

# The Occurrence and Distribution of Dolphins in Zanzibar, Tanzania, with Comments on the Differences Between Two Species of *Tursiops*

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**Abstract**—Incidental catches (bycatch) in gillnet fisheries off Zanzibar (Unguja Island), as a source of mortality among several species of dolphins, were reported in a questionnaire survey conducted in 1999. As a follow-up to that survey, from January 2000 to August 2003, we monitored the incidental catches of dolphins collected from 12 fish landing sites. Six species of dolphins were recorded from 143 specimens retrieved from bycatches in drift- and bottom set gillnets. Of these, 68 (48%) were Indo-Pacific bottlenose dolphins (*Tursiops aduncus*), 44 (31%) spinner dolphins (*Stenella longirostris*), 12 (8%) Risso's dolphins (*Grampus griseus*), 11 (8%) Indo-Pacific humpback dolphins (*Sousa chinensis*), 6 (4%) Pan-tropical spotted dolphins (*Stenella attenuata*) and 2 (1%) common bottlenose dolphins (*Tursiops truncatus*). Most of the bycatches (71%) were in nets set off the north coast of Unguja Island. In this paper, bycatch records are examined to describe the occurrence and distribution of dolphin species in Unguja Island coastal waters. The relatively large numbers of bycatch dolphins recorded indicate that bycatch may be a potential threat to local populations that need to be addressed in future conservation and management efforts in the region.

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## INTRODUCTION

Several cetacean species have been reported to occur in East Africa, although little information is available regarding the distribution and abundance of the species present in the area (Borobia, 1997). In particular, few surveys on the occurrence and distribution of cetaceans have been conducted in the coastal waters of Zanzibar (Unguja and Pemba Islands) and Tanzania. However, information from incidental catch (bycatch) in fisheries and sightings indicate that Indo-Pacific bottlenose (*Tursiops aduncus*), humpback (*Sousa chinensis*) and spinner dolphins (*Stenella longirostris*) are the most common species encountered in coastal waters

round Zanzibar (Ortland, 1997; Todesco, 1997; Stensland *et al.*, 1998; Amir *et al.*, 2002). Another dolphin species that has been reported in Tanzania and Zanzibar is the rough-toothed dolphin (*Steno bredanensis*) (Berggren *et al.*, 2001). The occurrences of dolphins have also been noted in the Rufiji Delta, Saadani, around Latham Island, Tanga (northern Tanzania) and Mtwara (south Tanzania) (Linden and Lundin, 1995), although without any reference to species. This lack of information on the distribution and abundance is significant, as Tanzania is located within the Indian Ocean Sanctuary established by the International Whaling Commission (IWC) to encourage conservation and research of cetaceans in the region (IWC, 1980).

Most of the research efforts conducted round Unguja Island have focused on Indo-Pacific bottlenose dolphins in Menai Bay. This include studies of the dolphin tourism and its impact on dolphin behaviour (Depres, 1998; Koch, 1998; Englund, 2001), dolphin tourism and community participation (Dudon and Keycroft, 1999; Logiuduce, 2000; Amir and Jiddawi, 2001) and boat based surveys to investigate the distribution, abundance and behaviour of Indo-Pacific bottlenose and humpback dolphins in Menai Bay (Särnblad, 2001; Stensland, 2002, 2004). The only previous attempt to investigate the occurrence and distribution of marine mammals around Zanzibar was an aerial survey conducted in March 2000, which covered the Zanzibar channel and coastal waters of Unguja Island, within 10 nautical miles of the coast (Berggren *et al.*, 2001). Five species of dolphins (Indo-Pacific bottlenose, Indo-Pacific humpback, Risso's, rough-toothed and spinner dolphin) were recorded.

The Scientific Committee of the IWC has acknowledged the urgent need for information on the status of cetaceans in eastern Africa (Anon, 1998). The United Nation Environment Programme (UNEP) has also expressed the need to improve our understanding of the distribution, abundance and ecology of small cetaceans in Africa (Borobia, 1997).

In this study we have used records of landed bycatch dolphins from 12 fish landing sites round Unguja Island to investigate the occurrence and distribution of dolphins around Zanzibar.

## MATERIALS AND METHODS

### Study Area

The study was conducted on Unguja Island between January 2000 and August 2003. Unguja Island is located at 06° South and 39° East about 40 miles off the central coast of mainland Tanzania and is often referred to as Zanzibar although the latter also includes Pemba Island (Fig. 1). The study area was divided into five regions according to the distribution of fishing effort: region 1 (Mwana wa Mwana, Uso wa Membe and

Bumbwini Mnarani), region 2 (Nungwi and Mnemba Is.), region 3 (Kwale Is., Pungume Is. and reef Kobela), region 4 (Pongwe, Uroa and Michamvi) and region 5 (Changuu Is. and Bawi Is). The study area also included the coasts of Tanga and Bagamoyo on mainland Tanzania (Fig. 1).

### Sample Collection

In January 2000, a programme was initiated, by the Marine Mammal Education and Research Group at the Institute of Marine Sciences (IMS), University of Dar es Salaam, to record and collect dolphin bycatch data from the drift- and bottom set gillnet fisheries around Unguja. This program is still ongoing and here we present data collected between January 2000 and August 2003. Fishermen from 12 fish landing stations were asked to send and report every dolphin found dead in their gillnets to fisheries beach recorders (employed by the Department of Fisheries and Marine Resources) or a contact person at Zanzibar Central market. The specimens were then transported to IMS where the dolphins were identified to species and dissected. When submitting dolphin specimens to the programme, fishermen were also asked to provide information on the number of specimens, date and location of capture and type of gillnet used.

### Involvement of fishermen

Initially, the fishermen agreed to supply the whole dolphins caught in their gillnets for a small financial compensation (US\$ 1-3) to cover their time and expenses to transport the fresh specimens to the location of the beach recorder or to Zanzibar Central market. However, in a three-month period only a few animals were submitted and subsequent enquiries revealed that other dolphins were sold for shark bait. Fishermen stated that our compensation was inadequate and that a higher fee was required. An increased fixed price of US\$ 5 for a small specimen and US\$ 10 for a large was offered, which was large enough for the fishermen to submit the carcasses to us, rather than sell them for bait, but still low enough to discourage efforts to purposely catch dolphins.

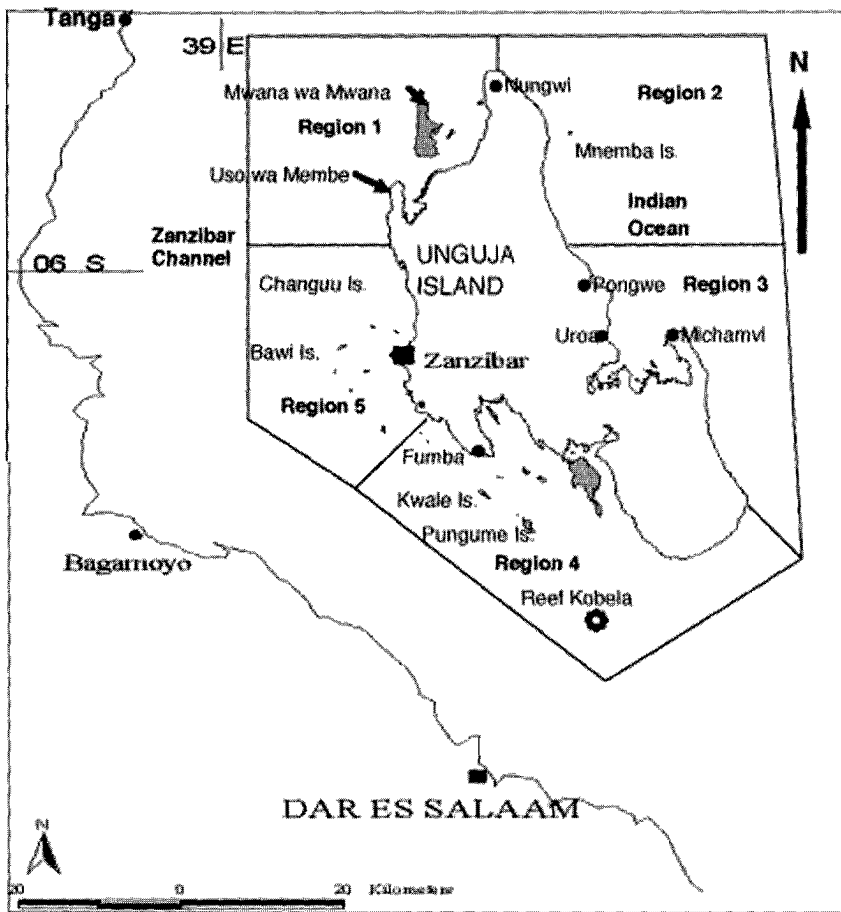


Fig. 1. Map of Unguja Island showing the study area divided according to the distribution of fishing effort

### Description of the fisheries

The fishermen involved in collection of dead dolphins use drift set nets for large pelagic fish and the bottom set nets for demersal species. Drift nets, targeting large pelagic fish such as kingfish, swordfish, sailfish, skipjack tuna and marlin, are approximately 500-900 m in length with variable mesh sizes from 7-20 cm, while bottom-set nets, targeting sharks and rays, vary in length to up to 450 m, with mesh sizes ranging from 20-40 cm. These bottom set nets are usually set very close to the shore.

The majority of the fishermen in the northern villages (Nungwi, Mkokotoni, Fukuchani, Tazari and Matemwe) operate their nets from dhows while fishermen in the southern villages (Kizimkazi Mkunguni, Kizimkazi Dimbani, Unguja Ukuu and

Fumba) use boats and outrigger canoes. Fishing is conducted at night, mainly during the darker phases of the moon. Vessels normally depart from port in the mid-afternoon and nets are set before sunset and hauled at dawn. One end of the string is attached to the vessel while the other end is attached to a buoy, allowing the nets and the vessel to drift freely with the current. The number and length of nets in a string in this fishery varies considerably among vessels and villages. For example, boats and dhows have about eight nets each, while outrigger canoes have about three.

### Species identification of dolphins

Collected dolphins were identified to species level using morphological characters (length and girth measurements, weight, tooth counts and

pigmentation patterns) and compared to published identification guides (Jefferson *et al.*, 1993; Folkens 2001). All specimens were fresh and intact at the time of identification. Figures 2-6 show pictures of some of the bycatch dolphin specimens collected. All photographs and measurements were taken by the first author. Unfortunately no pictures were obtained for the common bottlenose dolphin (*T. truncatus*) specimens collected.

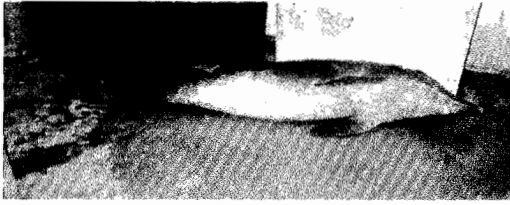


Fig. 2. Immature male Indo-Pacific bottlenose dolphin without ventral spotting, 1.93 m in total length, caught in drift gillnet fishery, in northwest coast, 14 September 2001. (Photograph by O. A. Amir)

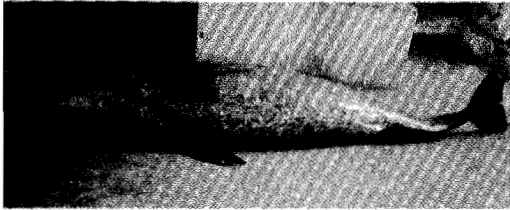


Fig. 3. Mature female Indo-Pacific bottlenose dolphin with ventral spotting, 2.20 m in total length, caught in drift gillnet fishery, in northwest coast, 9 May 2002. (Photograph by O. A. Amir)



Fig. 4. Mature female Indo-Pacific humpback dolphin, 2.21 m in total length, caught in bottomset gillnet fishery, in southwest coast, 4 August 2003. (Photograph by O. A. Amir)

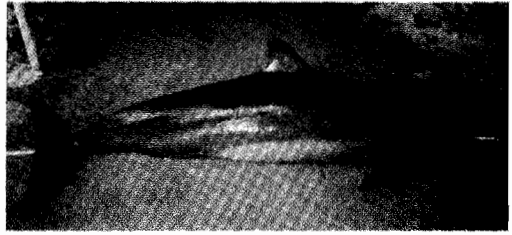


Fig. 5. Mature female spinner dolphin, 1.75 m in total length, caught in drift gillnet fishery, in Northwest coast, 4 March 2001. (Photograph by O. A. Amir)

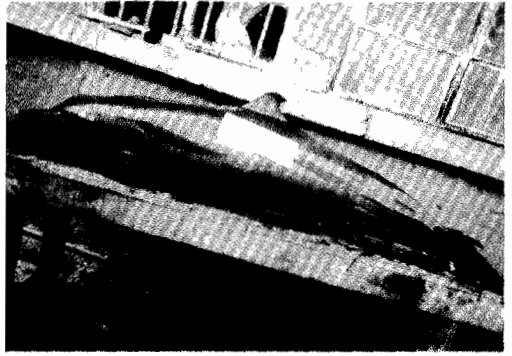


Fig. 6. Mature female spotted dolphin, 1.73 m in total length, caught in drift gillnet fishery, in Northwest coast, 27 May 2001. (Photograph by O. A. Amir)

## RESULTS

### Species Composition

Six species of dolphins were identified from a total of 143 specimens caught in drift- and bottom set gillnets (Table 1). Most of the specimens (95%) were from the drift gillnets. The Indo-Pacific bottlenose dolphin (*Tursiops aduncus*) was the most common species in the bycatch (48% of specimens), followed by spinner dolphin (*Stenella longirostris*), Risso's dolphin (*Grampus griseus*), Indo-Pacific humpback dolphin (*Sousa chinensis*), pan-tropical spotted dolphin (*Stenella attenuata*) and common bottlenose dolphin (*Tursiops truncatus*). The number of specimens collected from bycatch for each species and their relative frequencies are shown in Table 1.

## Distribution and Habitat

The majority of the dolphins were reported from the north coast of Unguja Island. The geographic distribution of the dolphin bycatch by region round Unguja Island is shown in Table 2.

## Seasonality of Entanglement

The monthly temporal distribution of the dolphin bycatch for the period January 2000 to August 2003 is shown in Table 3.

## DISCUSSION

The results from this study show that at least six species of dolphins (Indo-Pacific bottlenose, spinner, Risso's, Indo-Pacific humpback, pan-tropical spotted, and common bottlenose dolphin)

are bycatch of the drift- and bottom set gillnet fisheries around Zanzibar. Two of the species (pan-tropical spotted dolphin and common bottlenose dolphin) have not previously been reported in the area. The data provide the first information on the geographical and temporal distribution of dolphin species round Zanzibar and thus help fill the gap in information of small cetaceans in East African coastal waters. Only one previously-reported dolphin species (*Steno bredanensis*) for the area was not represented in the samples.

The larger number of dolphins caught in coastal waters north of Unguja Island is likely to reflect the greater fishing effort in this area (see Amir *et al.*, 2002) rather than a greater abundance of dolphins compared to the other regions. However, a broad survey of dolphin abundance would be necessary to confirm this. The methods used in the drift- and bottom set gillnet fisheries are similar

**Table 1. Species of dolphins identified from bycatches collected from January 2000 to August 2003**

Common name	Scientific name	Number of animals	%
Indo-Pacific bottlenose dolphin	<i>Tursiops aduncus</i>	68	48
Spinner dolphin	<i>Stenella longirostris</i>	44	31
Risso's dolphin	<i>Grampus griseus</i>	12	8
Indo-Pacific humpback dolphin	<i>Sousa chinensis</i>	11	8
Pan-tropical spotted dolphin	<i>Stenella attenuata</i>	6	4
Common bottlenose dolphin	<i>Tursiops truncatus</i>	2	1
<b>Total</b>		<b>143</b>	<b>100</b>

**Table 2. The geographical distribution of dolphin bycatch by region round Unguja Island. The number of specimens and their percentages are shown for *Tursiops aduncus* (Ta), *Stenella longirostris* (Sl), *Grampus griseus* (Gg), *Sousa chinensis* (Sc), *Stenella attenuata* (Sa) and *Tursiops truncatus* (Tt)**

Area of capture	Ta	Sl	Gg	Sc	Sa	Tt	Total	%
Region <sup>1</sup>	31	10		4	5	1	51	35.7
Region <sup>2</sup>	10	28	12		1		51	35.7
Region <sup>3</sup>	9	2		3		1	15	10.5
Region <sup>4</sup>	9	2		2			13	9.1
Region <sup>5</sup>	5						5	3.5
Tanga coast	2	2		2			6	4.2
Bagamoyo coast	2						2	1.4
<b>Total</b>	<b>68</b>	<b>44</b>	<b>12</b>	<b>11</b>	<b>6</b>	<b>2</b>	<b>143</b>	<b>100.0</b>

<sup>1</sup>Mwana wa Mwana and Uso wa Membe;

<sup>2</sup>Nungwi and Mnemba Is.;

<sup>3</sup>Menai Bay (Kwale Is., Pungume Is. and Reef Kobela)

<sup>4</sup>Pongwe, Uroa and Michamvi;

<sup>5</sup>Changuu Is. and Bawi Is

**Table 3. The distribution of bycatches of dolphins by month for the period January 2000 to August 2003**

Month	<i>Tursiops aduncus</i>	<i>Stenella longirostris</i>	<i>Grampus griseus</i>	<i>Sousa chinensis</i>	<i>Stenella attenuata</i>	<i>Tursiops truncatus</i>	Total
Jan	6	8	0	2	0	0	16
Feb	5	4	4	0	0	0	13
Mar	12	16	4	1	1	0	34
Apr	9	3	2	0	0	0	14
May	3	1	0	3	1	1	9
Jun	1	0	0	0	0	0	1
Jul	5	5	0	0	3	0	13
Aug	10	3	2	4	0	0	19
Sep	7	2	0	1	0	0	10
Oct	5	1	0	0	0	0	6
Nov	4	0	0	0	1	0	5
Dec	1	1	0	0	0	1	3
<b>Total</b>	<b>68</b>	<b>44</b>	<b>12</b>	<b>11</b>	<b>6</b>	<b>2</b>	<b>143</b>

and the target fish species the same in the various regions round Unguja Island. Half of the samples were collected during the first four months of the 12 month of the study. It is not clear what the reason behind is, but it could be due to the fact that the months of February-April are the intermonsoon periods and usually are the calmest and hence more drift gillnet operations are conducted during this period. The drifting gillnet operation is generally restricted to waters to the north and south west of Unguja Island, with water depths exceeding 100 m and water conditions are more oceanic. Fishing takes place over about three weeks during the dark moon phase.

Until recently, most scientists recognized a single species of bottlenose dolphin, the common bottlenose dolphin (*T. truncatus*), with a number of regional forms (Mead and Potter, 1990; Ross and Cockcroft, 1990). Previous reports of bottlenose dolphins round Zanzibar all referred to *T. truncatus* without any justification. We suspect that many of these reports may have been *T. aduncus*. Currently, the Scientific Committee of the International Whaling Commission recognizes two species within the genus *Tursiops*; *T. aduncus* (the Indo-Pacific bottlenose dolphin) and *T. truncatus* (the common bottlenose dolphin) (IWC, 2000). *T. aduncus* tends to be smaller than *T. truncatus*; has a proportionately longer rostrum and develops ventral spotting at about the time of sexual maturity (Ross and Cockcroft, 1990; Wells and Scott, 2002).

The separation of the two *Tursiops* species in our study was based on differences in morphological features and size in relation to reproductive maturity. Investigation of the sexual maturity of the *T. aduncus* caught during the present study showed that all specimens with a body length of 200 cm or greater were sexually mature (males based on microscopic examination of histological slides of the testes and females based on the presence of *corpora albicantia* in the ovaries (Amir, 2004). Further, all sexually mature *T. aduncus* had developed ventral spotting of various degrees. The two animals that were identified as *T. truncatus* were both immature with body lengths of 244 and 280 cm for the female and male, respectively. These measurements were greater than the maximum lengths recorded for any of the collected *T. aduncus* (females 232 cm and males 238 cm).

*T. aduncus* was the most common species identified, accounting for 48% of the total bycatch collected during the survey. The high percentage of *T. aduncus* caught in gillnets in the coastal waters indicates that they may be the most abundant inshore dolphin species around Zanzibar. This is also supported by the high percentage of this species in a previous survey of the incidental catch of dolphins in the gillnet fisheries in Zanzibar (Amir et al., 2002). However, alternative explanations to the high percentage of *T. aduncus* in the bycatch could also be that this species may be more vulnerable to entanglement in nets or that

the species' distribution has a greater overlap with the distribution of the gillnet fishing effort compared to other dolphin species in the area. Although the data in this paper indicate that *T. aduncus* is distributed in all inshore waters around Unguja Island. Further, *T. aduncus* share coastal habitats with *S. chinensis* off the south coast of Unguja Island (Todesco, 1997; Stensland *et al.*, 1998), and with *S. longirostris* off the north coast by Nungwi and Matemwe (Ortland, 1997). Preliminary results from genetic analyses using mitochondrial DNA, from specimens of bycatch and animals sampled in the field, indicate a restricted gene flow and limited female dispersion between northern and southern Unguja Island (Särnblad, 2005). In her study Särnblad, (2005) used thirty-four individuals from northern and southern Unguja (separated by a coastline of approx. 80 km) and sequenced tissue samples for a 385 base pair fragment of the mitochondrial DNA control region. The results revealed 14 polymorphic sites defining 10 distinct haplotypes with an average sequence divergence of 0.56 %. A significant population differentiation was found between animals from the northern and the southern part of Unguja ( $\phi_{ST} = 0.32$ ,  $p < 0.05$ ). These results are also supported by data from mark-recapture studies of photographically identified dolphins which show that about 161 (95% C.I. 144-177), repeatedly identified (within and between years), *T. aduncus* are present off the south coast of Unguja year round (Stensland, 2004).

The second most common species examined was *Stenella longirostris*, which accounted for 31% of the bycatch specimens supplied during the survey. The bycatch data indicate that the species is distributed in all coastal waters of Unguja Island except off the west coast where no specimens were retrieved from the fisheries in the Zanzibar channel. This area is relatively shallow (maximum depth <50m) and may not meet the habitat requirements for the species. *Stenella longirostris* has also been observed in mixed species groups with *S. attenuata* along the north coast of Unguja off Nungwi (O. Amir and P. Berggren, pers. obs.). In other areas of western tropical Indian Ocean *S. longirostris* is far more widespread and abundant than *S. attenuata*, although mixed species groups of the

two species have also been recorded by Ballance and Pitman (1998).

The records of *Grampus griseus* in the bycatch confirm previous observations of the species off the east coast of Unguja (Berggren *et al.*, 2001). However, *G. griseus* is probably more widely distributed off the east coast of Unguja than indicated in the bycatch records. For example, fishermen from the villages of Nungwi, Matemwe and Kizimkazi have reported that the species is occasionally observed off the north, east, and south coasts of Unguja Island.

*Sousa chinensis* was only recorded in the bycatch off the southwest, west and northwest coasts of Unguja, and in the Zanzibar channel, in water depths less than 50m. The species has been regularly sighted off the south coast of Unguja and frequently in mixed species groups with *T. aduncus* (Stensland, 2004). Re-sighting of identified individuals within and between years indicates a small resident population in this area. The latest available abundance estimate is from 2001, based on the mark-recapture analyses, which gave an estimated abundance of 71 dolphins (95% CI 48-94) (Stensland, 2004). Bortolotto *et al.*, (2001) have also recorded sightings of groups of *Sousa*, which they identified as *S. plumbea*, in the waters off the west coast of Unguja. It is likely that the animals encountered by Bortolotto *et al.*, (2001) belong to the same species of *Sousa* as recorded off the southwest coast of Unguja reported in this study and by Stensland, (2004). Humpback dolphins are distributed throughout the African and Indo-Pacific region (Jefferson and Karczmarski, 2001) and the taxonomy of the genus is still under review. The Scientific Committee of the International Whaling Commission (IWC) produces regular updates of the taxonomy of the cetacean species around the world. According to the latest list of species recognized by the IWC there are two species within the genus *Sousa*, the Atlantic humpback dolphin (*Sousa teuszii*) and the Indo-Pacific humpback dolphin (*Sousa chinensis*) (<http://www.iwcoffice.org/conservation/cetacea.htm#odontoceti>). However, others have argued that the animals found in the Indian Ocean and the Pacific should be split into two species - the Indian humpback dolphin (*Sousa plumbea*) and

the Pacific humpback dolphin (*Sousa chinensis*) (Rice, 1998). Ongoing efforts using both genetic and other methods and a broad geographic cover will hopefully soon resolve this issue (Reeves et al., 2004). In this paper we have referred to the Indo-Pacific humpback dolphin as *S. chinensis*.

The results of this study demonstrate a relative high diversity of dolphin species present in the coastal waters round Unguja Island. This information is important to the region since it demonstrates the potential for tourism based on dolphin watching. The results are also cause for concern regarding the possible impact of the high mortality due to the gillnet fishery on local populations and warrant further investigation.

## CONCLUSIONS

Dolphins were caught in gillnets at sites all round Unguja Island, in the Zanzibar Channel and along the coast of northern Tanzania. Indo-Pacific bottlenose dolphins and Indo-Pacific humpback dolphins were caught primarily in the inshore waters of all areas. Spinner and Risso's dolphins were found and caught in areas of deeper waters (depth >100m). Two species not previously recorded in the area were also present in the bycatch, the Pan-tropical spotted dolphin and Common bottlenose dolphin.

The high number of dolphin specimens collected from bycatch in this study is a serious cause for concern. There is a need for further research to estimate the magnitude of the bycatch. Although this information is needed for proper assessment of the biological impact on local dolphin populations, this should not delay conservation and management efforts to reduce the number of dolphins drowned in the Zanzibar gillnet fisheries. Any programme to reduce the use of gillnets will contribute to reducing dolphin mortality in Zanzibar.

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