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Occurrence and species diversity of delphinids off-Lagos shore, Nigeria

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ABSTRACT

Little has been documented about delphinid communities in the Nigerian coastal waters. This paper gives baseline information about the delphinid community sighted off-shore Lagos, Nigeria. A dedicated survey of the living resources of Nigerian coastal waters (6°08'N and $2^0$42'W to 6^o 13'N and 3^o 27'W) took place from the Nigeria/Benin boarder along Badagry area to the western part of Ondo State between 17th march and 6th June 2009 and included systematic visual searching of marine mammals. A total effective effort of 264 hours was logged. The boat moved along designated transect lines at a cruising speed of 9.2 km/h. Sighting rate for delphinids was obtained by processing visual data obtained at Beaufort wind scale of 2.5 to 4 nautical miles in visibility, using Distance 2.2 software. Species were identified through Photo-identification method. Fifteen (15) schools of 746 individual's sightings were made. Four (4) schools of 25 individuals representing 3% of total sightings were classified as "Unidentified", while 11 schools of 721 individuals (97%) were identified and classified into five (5) species. The pantropical spotted dolphin (*Stenella attenuate)* with two (2) schools of 150 individuals, (*Stenella frontalis)* with one (1) school of 54 individuals, bottlenose dolphin (*Tursiops trucantus)* with one (1) school of 32 individuals, Common dolphin (*Delphinus delphis*) with four (4) schools of 452 individuals and (3) schools of Atlantic hump-backed dolphin (*Sousa teuszii)* of 32 individuals. Sighting rate of 5.7 x 10^{-2} school/hr was estimated for schools while the sighting rate for individuals was estimated at 2.83 individual/hr. The results suggested that the Lagos coast is rich in delphinid biodiversity, which needs to be quantified more accurately during further research.

Keywords: Sightings, Oceanic dolphins, abundance, species richness, behaviour, Nigeria.

INTRODUCTION

Delphinids (ocean dolphins) are medium sized Cetaceans species that are migratory. They are generally fast, streamlined animals, and have cone-shaped teeth and range in size from about five to about thirty feet in length (Williams et al., 2012). Delphinids have a wide range of habitat, from coastal to pelagic areas (Peter et al., 2013). Ocean dolphins are long-lived, highly mobile animals, sensitive to anthropogenic stressors. They are considered as a good indicator-species, serving as an important barometer of the health of the ecosystem (Caroline et al., 2011). They have a long history of association with humans in coastal waters since the Greeks and are easily recognizable (Elwen et al., 2011). Their cosmopolitan distribution and frequent presence in coastal areas allows them to be the better-studied cetaceans in the world (Weir, 2011). They occur in a variety of

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habitats from inshore, coastal, shelf to pelagic oceanic waters, exhibiting a mixture of degrees of residence that range from transient to year-round residency (Hyot, 2011). However, the environmental plasticity of the delphinids leads to a range of intra-specific variations in site fidelity, individual and group movements, group composition, and behaviour patterns that make worldwide generalizations difficult (Marijke, 2010). Ecological features related to habitat type that influence food resources, such as sea surface temperature, depth, slope, seabed aspect and productivity are some of the factors influencing distribution of delphinids around the world (Stensland et al., 2007).

The social structure of delphinids is a dynamic unit, continually changing in size and membership, with some individuals maintaining long-term associations with each other and others more fluid within the group, in a fusion-fission style (Carreta et al., 2007). Group size of these units commonly ranges between 2 and 15 individuals in coastal areas but groups of hundreds or thousands do occur in offshore waters (Ballow et al., 2003). Environmental factors related to food resources, social factors, including mating, and strengthening bonds influence group size of delphinids (Appler et al., 2004). Behavioural patterns of common ocean dolphins, such as travelling, foraging/feeding, socializing and resting respond to a complex array of temporal, environmental and social factors, such as time of day, season, tides, depth, group size and group composition (Ballance, 1992).

The development and over-exploitation of coastal regions have resulted in significant environmental degradation of marine habitats of cetaceans (Hammond et al., 2008). Due to its coastal habitats, close to human activity, delphinids are vulnerable to various threats such as by-catch, direct hunting, habitat degradation, acoustic and chemical pollution, marine debris, physical habitat destruction and tourism (Hooker & Gerber, 2004). Several populations around the world risk a decline or outright extinction (Bearzi et al., 2009).

In Nigeria, little is known about the population trends of delphinids, although incidental catch, hunting, habitat degradation, and oil exploration may be threats to the occurrence of these marine mammals. However, few studies carried out in the gulf of Guinea have established that the region has a diverse cetacean fauna, which includes at least 28 known species (Van Waerebeek et al., 2009; Weir, 2010). Despite this richness, these areas are poorly studied and historical information about cetaceans in the region comes from whaling activity that dates back to the 19th century when humpback whales and other baleen whales were hunted (Carvalho et al., 2011). Recent scientific research has been undertaken almost exclusively on humpback whale (Carvalho et al., 2011) and information about small cetacean species is still very sparse (Picanço et al., 2001; Weir, 2011). São Tomé and Príncipe archipelago seems to be an important marine area for small cetaceans probably due to prey abundance and the existence of shallow and protected bays (Picanço et al., 2009a). Other small cetaceans of priority such as the bottlenose dolphin and pantropical spotted dolphin seem to have year round occurrence (Picanço et al., 2009b). However, there is paucity of information about the status of cetaceans in the gulf of guinea (Reynolds et al., 2009).

The main priorities in developing countries are economic development and the feeding of growing human populations. This is also true for Nigeria with a fast population growth, and limited industrial and infrastructural development. Growing demands for fish, urbanisation and anthropogenic activities along the coastal areas have resulted in depletion of some

types of resources in many areas (Debrah et al., 2010) and environmental considerations often have low priority. There is a critical need to investigate the status of dolphin populations and the factors that threaten them in the West African region (IWC, 2010). Information on cetacean distribution plays an important role in the identification of suitable boundaries for marine protected areas, but is also crucial for developing management and monitoring programmes (Van Waerebeek et al., 2009).

Information about delphinid populations in Nigeria is relatively scarce, despite ongoing research work in neighbouring countries like Benin, Ghana, Côte d'Ivoire and Cameroun. The lack of estimates for some of these species does not indicate that they are not present; rather it indicates the lack of sufficient or systematic studies that can yield data suitable for generating occurrence, biodiversity and abundance. This paper is principally to address this shortfall.

The main objective of this study is to identify the various species of delphinid that occur in Nigeria waters and suggest appropriate scientific approaches for adaptive management. The results of the research work are relevant to the development and subsequent implementation of local management policies/conservation initiatives for the protection of these and other coastal cetacean species in Nigeria.

MATERIALS AND METHODS

Study Area

The study covers an area of 182.2 Km from the Nigeria/Benin boarder to the western part of Ondo State, offshore Lagos (6°08' N $2^0$42'W to and 6^o 13'N and 3^o 27'W) (Figure 1).

Methodology

The survey covered an area of 185.2 km from the Nigeria/Benin boarder to the western part of Ondo State, Nigeria on board a commercial fishing vessel- F.T. Susainah (LOA 25, capacity 540 Hp). Eleven transects were sampled with seven stations on each transect line. Each transect line was 10 nautical miles (18.52 km) apart and the total distance between the first and the last transect was 100 nautical miles (185.20 km) (Figure1). Handheld Global Positioning System (GPS) receivers were used to record the position of animals sighted and the tracks of the research vessels while in the study area. During the surveys, the research vessel followed the predetermined track lines at 9.2 km/hr. Scientists searched the sea surface for cetaceans from the upper deck of the vessel (height of around 6 m from the sea surface). The search was with naked eyes and sometimes with the aid of binoculars. When cetaceans were sighted, the vessel approached the animals in order to identify species, count school size, observe surface behavior, and take photographs for identification of species or individual. Photographs were taken at the maximum of individuals possible and its dorsal fins for individual recognition and confirmation of group size and group composition, with digital cameras equipped with 75–300 mm zoom lenses. Surveys took place in sea states of Beaufort wind scale of 2.5 to 4 nautical miles in visibility to capture all cetaceans present at the surface, within a 500 m wide swath (250 m on either side of the vessel). However, any cetaceans not at the surface would likely go unaccounted. While this bias will have relatively little impact on observations of surface-dwelling cetaceans, it is likely to lead to an under-recording of deep and long diving species. Species identification was through Photo-identification method, which is the utilization of computer-assisted matching software for

the identification of known species (Morten, 2000). The species and school size for each encounter as well as the number of schools and individuals was recorded. Classification of schools was based on numbers per group; small (< 30), medium (31-60) and large (> 60). In order to have a value of occurrence of dolphins relative to the sampling effort (hours), a number of sightings per unit of effort (SPUE), expressed as the number of sightings per hour of search effort at sea was calculated. Time (hours) was the unit of effort rather than distance.

Delphinid diversity was determined with the Shannon-Weaver index (Frontier & Viale, 1995), by using all on-effort sightings: **H = - Σ (Nk/Nt) Log2 (Nk/Nt)** where, **Nk** is the number of observed individuals belonging to species **k** and **Nt** is the total number of observed delphinids.

Statistical analysis

Information from the Biota on record of Sighting forms were subjected to descriptive Analysis, correlation and Analysis of variance (ANOVA) at p=0.05.

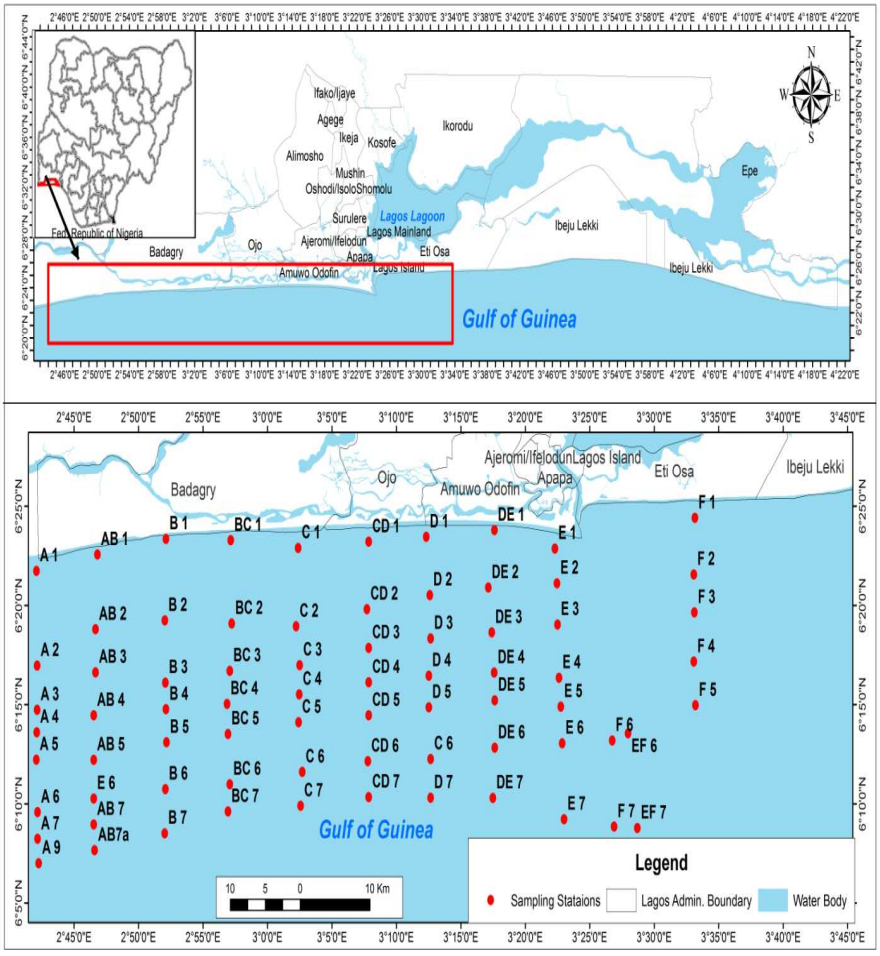

Figure 1: Map of study area.

RESULTS

Surveys took place during 22 non-consecutive days over 4 months, with observers present on-board FT-Susainah fishing vessels during17th march to 6 June 2009. Two hundred and sixty-four (264) observer-hours at sea were logged. Delphinid sighting survey recorded five identified species of 11 schools with 721 individuals and 4 schools of un-identified species with 25 individuals. Four (4) schools of Common dolphin (*Delphinus delphis)* of 452 individuals were sighted representing more than half of total sighting. Pantropical spotted dolphin (*Stenella attenuate)* was sighted in one (1) school of 150 individuals, Atlantic spotted dolphin (*Stenella frontalis)* was sighted in one (1) school with 54 animals, Bottlenose dolphins (*Tursiops trucantus)* was sighted only in one (1) school with 33 animals, and Atlantic hump-backed dolphins *(Sousa teuszi)* with 33 individuals from three schools (Table 1). *Delphinus delphis*, represents the largest freqency of the sighted species with 54%, followed by *Stenella attenuata* comes with 29%. *Stenella frontalis* with 6% comes third, followed by *Tursiops trucantus* and *Sousa teuszi* with 4% frequency each. Four (4) schools of 25 individuals representing 3% of total sightings were classified as "Unidentified". *Sousa teuszi* were sighted in small schools with less than thirty animals, *Tursiops trucantus* and *Stenella frontalis* were sighted in medium sized schools of between 31 to 60 animals while *Stenella attenuata* and *Delphinus delphis* occurred in large schools with more than sixty animals per group.

Sighting per unit effort (SPUE) value of 5.7×10^{-2} school/hr was estimated for schools while 2.83 ind/hr was estimated for individuals (Table1). Diversity Index was 3.36 (Table 2). The sighting survey could not covered the entire study zone because insecurity occasioned by the Niger-delta militia.

Behavioural data collected for sightings showed that the reaction of the animals to the observation vessel varied from no response to interaction. Predominant types of boat-related behaviours were approaching (46%), bowriding (21%), and scouting (20%) and no response (13%). Data suggested that there was no association between observed behavioural categories and school size ($\chi^2 = 5.04$, df = 10, p = 0.05).

Table 1: Delphinids species and sighting per unit effort (SPUE).

Common Names	Scientific names	School	individuals	School/hr	ind./hr
Bottlenose dolphin	*Trusiops truncatus*	1		0.0038	0.1212
Atlantic spotted dolphin	*Stenella frontalis*	1		0.0038	0.2045
Pantropical spotted dolphin	*Stenella attenuata*	2	150	0.0076	0.5682
Atlantic hump-backed dolphin	*Sousa teuszi*	3	33	0.0114	0.125
Common dolphins	*Delphinus delphis*	4	452	0.0152	1.712
Un-identified spp.		4	25	0.0152	0.0947
Total		**15**	**746**	**0.0568**	**2.826**

Table 2: Diversity index of dephinids sighted.

Species	NK	Nt	Nk/Nt	log2(Nk/Nt)	(Nk/Nt)log2(Nk/Nt)
Trusiops truncatus	32	746	0.04	-4.64	1.86
Stenella frontalis	54	746	0.07	-3.84	0.27
Stenella attenuata	150	746	0.20	-2.32	0.46
Sousa teuszi	33	746	0.04	-4.64	0.19
Delphinus delphis	452	746	0.61	-0.71	0.43
Un-identified spp	25	746	0.03	-5.06	0.15
Total	746		1.00	-21.22	3.36

Nk is the number of observed individuals belonging to species k
Nt is the total number of observed delphinids.
H = - Σ (Nk/Nt) Log2 (Nk/Nt) is the diversity index

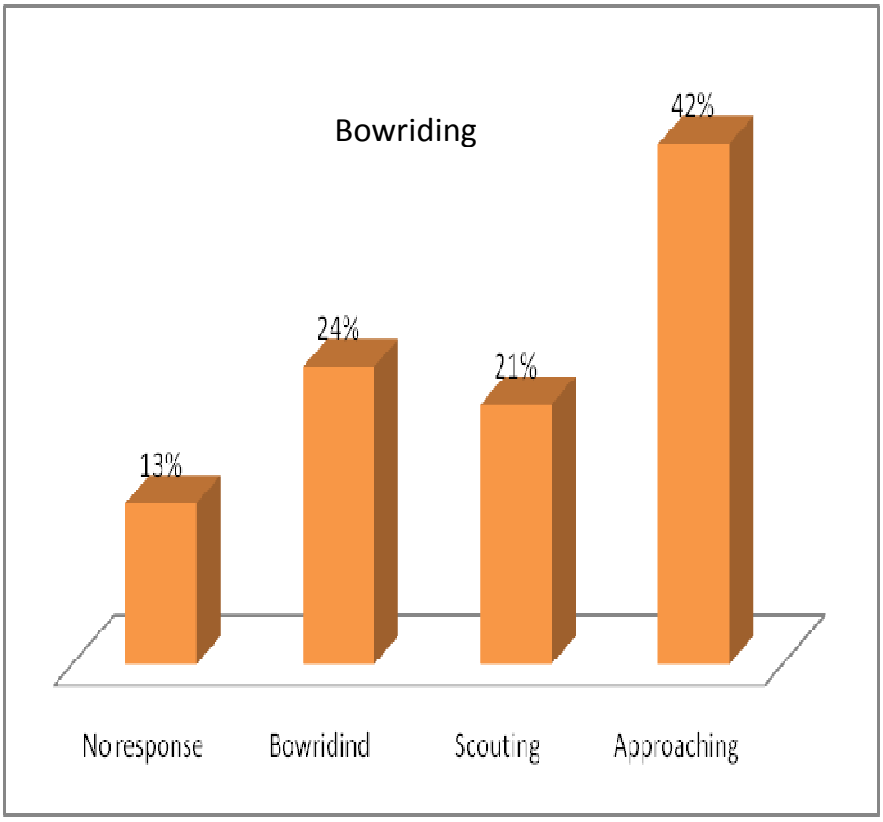

Figure 2: Behavioural response of delphinids to survey vessel.

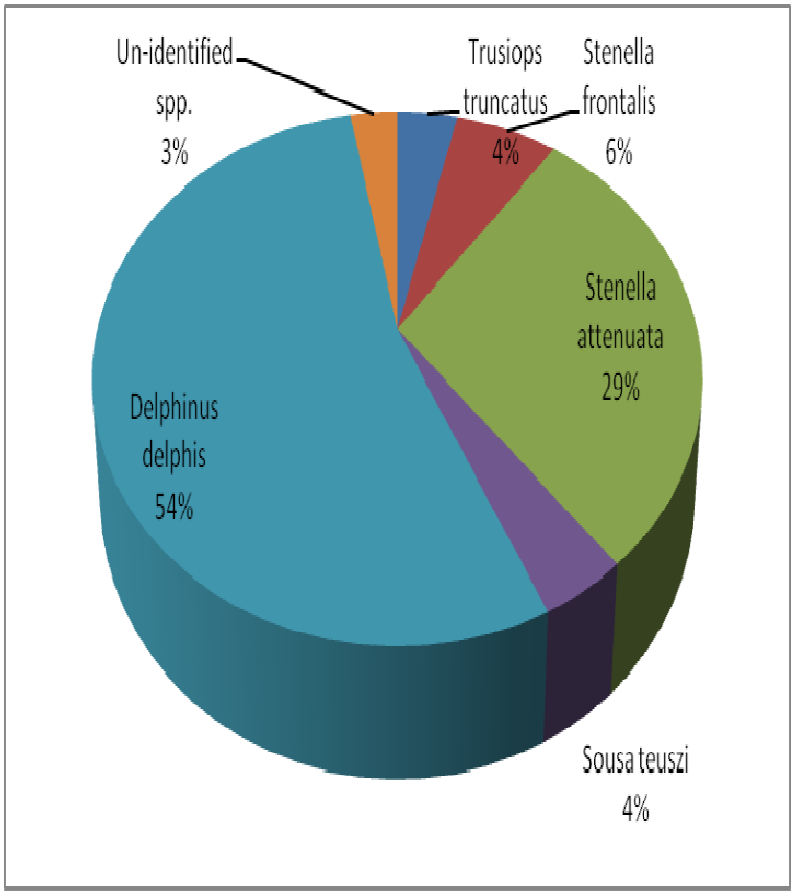

Figure 3: Sighting frequencies of identified and Un-identified delphinid species.

DISCUSSION

Studies of marine mammal distribution in dedicated surveys are time consuming and expensive. An alternative is to use opportunistically collected sightings data from observers placed on ferries or fishing boats so that other activities could be ongoing concurrently as it was in this study. Clearly, this tends to result in imperfect survey designs, with non-random distribution of survey effort, so that variation in survey effort must be taken into account in the model-building process. In addition, when fishery observers collect data, the efficiency of detection of marine mammals is inevitably reduced (especially when the catch is being sampled). Nevertheless, data obtained are potentially informative in the absence of data from sophisticated dedicated survey. There are few published studies about marine mammal distribution in Nigeria waters. This study bridges some of the gap of knowledge in Nigeria by assessing the status of ocean dolphins in the Lagos coast by studying their species composition, behaviour, relative abundance and social structure.

In spite of a modest survey effort, five species of the delphinidae family were identified in comparison to four species recorded off- Akwa Ibom coast by Olakunle et al. (2014). However, this is less than the number of species recorded by studies carried out in the coastal waters of neighbour countries like Benin, Togo, Ghana Côte d'Ivoire, (Ofori-Danson et al., 2003; Samba et al., 2013) and Saotome & Principe (Pereira, 2012). The short duration of the survey (22 days) might be responsible for the number of species encountered. Both diversity and individual sighting rate appear to be quite

moderate. This result is in agreement with the anecdotal information from fisherfolks reported by Solarin et al. (2010).

Behavioural patterns of delphinids in response to the survey vessel showed that the most observed activities were approaching, bowriding and scouting. The high values of response could be explained as reaction to short term disturbance, which can become more serious long-term impact, like the abandonment of important habitat, habituation to detrimental behaviour, or physiological conditions such as nutritional stress or reduced reproductive success. In time, the viability of the whole population can be at risk (Constantine et al., 2004). The group of dolphins sighted demonstrated low to moderate association values, with an average of 50 ind/school. Factors that influence association pattern are the age and sex of the individuals. Schooling aggregation behaviours observed suggest synchronous behaviours and 'tight' groupings during travelling, tactile contact as an important aspect of social interactions, and cooperative behaviour during play as also observed by (Steckener et al., 2012).

The dominance of *delphinus delphis* can be attributed to the abundance of small schooling fish as well as squid and crustaceans in the surveyed area as reflected in the catch composition of fish samples from the survey. However, there have been no detailed studies of stomach contents analysis studies to establish this supposition, but previous studies by Ohizumi et al. (1998) corroborates this supposition.

Understanding the behaviour and ecology delphinids in this area is essential to developing management and conservation strategies. This study represents a baseline assessment of delphinids in the Lagos coast, demonstrating the presence of these animals in Nigerian waters. Most sightings occurred in some of the most intense fisheries areas and other areas associated to boat traffic. Incidental entanglement and/or deliberate catch, disturbance, boat-strikes and alteration or loss of critical areas could pose a threat, which could lead to a downward tendency in delphinids abundance, especially the resident species. Further research along this line is imperative. Identification and subsequent protection of habitats and critical areas are ways of ensuring a sufficient amount of space, shelter and food for these marine mammals.

Conclusion

The result obtained might not completely capture all the species, possibly due to the short survey period (22 days). Notwithstanding, these preliminary results also corroborate a trend of delphinid occurrence and distribution along the gulf of Guinea. The result shows that Nigerian waters shelter an abundant and diverse population of dephinids. Therefore, additional surveys are required to provide an accurate knowledge of each species status to promote long term monitoring for the conservation of the delphinid populations.

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