short finned pilot whales were sighted at relatively intermediate depth levels (500 m to 650 m) far from the shoreline. Sperm whales and blue whales were observed at relatively deep sea areas with the depth of around 1000 m, farther away from the shoreline. Similar results have been obtained for blue whales by Davis *et al.* (1998) from a survey done for the cetacean along continental slope in the north central and western Gulf of Mexico.

Generally dolphins inhabit in relatively shallow areas about 100 m depth due to the high productivity of those areas (de Vos *et al.* 2012). Fishermen always use the path of dolphins to find yellowfin tuna. Therefore they can die due to entangling or attacking different fishing gears of fishermen (Chilvers and Corkeron 2001).

Spinner dolphins are relatively smaller than bottlenose dolphins and were observed at average depth of about 283 m. They were observed very rarely in areas deeper than 1000 m and were occasionally observed at very shallow areas where depth is below 60 m. The depth range where bottlenose dolphins and spinner dolphins is similar.

During the study period majority of blue whales (52.4%) were observed as individuals and 47.3% were observed as couples or small groups. The small groups often consisted of 3 individuals; but rarely groups of 4-5 could be observed. They are known to aggregate as couples or small groups and spend more times for their courtship behaviour during mating times. Occasionally sperm whales aggregate as small groups ranging from 3 to 20 individuals.

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