

Assessment of the status, threats and management of dugongs along coastal waters of Pemba Island, Zanzibar

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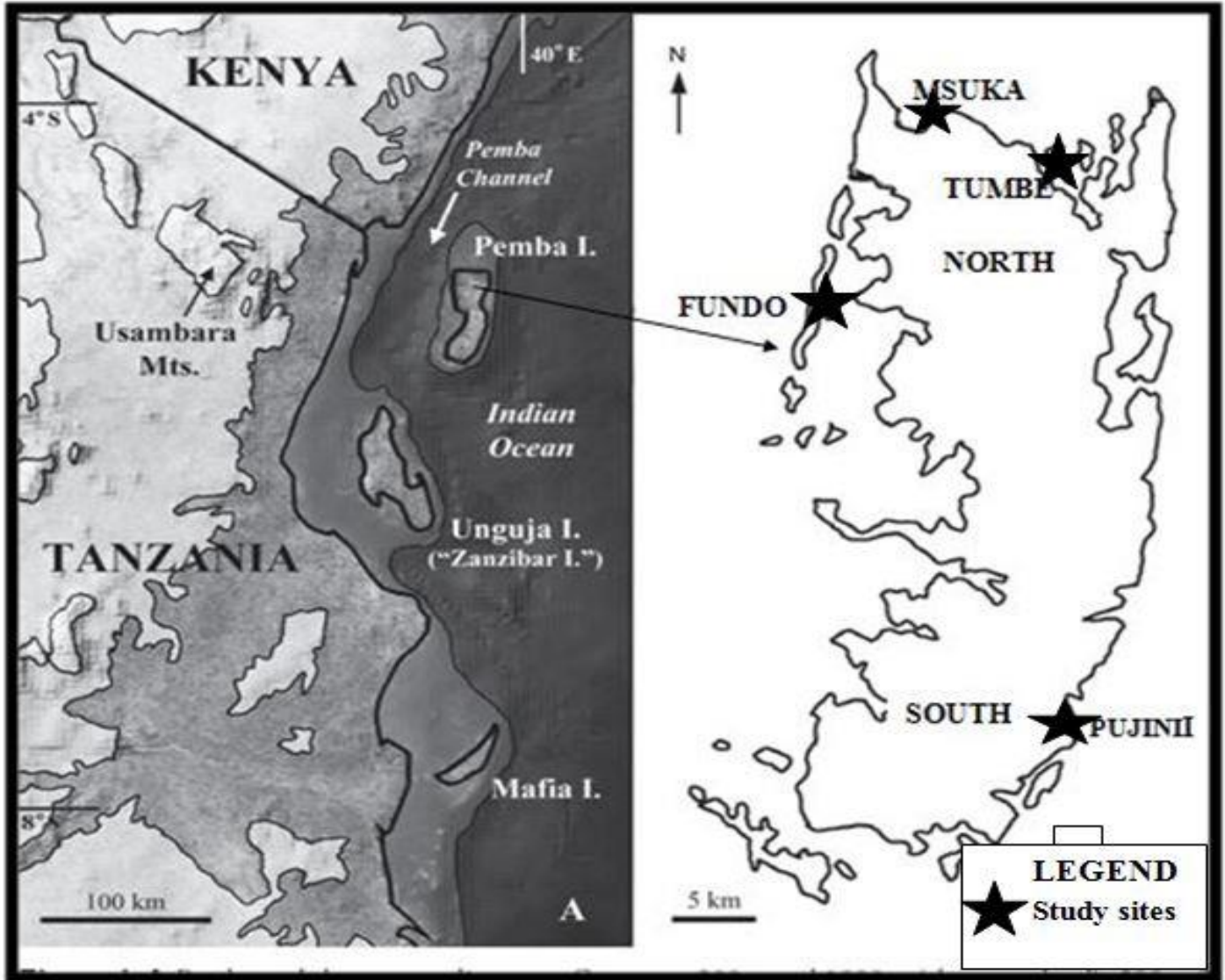
Abstract: This study was conducted to determine dugong's population status and their distribution in respect to explore the possible threats and managements approaches of dugongs and their habitat in coastal waters of Pemba Island. Questionnaire-based interviews were conducted between 2016 and 2017 with fishers (n= 180) at four sites. One focus group discussion was held in each site and six key informant interviews were carried out. Binary logistic regression was used to determine the effect of ages on dugongs sighting, and the results indicated that, there is no effect of ages on dugongs sighting since a p-value is 0.411. The results indicate that there are many anthropogenic and natural threats that affect dugongs and their habitats which include entanglement in a fishing gears, trawling, habitat destruction, bad fishing methods and natural environment changes. The finding of this study revealed that, there is occurrence of dugong in Pemba Island since one live dugong was accidentally caught in a fishing net in Chambani Mapape area of Pujini in May, 2017. The study recommends monitoring of dugongs and their habitats. Also conservation and management by establishing dugong hot spots at known dugong locations at Chambani Mapape area of Pujini.

Keywords: Dugong, Zanzibar, marine mammals, Conservation, threats

Introduction

Dugongs are marine mammals that play main roles in aquatic ecosystem by facilitating energy flow as well as nutrient cycles since they consume direct on the first trophic levels (seagrass), consequently, they influence the structure and function of marine communities (Bowen 1997). Dugongs perform essential ecological services in coastal marine ecosystems, which include regulating sea grass populations. The status of dugong populations in an area can be used as an indicator of general ecosystem health and the amount of sea grass that dugong are capable of consuming makes them an important part of influencing local distribution, productivity and nutrient cycling in sea grass ecosystems (Moore, 2008). Because of their dependence on coastal habitats, as well their low population growth rate dugongs are particularly vulnerable to several anthropogenic threats such as hunting, fishing pressure, bycatch as well as degradation of sea grasses which results decline significantly in the world (Kiszka et al., 2007). Though hunting and loss habitats of these animals were considered to contribute substantial to their mortality, but recently the major reason for reducing numbers of dugongs is bycatch (Pusineri and Quillard 2008). Because of these threats International Union for Conservation of Nature (IUCN) classified dugong as vulnerable to extinction in the Red List (Hines et al., 2008). In the Western Indian Ocean, dugongs were sighted near shore waters of Somalia, Kenya to Mozambique however,

recent studies show their population appear to have declined (Findlay et al., 2011). In Tanzania mainland, there are some cases which claim of dugong sighting at Southern parts of the country including Rufiji, Kilwa and Mafia Island however, in the Northern parts population have already disappear (Muir and Abdallah, 2003). In Zanzibar between 1980s and 1990s the Zanzibar-Pemba channel was an important dugong habitat and it was used to be the dugong's stronghold in East Africa (Korrubel & Cockcroft, 1997). Recently dugong population has almost disappeared particular in Unguja Island, where the last to be seen was 1982 though, in Pemba Island few populations remain and were sighted at Njao gap off the west coast in 2002 (Muir et al. 2003a). To date the information of dugong distribution and abundance is scarce since there are few studies done to collect their information and this hamper the conservation strategies. Therefore, the aim of this study was to assess the status, threats and management of dugongs along the coastal waters of Pemba Island in Zanzibar in order to suggest and implement the best management approaches that can help in conservation of dugongs and their habitat, hence to fill the knowledge gap of this species. The outputs from this research will upsurge our understanding on the status of dugong in the Island, also intending to make recommendations about the best ways to manage and conserve dugong in Pemba Island. Since Pemba Island was



neglected in more recent global assessments of this species.
 Source: www.mapeastafrica.com

Figure 1: map showing location of Pemba and study sites

Materials and methods

Study sites

Zanzibar is an archipelago which is part of Tanzania. It consists of many small islands and two large ones Unguja and Pemba, like many other African nations Zanzibar is considered as a developing country. Zanzibar Island is located about 40 miles off the coast of Tanzania mainland. This study was conducted in Pemba islands which is located about 50 km to the north of Unguja Island, in four locations namely, Msuka, Tumbe, Fundo and Pujini. The climate of these villages is characterized by bimodal pattern of rainfall with an average annual rainfall of about 1750mm. Long rains (*Masika*) comes from March to early June with about 900 – 1000mm. Short rains (*Vuli*) starts in October to December

with the amount ranging from 400–500mm. The islands experience cool south east monsoon period (*Kusi*) from June to August followed by a hot north east monsoon period (*Kaskazi*) from December to February. The maximum annual average temperature is 30°C and the minimum annual Msuka is situated in North-Pemba, average temperature is 22.3°C.

Its geographical coordinates are 4° 59' 0" South, 39° 44' 0" East, Tumbe is situated in North-Pemba, Tanzania. Its geographical coordinates are 4° 57' 0" South, 39° 47' 0" East while Fundo is located off the northwest coast of Pemba Island, It is one of the larger minor islands in the archipelago, and the largest of those surrounding Pemba its geographical coordinates are 5° 3' 0" South, 39° 39' 0" East and Pujini is located in the south of the island; its

geographical coordinates are $5^{\circ} 18' 0''$ and $39^{\circ} 48' 0''$. These villages were selected in this study since they are characterized by presence of shallow water and sea grass which is the favorable areas for dugongs and in addition to that fishing activities in these areas are the major economic activity.

Face-to-face structured questionnaires were administered in a survey of 180 fishers (45 individual from each study site) to collect data on dugongs population status and distribution in selected sites, past and present sighting of dugongs, to explore uses, perceptions and beliefs of fishers on dugong in Pemba Island and to investigate threats and possible management techniques of dugongs and dugong habitats in selected sites in Pemba Island. Simple random sampling was used to select fishers, and survey questionnaires were administered at study sites when fishers returned from fishing trips, repaired their fishing gears, relaxed at landing sites, or at their homes. Interviews were conducted face-to-face. Fishers were asked for their consent before the interview was conducted, secrecy was assured, fishers were free to choose not to answer any questions that they did not feel comfortable with, and could end the interview at any time. Focus group discussions was conducted to obtain information on the distribution of dugong and management strategies that had been put in place, threats of dugongs, historic and presence occurrence of dugongs in the study sites. In each study site, one focus group discussion was conducted where the researcher led different stakeholders such as leaders of the villages, fishers and fisheries officers from fisheries department. Each group had a number of less than eight participants who are suitable sample size for any focus group discussions; this range of participants was recommended as a sizeable group for effective discussions (Charlesworth and Rodwell 1997). Each discussion took an average of one and half hours. Key informant interview is the in-depth interview with the people who is expert, experience and ability to share useful information in a particular field (Ali *et al.*, 2013). In this study six (6) different key informants were interviewed. This included one stakeholder from each study site two from fisheries department in Pemba office The key informants was done to gather information on the direct and indirect anthropogenic and environmental threats of dugongs and dugong habitat as well as past and present occurring of dugongs in each study site. Quantitative data from the survey questionnaire returns were analyzed by using statistical software SPSS version 20 where in binary logistic regression was employed to effect of ages on dugongs sighting, and the results indicated that, there was no effect of ages on dugongs sighting a significance level (α) of 0.411 was used. Content analysis was employed to analyses qualitative data from focus group discussions and key informant interviews, where opinions recorded were listened to carefully, coded and interpreted to provide meaningful data which are presented below in the form of tables.

Results

Population status and distribution of dugongs in Pemba Island

From the survey questionnaire returns, the results showed that (63.8%) have never seen dugong in their life while 36.2% saw them; also older fishers with age greater than 70 years had got greater proportion (63.9 %) of interviewed fishers who saw dugongs compared to other age groups (Figure 3). However statistical test shows that the age of the fishers had no significant effect on dugongs sighting since the p -value of the age of fishers was 0.411, which is greater than the significant level (α) of 0.05 (Table 1). The survey revealed that, dugong distributed at different areas of Pemba Island and whereby they were highly distributed in Tumbe and Msuka since there were five (5) different fishing grounds where dugongs were sighted in each village compared to other study areas (Table 1). In all fishing grounds Kifungu Tundu at Msuka village had higher frequency of different dugong sighted (8) compared to other fishing grounds while Mto ngisi and Mpiga ngoma. Fundo had got low frequency of dugongs sighting (Table 2). Though, Chambani showed higher frequency of dugong sighting at Kwa bin Mussa but it was the same animal that was accidental caught in fishing gear.

Past and present sighting of dugongs in selected sites in Pemba Island

The results showed that, in the past dugongs were sighted more compared to present time where, 1971-1980 had higher sighting 14 individuals compared with other time followed by 1961-1970 with 10 individuals however, in 2011-2017 showed higher individual dugong sighting but it was the same animal that was accidental caught in fishing gear.

Threats of dugongs and dugong habitat in selected sites in Pemba Island

In this study, there were many threats that were explained by the fishers which face dugong and their habitats in Pemba Island which are summarized in figure 4.

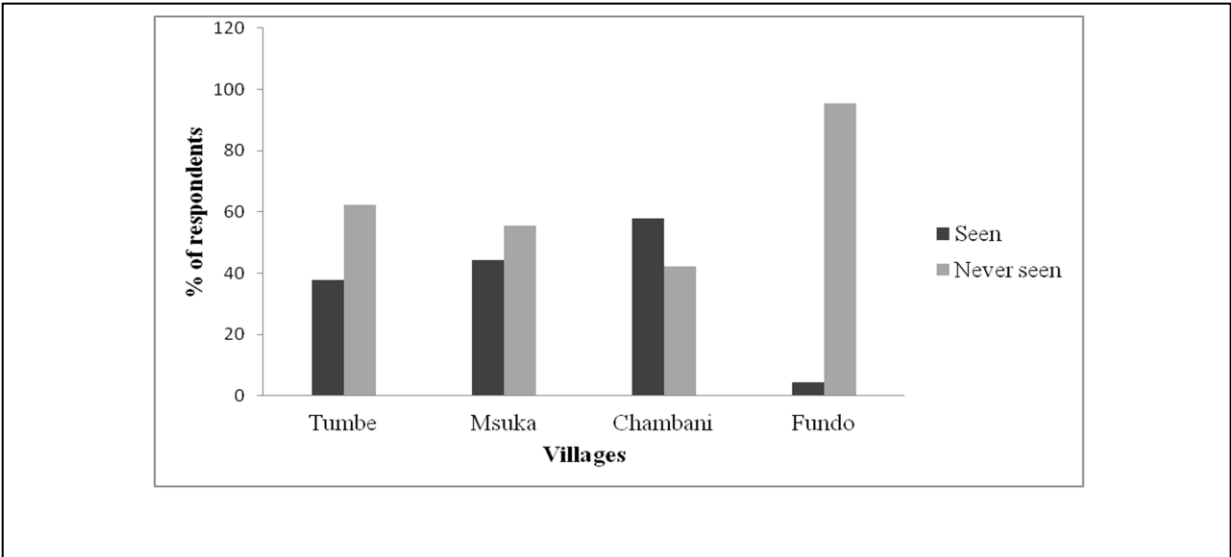


Figure 2: Percentage of fishers who saw dugongs in study sites

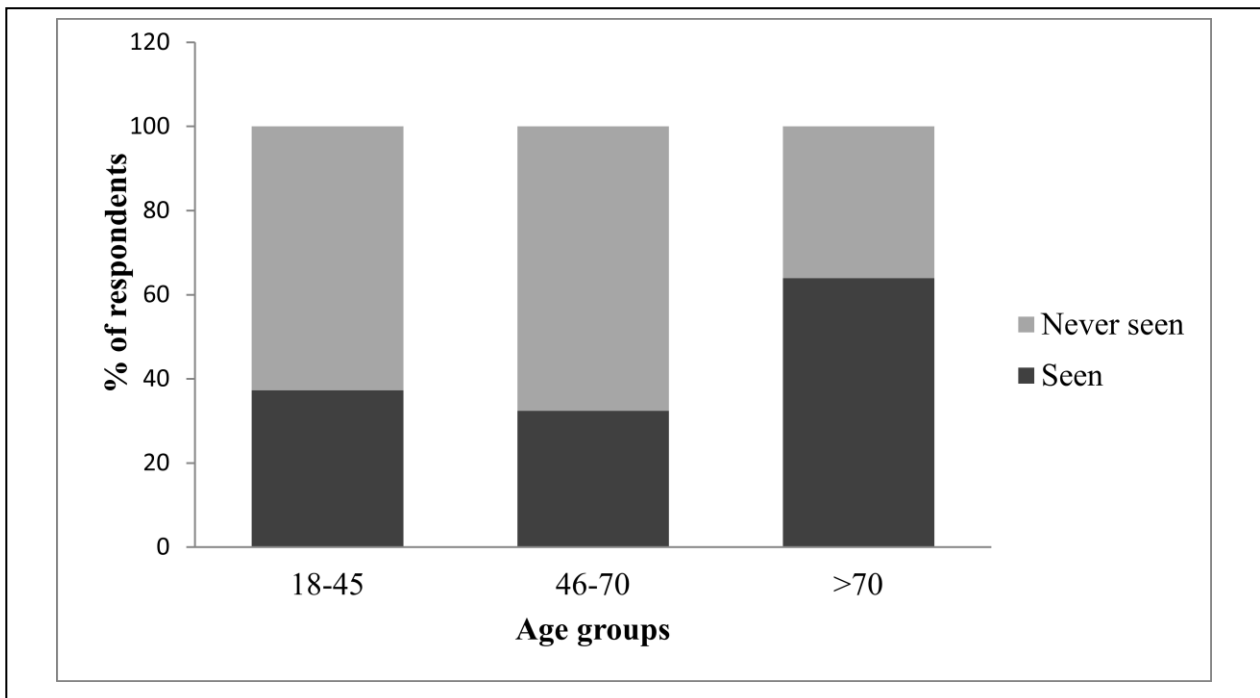


Figure 3: Percentage of fishers who saw dugongs in age groups

Table 1: Binary logistic regression analysis on age of the fishers effect dugongs sightings

| Dugong sighting | Coefficient (β) | SE | Exponent of (β) | <i>p</i> -value |
|-----------------|-------------------------|-------|-------------------------|-----------------|
| Age | -0.008 | 0.010 | 0.992 | 0.411 |

Table 2: Shows the distribution of dugongs in study areas.

| Village | Fishing grounds | Frequency of dugong sighting |
|----------|-------------------|------------------------------|
| Tumbe | Mkinga | 5 |
| | Vuma wimbi | 7 |
| | Ngomeni | 5 |
| | Maziwa ng'ombe | 3 |
| | Uziwani | 3 |
| Msuka | Kifungu tundu | 8 |
| | Rasi kiuyu | 7 |
| | Rasi mbuyuni | 6 |
| | Funguni | 4 |
| | Mkondo wa kongowa | 5 |
| Chambani | Kwa bin mussa | 26 |
| Fundo | Mto ngisi | 1 |
| | Mpiga ngoma | 1 |

Table 3: Shows past and present number of dugongs sighted in selected sites in Pemba Island

| Period | Years | Tumbe | Msuka | Chambani | Fundo | Total |
|---------|-----------|-------|-------|----------|-------|-------|
| Past | 1950-1960 | 3 | 0 | 0 | 0 | 3 |
| | 1961-1970 | 3 | 7 | 0 | 0 | 10 |
| | 1971-1980 | 3 | 9 | 0 | 0 | 12 |
| | 1981-1990 | 2 | 4 | 0 | 0 | 6 |
| | 1991-1999 | 5 | 3 | 0 | 0 | 8 |
| Present | 2000-2010 | 7 | 7 | 0 | 0 | 14 |
| | 2011-2017 | 0 | 0 | (1) 26 | 0 | 26 |

Table 4: Shows product, uses and beliefs of dugongs in Pemba Island

| | | |
|-----------------|---|--|
| Flesh (meat) | Source of food | Best source of protein |
| Oil | Cooking and medicine | It cure diseases like skin diseases |
| Bones and stool | As ingredients for local doctor's medicines | They have supernatural power help people to solve their different problems |
| Tears | As ingredients for local doctor's medicines | They have supernatural power that can help people in love |

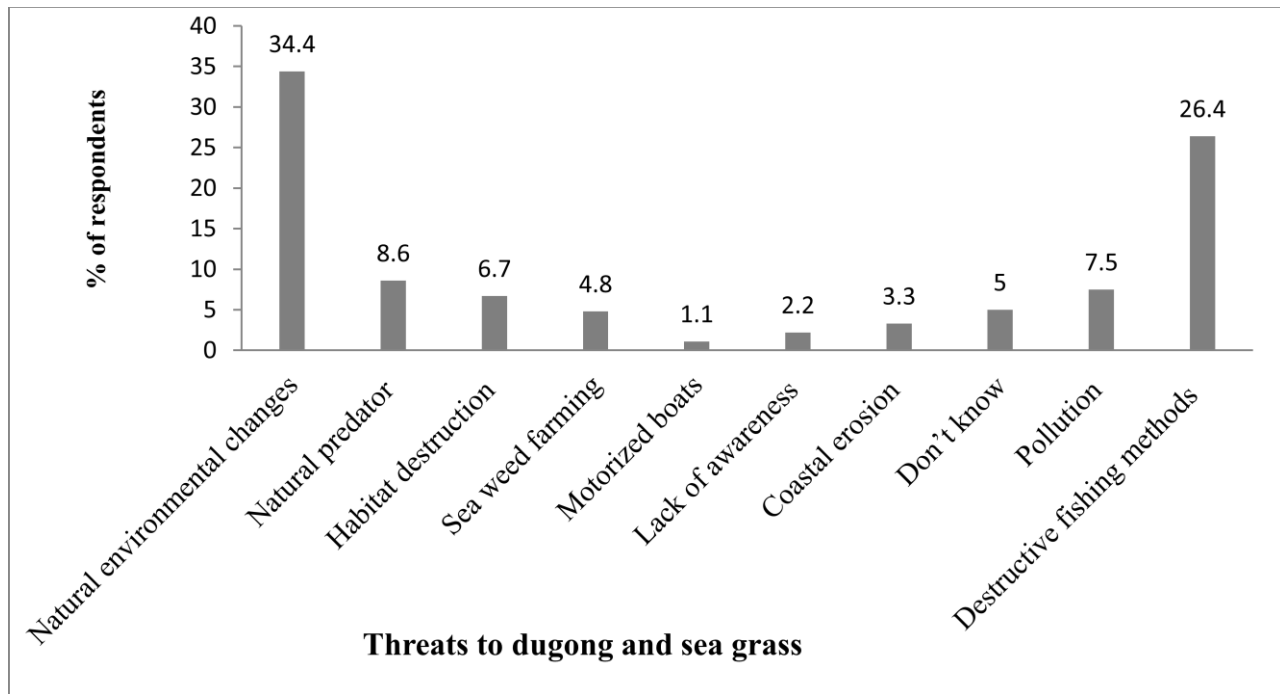


Figure 4: Shows threats of dugongs and sea grass

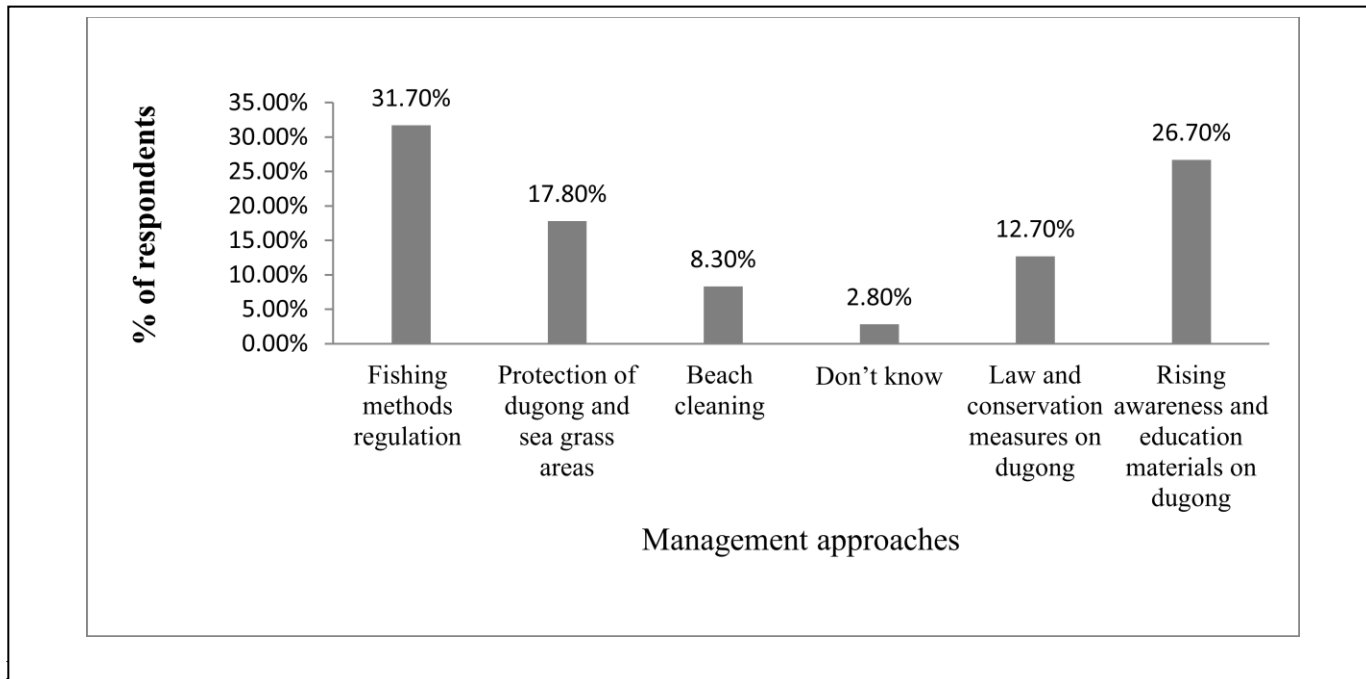


Table 5: Shows threats, managements and responsible institution and personnel

| Threats | Ways suggested for managements | Responsible institution and personnel |
|---|---|--|
| Bycatch from fishing gears like drift nets | To manage number of drift nets particularly in dugongs hotspots | Fisheries Department |
| Noise pollution especially from Motorized boats | Reducing number of motorized boats especially in dugongs hotspots | Fishers |
| Marine pollution example oil spill | Educate fishers the impacts of pollution to this species | Marine Conservation Unit, Fisheries Committees and Local Communities |
| Sea grass destruction fishing gears such as beach seining and metal traps | To ban all sea grass destructive fishing gears | Fisheries Departments |
| Natural sea grass destruction example Sea urchins and soil erosion | Afforestation around the beach (Mangroves plantation) | Marine Conservation Unit, Fishers and Fisheries Committees |
| Seaweed farming can distracts sea grasses as well as the ropes can entangle the dugongs | Educate seaweed farmers the importance of dugong and sea grass | Fisheries Department |

Uses, beliefs

and perceptions of fishers on dugong in Pemba Island

According to interviewed fishers, dugongs have many uses for people living in coastal areas around Pemba Island such as source of food also they believed some of their products they have medicinal value like oil which can cure several diseases as shown in (Table 2). In addition to that, from the focus group discussions and key informant interviews showed that fishers have different perceptions on dugongs some they perceived dugong is half human and half fish, also most fishers perceived that dugong is the just types of fish.

Threats of dugongs and dugong habitat in selected sites in Pemba Island

In this study, there were many threats that were explained by the fishers which face dugong and their habitats in Pemba Island which are summarized in figure 4.

Management techniques of dugongs and habitats in selected sites in Pemba Island

During focus group discussions fishers suggested several management approaches that will help to conserve dugongs and their habitats, these approaches include fishing methods regulation, protection of dugong and others are summarized in figure 5.

Discussion

Population status and distribution of dugongs in Pemba Island

The results revealed that most interviewed fishers 63.8% have never seen the dugongs in their lifetime; this was caused by decreasing numbers of dugongs sighting in present time due to accidental captures in a fishing nets, this results is in line with the findings of (Muir *et al.*, 2003a) when they stated that dugongs population decimated due to human activities include hunting and habitat destruction which result in these animals to become rare in Tanzania. Dugongs are distributed in different areas of Pemba Island whereby in the past the animals were more distributed at Tumbe and Msuka in northern part of Pemba Island. This distribution of dugongs in Msuka was in shallow waters, in sea grass areas and some were in deep water. Specific locations were in Ras kiuyu, Ras mbuyuni, Funguni, Kifungu tundu and Mkondo wa kongowa, however Kifungu tundu was the most important area for dugongs, since eight sighting were observed. The distribution of dugong in Tumbe was in Vuma wimbi, Maziwa ngombe, Uziwani, Mkinga and Ngomeni, where by Vuma wimbi was important site for dugongs since seven sighting were observed. The reported of higher number of dugongs in northern part of Pemba in past time may be caused by absence of non destructive fishing gears and there was no fishing pressure, this results is in line with the finding of (Lewison *et al.*, 2004) found that absence of non destructive fishing gears and control fishing pressure favours the living of marine mega fauna and their habitats to survive

Past and present sighting of dugongs in selected sites in Pemba Island

In the past dugongs were sighted more compared to present time; the result proved that there is rapid declined of dugong sighting in recent time. This result is in line with the study of (Marsh *et al.*, 2002) indicated that dugong was historically abundant along South-east Asian coasts but reduction in numbers and local extinctions have left small, isolated groups with a high risk of extirpation. Between 1960 and 1980's there were more dugongs in Pemba Island since more sightings were observed in this period, this result in line with the findings of (Korrubel & Cockcroft, 1997). This results caused by low fishing pressure and high abundance of sea grass, this result is similar with the study of (Preen, A., & Marsh, H. 1995) suggestion that, destruction of sea grass caused to be very few dugongs sighting in the areas where they were previously most abundant. The sharp decline of dugong existence in recent years may be caused by the loss of sea grasses due to coastal activities which has been emerged as a major source of habitat loss for marine creatures (Paling *et al.*, 2009). In the past time there was no any report of dugong sighting in Chambani area but in recent time there is existence of dugongs, since fishers declares to sight this animal several time. This occurrence of dugongs caused by absence of motorised boats since all fishers in area use dugout canoes locally known as *mtumbwi* and other small boats which are not motorised, this results is in line with the study of (Ellison *et al.*, 2012 and New *et al.*, 2013) reported that, in areas where there lots of motorised boats dugongs can be hit, particularly if the water is shallow.

Uses, beliefs and perceptions of fishers on dugong in Pemba Island

For many decades dugongs have been used for various uses particularly meat as a food, oil and bones are used to cure some diseases such as labour pain, arthritis asthma, back pain, and shock and the results of this study showed that, dugongs are mostly used as food (Table 4) which is in line with the studies of (Rajamani *et al.*, 2006) and (Marshall, 1998). The present study together with previous studies all emphasize that dugongs are being used as a food. Fishermen perceive differently on dugong some said that dugong is half human and half fish, but others explained that dugong is just a type of fish. In term of belief most fishers believed that, dugong have super natural power that can be used by local doctors for protection against evils spirits (Marshall, 1998). In this study it showed that, dugongs have supernatural power that can help people in love to solve their problem, this result concur with the study of Rajamani *et al.*,(2006) who reported that, dugong's tears are reputed to be used as a love potion, especially when a man or woman wants to win the heart of a beloved one.

Threats facing dugongs and their habitats in Pemba Island

Natural environment change such as rising of sea level, increasing temperature, strong wind and currents in the sea may cause great threat to dugongs and their habitats (34.4%) of respondents. Tidal surges are more frightening as it leaves dugongs stranded on mudflats and beaches, this situation has already occurred in Pemba Island. This finding is well supported by (Muir *et al.*, 2003) when reported that in Pemba Island, there were 13 reports of dugongs stranding in 1990s. Bycatch from fishing gears like gillnets causes the declining of marine mega fauna population in the world (Croxall *et al.*, 2012), and from 1990 to 1994 about 653,365 marine mammals were accidentally caught worldwide (Kiszka *et al.*, 2008) The result of this current study provide the evidence of accidental caught of dugong in fish net at Chambani Mapape, since dugongs are more often entangled and die in gill and mesh nets. Noise pollution especially from motorized boats affect dugongs especially in shallow water since they affect feeding behaviour (New *et al.*, 2013), meanwhile boats are travelling at speed or in shallow waters over seagrass beds cause the greatest threats to dugongs. Marine pollution is another source of dugong threats since dugongs can become entangled in plastic, old nets, fishing line and rope that have been thrown into the sea. They may also cut themselves on sharp glass and rubbish that ends up among the seagrass (Reijnders *et al.*, 2009). Destruction of sea grass seems to be another threat of dugong since dugongs needs to eat large amounts of seagrass every day to get enough energy to live, contraction activities, land reclamation, dredging and trawling fishing in the coastal areas can greatly cause loss of sea grass beds and abject water quality, also soil washing away from the land to the ocean can kill large area of sea grass causing dugong to starve and eventually die. Lack of education and awareness, since most of fishermen have no knowledge about the importance of conserving dugongs, since very little scientific research has been conducted on dugongs in Pemba Island

Management techniques of dugongs and dugong habitat in Pemba Island

This study shows that management actions must be used to protect dugongs and their habitats, but many studies suggested effective managements approaches of dugongs because dugongs can travel large distances which indicates the importance of regional collaboration in their management (Marsh *et al.*, 2001). This present study various management approaches have been proposed (Figure 5). Fishing methods regulation is the best management approach that can be used in Pemba Island in order to protect marine mammals since this approach has highest proportion (31.7%) of respondents. Dugong education and awareness campaign targeting local coastal communities seems to be the second best management approach that can save dugongs and their habitats (26.7%), since education is the key component in the effective management systems, through education, several important issues are involved in addition to basic provision and communication of information on conservation and management of aquatic creatures include

marine mammals (Jawad, L. A. 2006). Protection of dugong and sea grass areas since sea grass is the chief foods of the dugong, nursery ground for invertebrates and vertebrates, area for scientific study and indicator for monitoring of sea grass communities on effect of global warming (Bujang *et al.*, 2006)

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