

The Incidental Catch of Dolphins in Gillnet Fisheries in Zanzibar, Tanzania

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Abstract—The level of incidental catches of dolphins in artisanal gillnet fisheries was investigated in a questionnaire survey of 101 gillnet vessel operators from 10 villages in Unguja island of Zanzibar, representing half of all the gillnet fishing fleet in 1999. A total of 96 dolphins were reported to have been incidentally caught between 1995 and 1999; 43 Indo-Pacific bottlenose dolphins (*Tursiops aduncus*), 29 spinner dolphins (*Stenella longirostris*), 5 Indo-Pacific humpback dolphins (*Sousa chinensis*) and 19 unidentified dolphins. Most of these incidental catches (46) were reported in 1999. We extrapolate that 93 animals may have been incidentally caught by the entire fishing fleet (201 vessels) during 1999. This estimate represents a serious cause for concern, suggesting that the incidental capture of dolphins in Zanzibar's artisanal gillnet fisheries may be high enough as to have a significant negative impact on local populations. Further studies to accurately estimate the total bycatch, as well as the abundance of dolphin populations in the area are essential to assessing the biological significance of these incidental catches. However, management efforts should be implemented immediately to reduce the number of dolphins killed in these fisheries.

INTRODUCTION

Cetacean populations throughout the world are threatened by a number of environmental and anthropogenic factors. These include direct killing, incidental kills in fisheries, habitat destruction, noise disturbance, contamination by pollutants (Whitehead et al., 2000) as well as eco-tourism (Todesco, 1999; Berggren, 2000).

The incidental catches of small cetaceans in fishing gear have been reported worldwide as a major cause of mortality (Harwood & Hembree, 1987; Leatherwood & Reeves, 1989; Dawson, 1991; Kruse et al., 1991; Perrin et al., 1994; Tregenza et al., 1997). Entanglement of marine mammals in gillnets has been reported wherever marine mammals and substantial gillnetting occur in the

same area (O'Hara et al., 1986; Jefferson & Curry, 1994). Fisheries interactions with dolphins occur mostly in gillnets (particularly drift- and bottom-set gillnets) (Cockcroft & Krohn, 1994). Dolphin catches have increased as a result of changes in fishing practices in many areas, especially the introduction of nylon nets (Leatherwood & Reeves, 1989).

Dolphins are common in the waters around Zanzibar (Unguja and Pemba islands). Indo-Pacific bottlenose dolphins (*Tursiops aduncus*), Indo-Pacific humpback dolphins (*Sousa chinensis*) and spinner dolphins (*Stenella longirostris*) are the species most often encountered in coastal waters (Ortland, 1997; Stensland et al., 1998; Todesco, 1999). The first two species are regularly sighted in Menai Bay outside the reefs off the southwest

coast of Kizimkazi (Fig. 1) (Stensland et al., 1998; Todesco, 1999). Spinner dolphins have been observed in association with bottlenose dolphins along the coast of Nungwi and Matemwe, in the north off Unguja Island (Ortland, 1997). Other dolphin species such as Risso's dolphins (*Grampus griseus*) and rough toothed dolphins (*Steno bredanensis*) have also been observed in coastal waters of Unguja Island (Berggren, 2000).

Gillnets were introduced in Zanzibar in the late 1960s (Tarbit, 1984) and their use has greatly expanded and gained popularity in recent years (Lyimo et al., 1997). Although the existence of incidental catch of dolphins in the artisanal gillnet fisheries in Zanzibar has been reported previously (Ortland, 1997; Stensland et al., 1998), this problem has not previously been investigated in a systematic study. The aim of the study reported here was to investigate the occurrence and distribution of the incidental catches of dolphins in artisanal gillnet fisheries in the coastal waters of Zanzibar.

Current fisheries of Zanzibar

The fisheries of Zanzibar are exclusively marine and artisanal. Fishermen use traditional crafts (mostly non-motorised) and simple fishing gear. Almost all fishing vessels are locally made and range in length from 4–10 m. The most common means of propulsion are oars, poles or sails. The large dhows (*dau*) and boats (*mashua*) are usually wooden planked and sometimes motorised. Outrigger canoes (*ngalawa*) are made from a single log just like dugout canoes. Fishing is commonly done using lines (troll line, handline and longline), traps, nets (purse seine, scoop, drift [small-mesh] and demersal [large-mesh] gillnets), spear guns and iron harpoons (Jiddawi & Stanley, 1999).

The main groups of fish targeted are demersal fish such as parrotfish (Scaridae), mullet (Mullidae), emperors (Lethrinidae), groupers (Serranidae) and snappers (Lutjanidae) which are caught with lines, traps and nets. Small pelagic fish such as sardines (Clupeidae), mackerel (Scombridae) and anchovies (Engraulidae) are caught with purse seine nets and scoop nets, while large pelagic fish such as kingfish (Scombridae), sailfish and marlin (Istiophoridae), shark (Carcharhinidae) and ray (Dasyatidae) are caught

using lines, drift and bottom set gillnets (Omar et al., 1995 [cited in Barnett, 1997]).

Fishing is undertaken along the entire coastline of both Unguja and Pemba islands within 2 km of the shore. These areas are protected by a fringing coral reef, and the water depth is less than 20 m. However, some fishing, particularly using drift gillnets, occurs outside the reef over depths of 100 m or more (Jiddawi & Stanley, 1999).

MATERIALS AND METHODS

Study site

A questionnaire survey was conducted on Unguja Island of Zanzibar, located about 40 miles off the central coast of mainland Tanzania. The island is situated at approximately latitude 6 °S and longitude 39 °E (Fig. 1).

Catch methods

The surveyed fishermen 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 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.

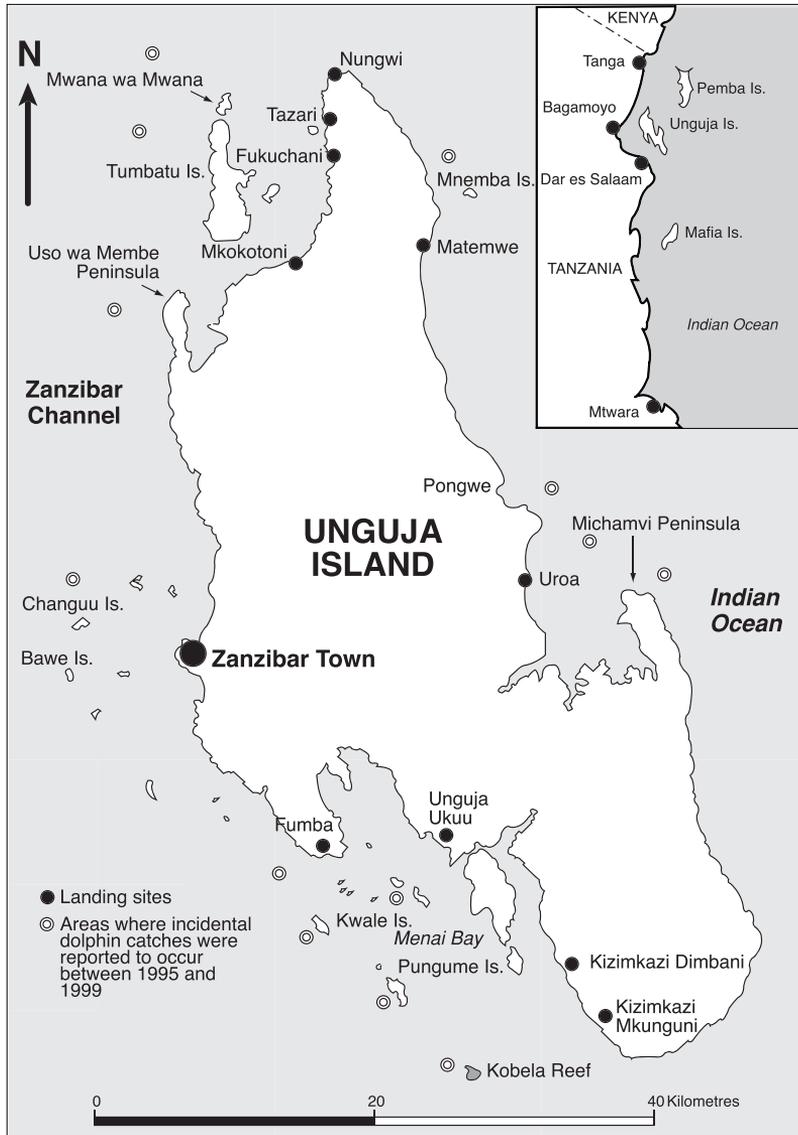


Fig. 1. Map of Unguja Island showing the fish landing sites and the distribution on incidental catches. Inset: Zanzibar in relation to Tanzania

Data collection

Data were collected from October to December 1999 using a questionnaire (Appendix 1). The following fish landing sites were covered: Nungwi, Tazari, Fukuchani, Mkokotoni, Matemwe, Uroa, Kizimkazi Mkunguni, Kizimkazi Dimbani, Unguja Ukuu and Fumba (Fig. 1).

Interviews were conducted while visiting the fish landing sites, where the interviewer filled out the questionnaire after posing the questions to the

fishermen. Fishermen were asked standard questions covering the period 1995–1999. The questions included vessel and gear types and fish species targeted. Fishermen were also asked in which areas they had been fishing, if they had caught any dolphins and if so, what species, where, and when, as well as how these were utilised in the village. In order to identify the different dolphin species interviewees were shown illustrations of the most common species in the area.

To estimate bycatch rates and total bycatch, we

considered an individual vessel as the best available unit of effort since it was difficult to determine the number of nets for each vessel. Official statistics of total number of fishing vessels using gillnets in each village surveyed were obtained from the Department of Fisheries, Zanzibar.

RESULTS

Observed fishing effort

A total of 101 gillnet vessel operators were interviewed. This corresponds to 50 % of the total fishing effort using gillnets in 1999. Interview coverage of gillnet vessels at various fish landing sites ranged from 37.5 to 75.0 % (Table 1).

Incidental catches of dolphins

In total, 96 dolphins were reported as having been caught between 1995 and 1999. Forty-three (45%) were bottlenose dolphins, 29 (30%) were spinner dolphins, 5 (5%) humpback dolphins and 19 (20%) were unidentified. The geographical distribution of these catches is shown in Fig. 1. The number of dolphins caught, as reported by respondents from each fish landing site, are presented in Table 2 and the percentage of dolphins by species for different parts of Unguja Island is shown in Table 3.

Bycatch estimate

In order to estimate the total annual bycatch of dolphins, we used 1999 data and extrapolated this

Table 1. Total number of vessels, and number and percentage of vessel operators interviewed at the landing sites surveyed in Unguja Island in 1999

Fish landing site	No. of vessels ⁺	No. vessel operators	% vessel operators
Kizimkazi Mkunguni	13	6	46.2
Kizimkazi Dimbani	8	3	37.5
Unguja Ukuu	19	14	73.7
Fumba	8	6	75.0
Uroa	16	6	37.5
Matemwe	8	5	62.5
Nungwi	32	23	71.9
Tazari	33	15	45.5
Fukuchani	17	11	64.7
Mkokotoni	21	12	57.1
Malindi	10	–	–
Chwaka	8	–	–
Buyu	8	–	–
Total	201	101	50.2

⁺From fisheries statistics; –, not interviewed.

to the total number of fishing vessels for the sampled villages active that year according to official statistics. During 1999 the number of incidentally caught dolphins reported was 46. The total yearly bycatch estimate using a bycatch rate of 0.46 dolphins per vessel was 93 animals for the sampled villages of Unguja Island (Table 4).

Utilisation of dolphins

According to the respondents to the questionnaire there are regional differences on Zanzibar whether the bycaught dolphins are used locally or discarded. In some villages dolphin meat is not eaten and hence the fishermen discard the bycaught

Table 2. Number of dolphins caught from 1995 to 1999 in Unguja Island—Results of a questionnaire survey of 101 fishermen

Fish landing site	1995	1996	1997	1998	1999	Total
Kizimkazi Mkunguni	0	0	0	1	3	4
Kizimkazi Dimbani	0	0	0	0	2	2
Unguja Ukuu	0	1	3	3	3	10
Fumba	0	0	1	2	0	3
Uroa	0	0	1	1	1	3
Matemwe	1	1	1	1	4	8
Nungwi	3	4	3	5	12	27
Tazari	0	1	2	2	6	11
Fukuchani	0	0	1	8	5	14
Mkokotoni	1	0	0	3	10	14
Total	5	7	12	26	46	96

Table 3. Percentage of bottlenose (BN), spinner (S), Humpback (HB) and unknown (U) dolphin species caught in gillnets in different parts of Unguja Island in 1999—Results of a questionnaire survey

Area of capture	BN	S	HB	U	Total	%
Northwest ¹	26	24	3	13	66	68.7
Northeast ²	—	5	—	6	11	11.5
Southwest ³	6	—	2	—	8	8.3
East ⁴	7	—	—	—	7	7.3
West ⁵	4	—	—	—	4	4.2
Total	43	29	5	19	96	100

¹Nungwi, Mwana wa Mwana, Uso wa Membe;

²Mnemba Is.;

³Fumba, Kwale Is., Pungume Is., Kobela;

⁴Pongwe, Uroa, Michamvi;

⁵Changuu Is., Bawi Is., Fawatu and Mapape reefs.

Table 4. Dolphin bycatch data from villages in Unguja Island in 1999—Results of a questionnaire survey of 101 fishermen

Landing site	N	NI	DC	BCR	EDB
Kizimkazi	13	6	3	0.50	7
Mkunguni					
Kizimkazi	8	3	2	0.67	5
Dimbani					
Unguja Ukuu	19	14	3	0.21	4
Fumba	8	6	0	0	0
Uroa	16	6	1	0.17	3
Matemwe	8	5	4	0.80	6
Nungwi	32	23	12	0.52	17
Tazari	33	15	6	0.40	13
Fukuchani	17	11	5	0.45	8
Mkokotoni	21	12	10	0.83	17
Malindi	10	0	0	0.46	5
Chwaka	8	0	0	0.46	4
Buyu	8	0	0	0.46	4
Total	201	101	46	0.46	93

N, total number of vessels; NI, number of vessels interviewed; DC, number of dolphins caught; BCR, bycatch rate; EDB, estimated total dolphin bycatch.

specimens at sea. In other villages the dolphin meat is either eaten by some of the villagers or used as shark bait in the longline fisheries. In these villages the fishermen bring the bycaught animals to the beach where the people get access to the meat. Finally, it was also reported that during the longline fishing season whole bycaught dolphins are also transported to Nungwi or the central market in

Zanzibar town, where dealers pay between Tshs 5,000 and Tshs 10,000 (US\$ 6.25–12.50) per dolphin.

DISCUSSION

This study represents the first attempt to investigate the occurrence and distribution of incidental catches of dolphins in artisanal gillnet fisheries in Zanzibar. Although the collection of data using opportunistic port interviews has the disadvantage that it cannot provide a rigorous estimate of catch numbers (Northridge, 1996) nevertheless it has identified the distribution and occurrence of these catches, information necessary to design and conduct further studies.

We used the bycatch data from 1999 to obtain an estimate of total annual bycatch. This may have introduced a bias if 1999 was an unusual year for bycatches for any reason. According to the results from the questionnaire the number of bycatches per year increased between 1995 and 1999 and particularly in the latter two years (Table 2). Rather than representing an increase in the bycatch rate, this increase may be due to an increased awareness of marine mammals in Zanzibar. The marine mammal research project (a collaboration between Stockholm University, Sweden and the Institute of Marine Sciences [IMS], Zanzibar) was initiated in the spring of 1998. It is possible that the launch of this project, which partly focuses on bycatch, has created a greater awareness in the people involved in the fisheries of bycaught marine mammals.

There are also a number of other factors that may influence the results of questionnaires, which is why numbers derived from surveys like the present one should be treated with caution (see e.g. Lien et al., 1994).

The calculated total bycatch number for dolphins should be considered a minimum estimate for Unguja since this was based on a reported number and not derived from independent observation. Furthermore, there is also additional fishing effort from other villages of Unguja that was not included in the extrapolation. A complete evaluation of incidental catch of dolphins by gillnet fisheries in Zanzibar waters, would also include gillnet vessels from Pemba Island, whose fishermen also fish in coastal waters around Unguja Island.

Our findings indicate that bottlenose, humpback, and spinner dolphins are caught in driftnets and bottom set gillnet fisheries around Zanzibar. The unidentified portion may also include other dolphins, such as Risso's, rough-toothed and spotted dolphins, all of which have been reported in Zanzibar waters. The respondents reported that drift gillnetting resulted in the majority of the incidental captures of dolphins. However, it was not possible to categorise the number of dolphins caught by type of gillnet, since some of the fishermen did not remember in which gear type the dolphins had been caught. This is because some fishermen use both gear types but during different seasons of the year.

For management purposes, we suggest that future evaluation of incidental catches of dolphins in Zanzibar waters should be stratified according to geographical area, fishery and season (e.g. Southeast and Northeast Monsoon). The seasonal stratification is important because the Zanzibar climate is affected by the two monsoon periods that lead to seasonal and geographic changes in the gillnet fishing effort (Horrill & Ngoile, 1992).

The estimated figure of 93 dolphins caught incidentally in 1999 represents a serious cause for concern, as this level may be high enough to have significantly negative impacts on local populations of the dolphin species. Further studies using independent observers aboard fishing vessels are necessary in order to accurately estimate the total bycatch. However, such schemes are expensive, and it is more economical to embed them in a larger (e.g. eco-tourism or other) project (Guard, 1999) or integrate them with a broader fisheries framework (Richmond, 1999). Observer programmes with more than one objective are more cost effective, and are generally the way that marine mammals observer programmes are established (Northridge, 1996).

Surveys to estimate the abundance of dolphin populations in the area are also essential in order to fully assess the biological significance of these incidental catches. Notwithstanding, we assert that management efforts to reduce the number of dolphins killed in these fisheries should be implemented immediately, rather than awaiting the findings of longer-term studies.

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Appendix 1. Questionnaire used in the investigation of the incidental catch of dolphins in gillnet fisheries in Zanzibar, Tanzania

1. Name of fisherman
 2. Location
 3. Sex
 4. Age
 5. How long have you been fishing?
 6. What kind of vessel do you use?
 7. What kind of gear do you use?
 8. Which area do you mostly fish?
 9. Do you target any specific fish species?
 10. How many types of dolphins do you know in your fishing area?
 11. Can you differentiate them?
 12. Do you recognize the type of dolphins shown in the pictures?
 13. In what types of gear do dolphins get caught?
 14. Are dolphins caught on purpose or accidentally?
 15. Have you ever seen dolphins caught in your gear?
 16. If yes, do you remember how many, when and where?
 17. Did you recognise the species?
 18. Which types of dolphins are eaten?
 19. What else are dolphins used for in your village?
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