PARTICIPATORY HABITAT CHARACTERIZATION AND GIS DATABASE DEVELOPMENT FOR THE CONSERVATION AND MANAGEMENT OF SEA TURTLES IN SOUTH COAST KENYA

BY

SIMON NZUKI AND JOHN MUASA

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Simmons Nzuki and John Muasa

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Cover Photo: A green turtle heads for the surf after a release by a local fisherman in Msambweni.

Abstract

Three sites in south coast Kenya i.e. Msambweni, Funzi and Bodo were studied with an overall objective of characterizing the existing sea turtle nesting and foraging habitats. Nesting beach stretches in Msambweni and Funzi were evaluated based on human and natural predation indices and environmental factors which considered temperature measurements. The targeted foraging grounds consisted of seagrass beds and associated food items which included sponges and mollusks. Participatory approaches as well a stratified sampling design were used in studying both habitats.

A total of 10 beach stretches measuring 5.84km were identified in both Funzi and Msambweni. Msambweni beaches had a higher index of human pressure than Funzi beaches although the later had a higher natural predation index in relation to clutch and nesting females' survival. The mean temperature range at a depth of 10-30cm was higher for the Funzi hatchery when compared with samples from Funzi beaches ($t= 2.7$, $p<0.05$) but was not significant when compared with measurements from Bodo beach stretches ($t= 0.05$, $p>0.05$). However there were significant differences in temperature range reported within sites i.e. Funzi ($t= 1.73$, $p< 0.05$) and Msambweni beaches ($t= 4.00$, $p<0.05$) at depths of 10-30cm. Funzi had the highest mean temperature range at all depth measurements.

Seagrass cover ranged from 1.3-44.23% but there was no significant differences ($p>0.5$) between sites. Most of the sampling stations were dominated by *Thelassodendron ciliatum, Thalassia hemprichii, Siringodium isoetifolium, and Halodule uninervis.* A two-factor ranking exercise identified fisheries, sea urchins and pollution as the most immediate threats to sea turtle habitats within the study sites. The overall mean densities of sponges were higher in Msambweni than in Funzi - Bodo sites pooled ($p<0.001$) while there were more mollusks within the Funzi-Bodo channels compared to Msambweni ($p<0.001$). The distribution of gelatins was not significant between the two sites ($p>0.05$). Interviews with fishermen and observations suggest a spatial coincidence between specific seagrass pastures and green turtle sightings.

During the survey period 67 green turtle nests were sighted in Funzi and Msambweni beaches and a total of 32 mortality cases reported.

Acknowledgements

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Introduction

The complex life history patterns of sea turtles encompass a diversity of ecosystems ranging from terrestrial habitats where oviposition and embryonic development occur to developmental and foraging habitats in coastal waters (neritic zone) as well as in the open ocean (oceanic zone) (Bolten, 2003). However the existence of several kilometers of sandy beaches or foraging grounds for example seagrass beds and coral reef systems does not necessarily indicate habitat integrity to sustain effective sea turtle populations (Diez and Ottenwalder, 1999). At a global scale, sea turtle nesting habitats are continually degraded as a result of coastal development, artificial lighting and beach stabilization structures (Eckert, 1999). Sea turtle foraging grounds have on the other hand been lost to destructive fishing practices and pollution which constitute important sources of sea turtle mortality. Several studies Hillstead *et al.* (1982), Chan *et al.(*1988), Lutcavage *et al*.(1997) and Oravetz (1999) underscore the impact of anthropogenic pressure on marine turtle habitats.

Sea turtle population demographics have been shown to reflect the effects of natural and anthropogenic stressors that include environmental variability, terrestrial habitat loss, terrestrial and aquatic habitat degradation, and direct and indirect fishing mortality (National Research Council, 1990; Lutcavage et al., 1997). Sea turtles swim a gauntlet of fishing gear, including trawls, gill nets and long lines as they migrate across ocean basins and feed in nearshore areas. These stressors have been shown to affect the survival and growth rates of each sea turtle life stage thus influencing population growth rates and dynamics (Heppel, et al., 2003).

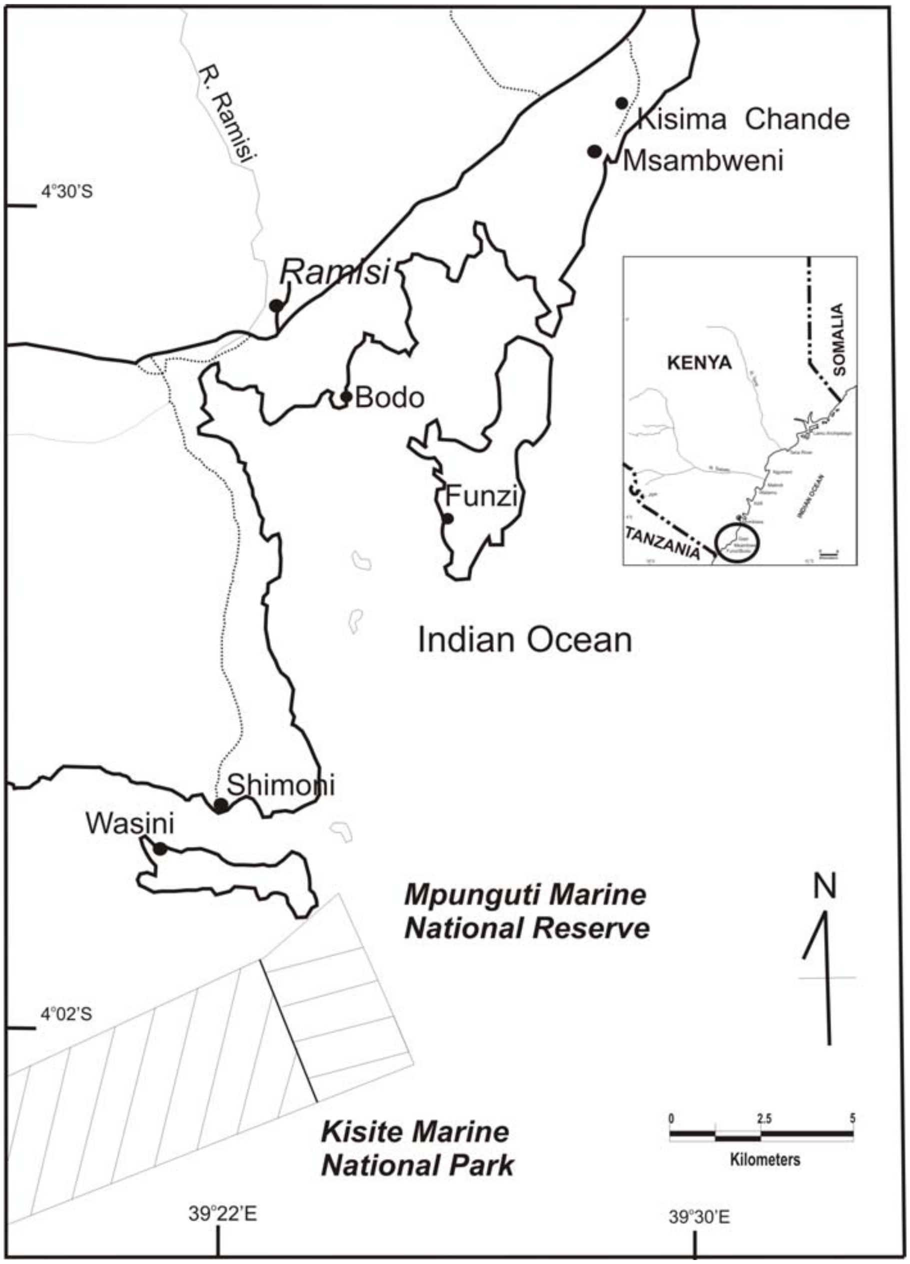
The threats identified above reflect to a large extent the character of marine turtle habitats of the range states within the Western Indian Ocean (WIO). Conservation actions to address threats in several of the range states have followed research (e.g. Mortimer, 1982, Humphrey and Salm, 1996 and Wamukoya et al., 1997), community initiatives (Nzuki 2005, Okemwa et al., 2004) and eco-tourism programs (e.g. www.watamuturtles.org). In Kenya although a Sea Turtle Recovery Action Plan (STRAP) exists for the conservation and management of sea turtles and their habitats, only three studies i.e. Wamukoya et al., 1997, Okemwa et al. 2004, Nzuki, et. al., 2005) provide useful insights into the character of marine turtle habitats in Kenya. Preliminary surveys exist on seagrass beds in Vipigo and Gazi (Gwada, Pers. Com). Coral reef systems in Kenya’s Marine Protected Areas (MPAs) and fished grounds have been extensively studied (McClanahan, 1988-2004). Seagrass beds and reef systems which constitute important sea turtle foraging habitats have been impacted by over fishing (McClanahan, 2004) and coastal sedimentation (Abwodha, 1994, 1995). Currently it is estimated that over 40% of the initial important nesting grounds along the Kenyan coast are now under pressure from coastal development and tourism activity although surveys to assess the spatial extent and character of nesting beaches in Kenya is on-going.

In response to the threats to sea turtles and their habitats in Kenya, the Kenya Sea Turtle Conservation Committee (KESCOM) initiated a site based conservation approach led by local communities and other grassroots stakeholders (Lelo, 2001). In total, KESCOM coordinates sea turtle conservation action at 15 sites spread along the Kenyan coast (Fig). We utilized a participatory approach (Lelo, 2001) building on the KESCOM community initiatives in south coast Kenya to i) provide data and information on the character and status of nesting and foraging grounds in south coast Kenya and ii) to build local capacity to enhance the conservation and management of sea turtles and their habitats. These two main aims of the study are listed as core action areas under the Indian Ocean and South East Asia Memorandum of Understanding on the Conservation and Management of Marine Turtles and their Habitats (ISOEA-MoU) (IOSEA, 2001).

Study sites

The current study focused on three sites i.e. Funzi, Bodo and Msambweni (Fig. 1) which constitute the only remaining viable nesting grounds for green turtles *Chelonia mydas* and Hawksbills *Eretmochelys imbricata* in south coast Kenya (KESCOM, 2003). The conservation and management of sea turtles within these sites began in 2000 with the establishment of a turtle club on Funzi Island under the auspices of KESCOM. Funzi Island is an important tourist destination while Msambweni and Bodo are important market centers and a fishing village respectively. The off shore waters of Funzi Island border the Kisite-Mpunguti Marine Park and Reserve to the South West. Documented threats to sea turtles (Nzuki, 2002) and their habitats in this area include poaching and trade in turtle products, entanglement in artisanal fishing gear, use of destructive fishing methods, and coastal development and tourism (Wamukoya, et. al., 1997; Okemwa, et.al., 2004). Fishermen and dive schools have reported several aggregations of foraging green turtles within seagrass beds in Msambweni and

Kidomoni, the major inlet channel to the south east of Funzi Island.



There are no important foraging grounds for sea turtles in Bodo, but the fishing village continues to report cases of illegal trade and consumption of sea turtle products (Nzuki, 2005). In addition Funzi Island hosts immigrant fishers from Pemba, Tanga and Zanzibar (Msambweni Fisheries Office, Pers. Comm.) who set up gillnets and shark nets (40cm by 40cm-mesh size) in important sea turtle feeding grounds. It also reports the highest number of nesting activities within the south coast area.

Materials and methods

Field work was accomplished within two timeframes i.e. the first one between September 2003 and June 2004 and the second one between February to July 2005. The data collection approach included interpretations and digitizing of remotely sensed data and a structured sampling design.

Nesting beaches were identified from aerial photographs acquired in 1992 at a scale of 1:12,500. The interpretations were conducted together with local communities guided by data and information provided through structured interviews, rankings and transect walks. The resulting overlays were digitized and geo-referenced in ArcView GIS to provide preliminary nesting beach length estimates and training sites in determining the sampling stations for sea grass beds and sea turtle food items. A Garmin hand held Global Positioning System (GPS) was used to georeference transects and facilitate an accurate (10m resolution) entry of attribute data into a database. Characterization of beach stretches followed the methods described by Mortimer (1982) and focused on human pressure indices (tourism infrastructure, fishing villages and market centers) environmental parameters (temperature range) and coastal geomorphology (erosion and offshore approach). Anthropogenic and natural pressure indices were scored on an ordinal scale ranging from low to high impact. The ordinal range were presented to local communities for scoring and the average frequencies calculated for each of the beach stretches and used to classify data layers in GIS.

Nest temperature measurements were used to approximate beach temperature variations although measurements were also obtained from several beach sectors (marker points) in Funzi and Msambweni to serve as controls. A total of 10 sampling stations each were established haphazardly but spread over several beach stretches above the high water mark in Funzi and Msambweni. Temperature readings were obtained at depths of 10, 30 and 60cm using modified soil thermometers (although temperature data loggers/probes would be more appropriate) with an accuracy of 0.5^0C. However only two measurements at 10 and 30cm were obtained from relocated nests so as not to interfere with incubation processes. Measurements were obtained twice a week over the entire nesting season from February to June (Okemwa, et al., 2004). All the nests sampled for temperature survey were laid within this period. Ninety percent (90%) of the total nests laid on Funzi Island beach stretches are translocated to a tourist's beachfront property on the Island and were considered separately so as to compare temperature variations with nests incubating insitu (Collingbron, 2003).

Other sand parameters i.e. organic matter, water and calcium carbonate content, PH, color and particle size distribution were not considered since a number of studies for example Stancyk and Ross (1978) have shown that they do not affect nesting frequency among sea turtles.

Estimation of cover and species composition among sea grass communities was accomplished using a structured sampling design protocol described by Saito and Atobe (1970). A 50 × 50 centimeter quadrat subdivided into 25, 10×10 centimeter sectors were placed on the substratum within sampled areas. The dominance of each species in each of the 25 sectors was then recorded. A total of 21 transects were laid resulting in over 500 quadrats. The density and availability of other food items within sea grass beds and reef systems considered mollusks and sponges which were assessed based on counts per snorkeling time within a defined line transect. A total of 10 haphardly placed line transects were surveyed in each of the three study sites.

Training sessions on conservation and management of sea turtle habitats were organized and held for a period lasting 20 days but spread over two months in early 2004. The training modules targeted community members from the Funzi and Bodo Turtle Conservation Groups established under the auspices of KESCOM. The methods of training included field exercises, demonstrations and theory classes on sea turtle biology, patrols and monitoring programs , data recording and group management skills. A total of 30 local community members were trained while 50% of the trainees participated in the habitat characterization exercise. The study also conducted awareness sessions targeting local fishermen and other stakeholders to help establish and ground sea turtle activity i.e. nestings, strandings, sightings networks within the study sites.

Results

Participatory mapping of nesting grounds

The location and spatial extent of the major sea turtle and foraging grounds within two of the study sites, i.e. Funzi and Msambweni were identified (Fig.2). Seven nesting beach stretches totaling 1.95Km occur to the east of Funzi Island (seaward side) as sandy crescents varying in overall shape, accessibility and substrate composition. Msambweni has relatively long open beach stretches totaling 3.89 Km. In both sites beaches are interspersed by rock cliffs and coastal vegetation running into several meters.

The beaches in Msambweni are prone to poachers and intertidal erosion while the success of sea turtle nesting activity on Funzi Island is threatened by natural predation mainly by porcupines, mongoose and opportunistic poaching by fishermen. However the index of human pressure on marine turtle nests was found to be higher in Msambweni than in Funzi (Fig.3) although cases of illegal off - takes from fishing grounds are more pronounced in Msambweni than Funzi Island (Nzuki, 2005).

This result correlates well with community rankings of the threat levels to sea turtles and their habitats within the three study sites (Table 1). Community members from Funzi and Bodo thought that poaching of sea turtle products and subsequently their trade and consumption poses the biggest challenge to conservation efforts. The Msambweni community group when presented with the same issues ranked fisheries as the most immediate threat to the

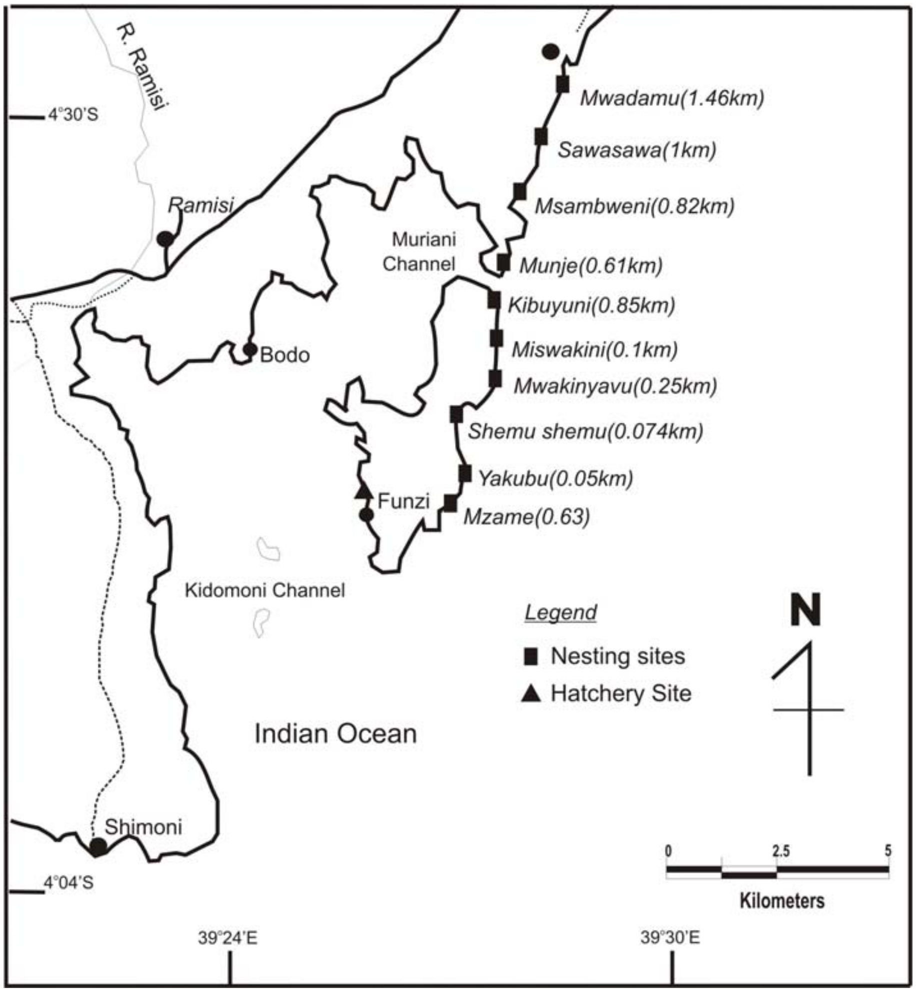


Figure 2. Identified nesting beach stretches in Msambweni and Funzi Island and respective lengths

Table 1. Two-factor ranking of threats to marine turtles and their habitats by local communities, government representatives and Conservationists (results pooled for the three sites)

		Threats							
		Fi	Po	Hl	Cd	Np	**Score**	**Rank**	**% of respondents**
Threats	Fi		Po	Fi	Fi	Fi	3	2	*68*
	Po			Po	Po	Po	4	1	*76*
	Hl				Hl	Hl	2	3	*71*
	Cd					Cd	1	4	*13*
	Np						0	5	*12*
	Fi-Fisheries; Po-poaching; Hl- Habitat loss, Cd-Coastal development, Np-Natural processes								

survivorship of marine turtles within their area followed by poaching. Funzi and Bodo considered fisheries as second in rank to poaching. Natural processes which mainly include

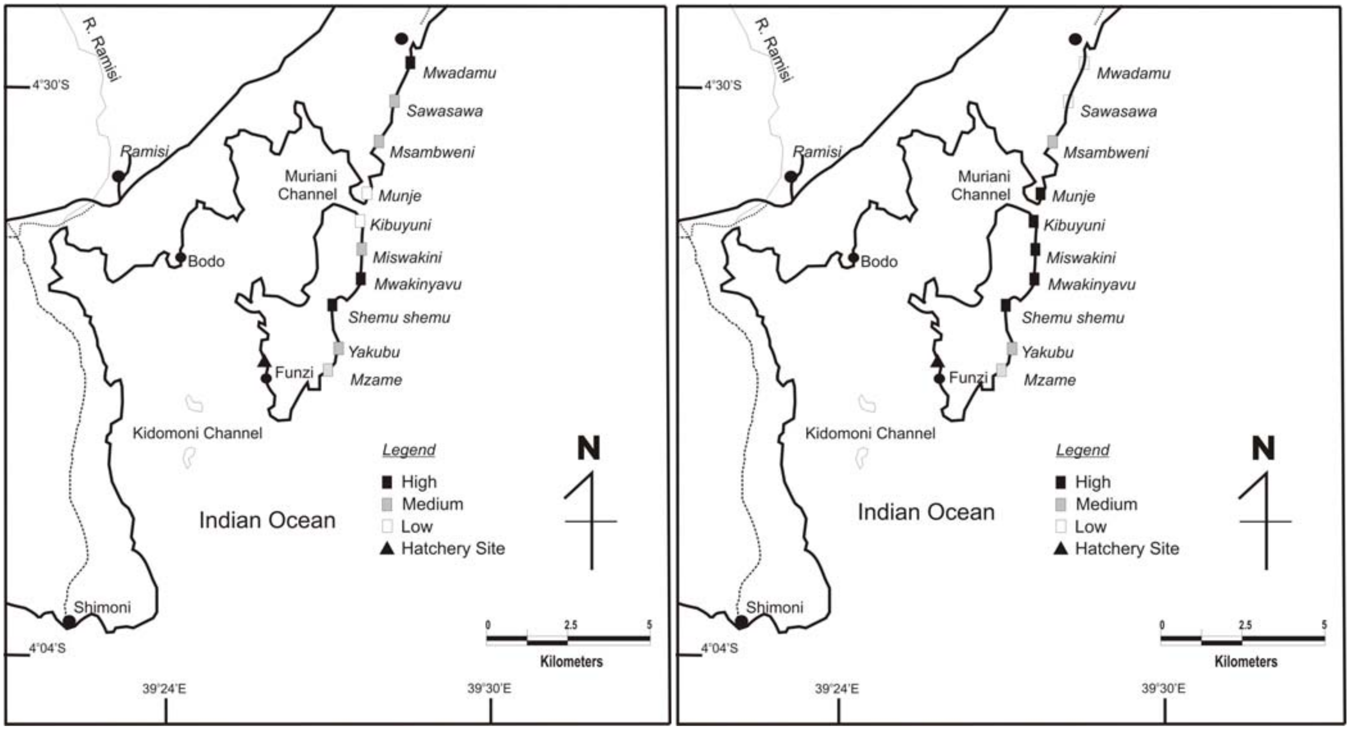


Figure 3. (a) Human and (b) Natural threat indices scaled based on community ranking of specific threats to nesting beaches within Msambweni and Funzi Island.

predation of turtle eggs and erosion of nesting beaches had the lowest score in the two – factor ranking exercise.

Fisheries were also cited as impacting on sea turtle habitats when communities were presented with an opportunity to assess resource prevalence overtime (Fig. 4).

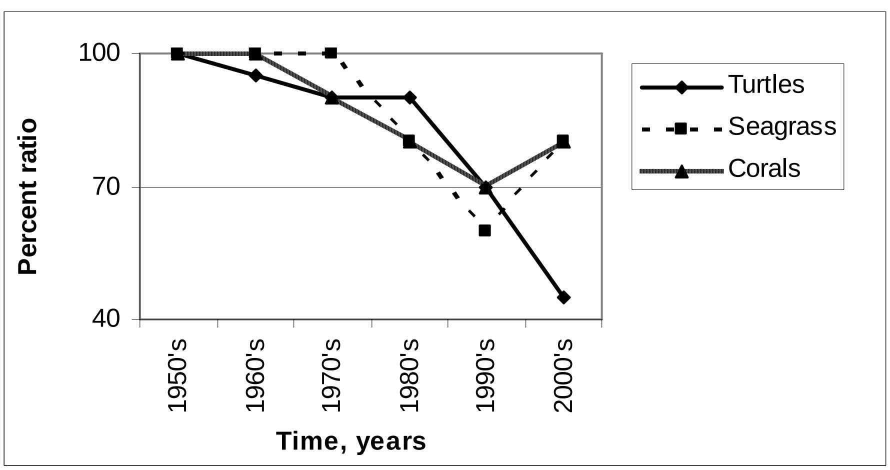


Figure 4. Community assessment of resource prevalence (turtles, corals and seagrass beds) trendlines over the years within the three sites (data based on score percent ratio averages)

An initial PRA exercise carried out by KESCOM (Nzuki, et. al., 2005) indicated that turtle populations had declined by 40% based on fishermen reports on frequency of sightings and capture in fishing gear. The study focused on the time period 1998-2004. The current project sought participation by older members of the community in assessing resource prevalence using 1958 as the base year and recorded a perceived decline of 55%. This result has important implications in terms of age group composition of PRA meetings although the two results are comparable. Both coral cover and seagrass beds were recorded as having declined by a margin of 20% although a 30and 40% decline was reported during the 1990's and was attributed to the El Nino phenomena.

Seagrass beds

Six species of seagrass exhibiting different zonations and cover types were identified within the study area. They include *Zostera capensis, Halodule univervis, Cymodecea serrulata, Thelassia hemprichii, Siringodium isoetifolium* and *Thelassodendron ciliatum.* The dominant zonation pattern from open beach stretches to the sublittoral zone followed cover types of *Halophila ovalis* or *Halodule univervis* gradually giving rise to pure *Cymodocea spp.,* then zones of *Zostera capensis* and *Siringodium isoetifolium. Thelassodendron ciliatum* formed extensive beds within the sublittoral zone in Msambweni and off Funzi Island.

Both *Halodule univervis* and *Zostera capensis* occupy the eulittoral flats in Msambweni but have limited distribution within the Funzi-Bodo channels. *Zostera capensis* also occurred as small pockets on sandy substrates in all the three sites. *Thelassia hemprichii* was widely distributed along entire eulittoral flats but was the most dominant species within sheltered pools. The percent cover per species ranged from 4.83 to 44.23% at Funzi, 1.3 to 30.8% in Muriani and 3.23 to 28.25% in Msambweni. *Thelassodendron ciliatum* had the highest percent cover (up to 44.23%) and dominated areas well beyond the reef in Msambweni and off Funzi Island (Fig. 5). Within the Funzi-Bodo channels, it occurred in isolated pockets in relatively deeper (4-5m) areas. A two-way ANOVA statistic indicated no significant differences in cover between and among the three sites. In general, most of the sampling stations were dominated by *Thelassodendron ciliatum, Thalassia hemprichii, Siringodium isoetifolium, and Halodule uninervis.* The cumulative cover of seagrass per site (Fig. 6) was proportional to the sampling effort although there is an indication of leveling after $10m^2$ of sampling for Funzi and Msambweni areas.

Reports on green sea turtle sightings and capture by local fishermen (n=68) were spatially related to areas dominated by pure mixed pastures of *Cymodocea spp. Halodule uninervis Thalassia hemprichii and Thalasodendron ciliatum* and nearshore rocky reefs. Observations and examination of gut contents of stranded green turtles (n=3) revealed diets of mainly *Thalassia (50%), Cymodocea (30%), Syringodium (12%) and Ulva spp. (4%).* The rest consisted of red and brown algae.

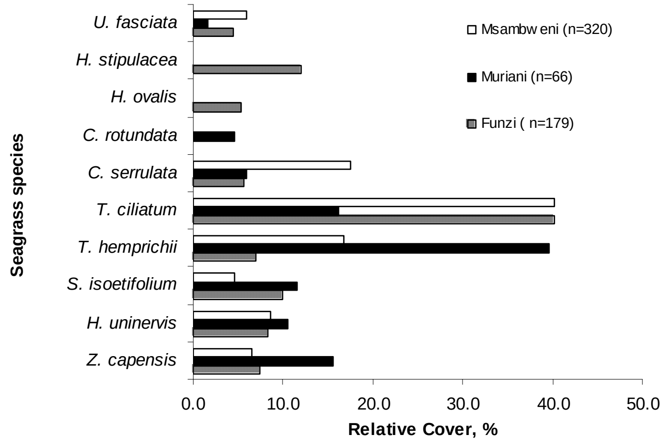


Figure 1. Comparison of the mean percent relative cover of the reported sea grass species for the three sites i.e. Msambweni, Muriani and Funzi

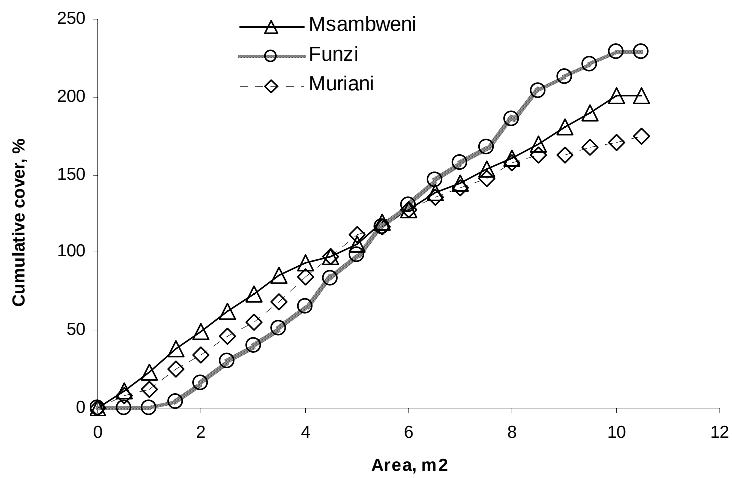


Figure 2. Sea grass species cover (%) curves (mean cumulative cover per $1M^2$) for the three studied sites

Mollusks, gelatins and sponges

The overall mean densities of sponges were higher in Msambweni than in Funzi - Bodo sites pooled ($p<0.001$) (Fig. 7) while there were more mollusks within the Funzi-Bodo channels compared to Msambweni ($p<0.001$). The distribution of gelatins was not significant between the two sites ($p>0.05$). The dominant sponge species, *Pseudaxinella coccinea* was widely distributed within intertidal pools in Msambweni and Kidomoni in Funzi while *Aaptos cf chromis* occurred on seagrass beds dominated by *Thalassia hemprichii. Carteriospongia* *foliascens* and *Strepsichordaia radiata* were recorded within the reef systems. *Terebralia palustris* and *Cerithium caerulem* dominated rocky substrates in all the study sites while gelatins (mostly of the genus- *Crambionella orsin* and *Mastigias papua*) were counted off-shore from Funzi Island and Msambweni.

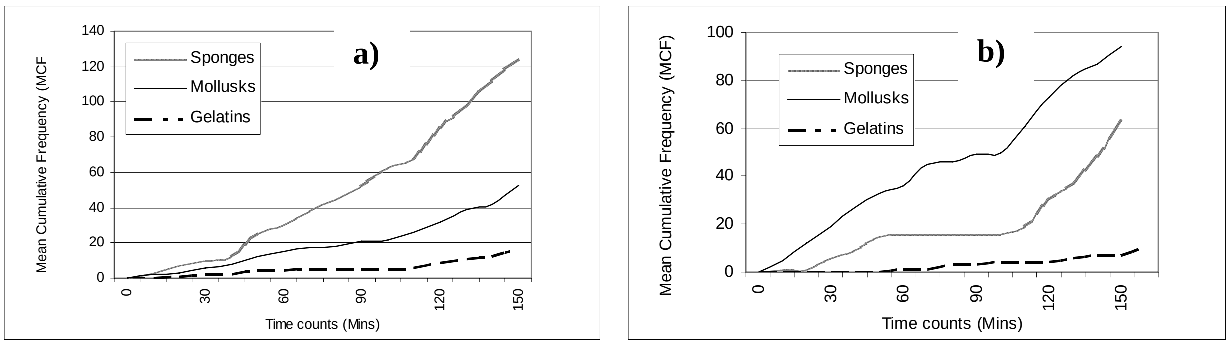


Figure 3. The cumulative mean frequencies of selected sea turtle food items (sponges, mollusks and gelatins) based on time counts for a) Msambweni and b). Funzi-Bodo area.

Beach temperature

A t-test comparison of differences in nest and beach temperature measurements showed no significance (Fig. 8). The mean temperature range at a depth of 10-30cm was higher for the Funzi hatchery when compared with samples from Funzi beaches ($t= 2.7, p<0.05$) but was not significant when compared with measurements from Bodo beach stretches ($t= 0.05, p>0.05$). However there were significant differences in temperature range reported within sites i.e. Funzi ($t= 1.73, p< 0.05$) and Msambweni beaches ($t= 4.00, p<0.05$) at depths of 10-30cm. Funzi had the highest mean temperature range at all depth measurements. Between 10-30cm, 30-60cm and 10-60cm the ranges were 1.85, 1.13 and 2.98^{o}C respectively (Fig.9). The lowest temperature range reported was 0.05, (10-30cm) at the Funzi hatchery.

Across sampling stations, the mean temperature range at a depth of 10cm was recorded as 28.42 – 33.50^{o}C and that of 30cm as 27.0 – 31.5 ^{o}C. At depths of 60cm, the mean temperature range within the beach stretches was recorded as 26.75-30.58 ^{o}C with many of the values clustering above 29 ^{o}C. The upper temperature limit compares well with the findings of Collingborn, 2003 during a study of the Mombasa beaches where temperatures at 60cm were shown to fall between 28.5 – 30.0 ^{o}C. The mean incubation period for the Funzi hatchery was reported as 55.7± 1.85 days and was found to be correlated with the mean monthly temperature range (r=0.67).

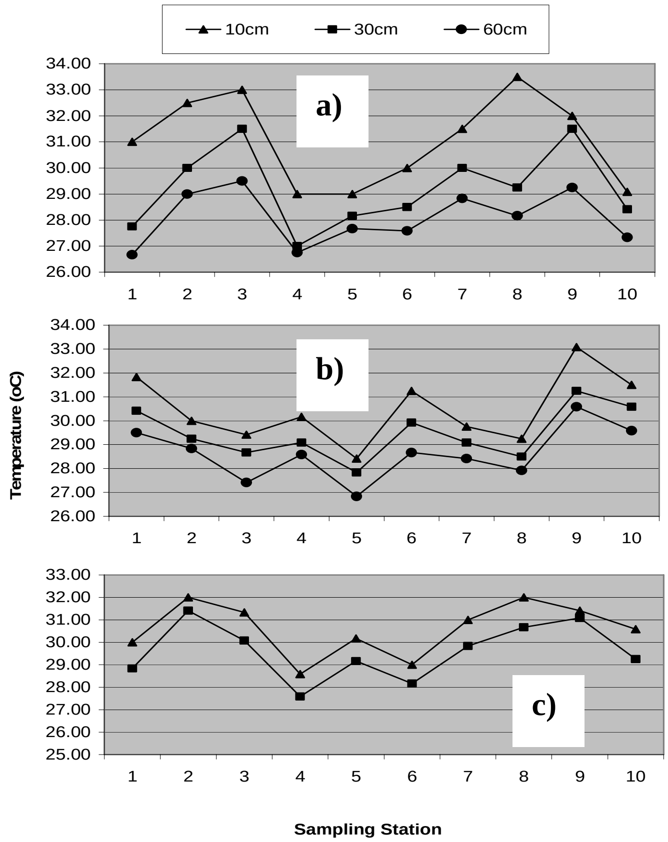


Figure 4. Mean temperature (^oC) variations across sampling stations in a) Funzi, b) Msambweni and c) Hatchery site

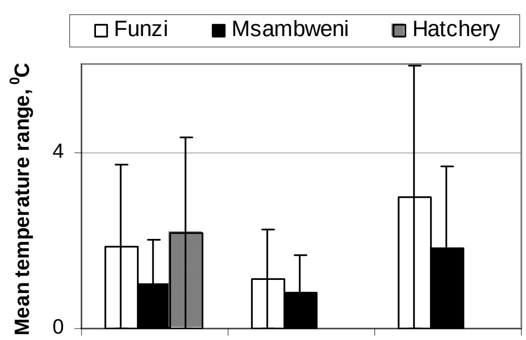


Figure 5. The mean temperature range (^oC) recorded for various depths for the entire survey period from beach stretches in Funzi , Msambweni and the hatchery site located in Funzi (error bars are based on ±S.E.M)

Nesting frequency, mortalities and sightings

The green and hawksbill turtles nest on Funzi Island and the Msambweni beaches. A total of 67 nests were reported for the period between January 2004-July 2005 accounting for about

10% of the national total (Table 2). Funzi Island had a total of 50 nests out of which 50% were from Shemu shemu beach. The green turtle, *chelonia mydas* had the highest nesting, sightings and mortality frequency (>90%) (Table) which compares well with the national estimates (Okemwa, et.al., 2004). An analysis of the reported mortality cases (Table) shows that the Funzi-Msambweni artisanal fishery is a leading threat to both sea turtles and their habitats.

Table 2. Reported nesting, tagging, releases and sightings of marine turtles reported in Funzi-Bodo and Msambweni during the study period (July 2003-July 2005) compared with similar reports from other areas along the Kenya coast

Turtle Group	*Nests*	*Tagged turtles*	*Fishermen releases*	*Sightings*
Diani-Chale	7	*	2	*
Funzi	**50**	**72**	**88**	**62**
Msambweni	**17**	*	*	*
Baobab	131	2	4	*
Kilifi	25	*	2	36
Watamu	132	595	961	11
Robinson	4	6	3	*
Tana Friends	59	9	77	191
LamuCop	69	61	47	7
WWF-Kiunga	197	19	*	37
Totals	*691*	*764*	*1184*	*344*

* Data missing or not available

Discussion

Human pressure as well as natural threat indices affects the status and character of beaches, seagrass beds and reef systems which have important implications for the survival of sea turtles. The selection of nesting beaches by green turtles has been shown to be influenced by off-shore approach, beach vegetation, biotic and abiotic factors (Mortimer, 1982). Nesting sites on Funzi Island are characterized by the presence of thickets, bush land and coastal forests thus providing a suitable habitat for non-human predators mainly porcupines and mongoose. As a result although nesting frequency is highest at Shemu shemu (50%) and Mwakinyavu (30%) beaches on Funzi Island they have the highest natural predator index. The effect of beach front vegetation on the choice of nesting sites was also noted in Mwakinyavu where green turtles tend to nest (n=10) below the high water mark. As a result clutch survival rates on Funzi beaches are low (<50%) compared to Msambweni (>70%). In addition Funzi beaches are located in remote areas of the Island which are regularly accessed by fishermen and are difficult to patrol in terms of logistics. However due to an incentive scheme provided by a local hotelier local community members actively search for nests and provide regular reports in anticipation of monetary rewards.

The higher rates of clutch survival in Msambweni are attributed to the establishment of a local community conservation group during the period of this study. A patrols and monitoring program was subsequently initiated with modest support from KESCOM and stakeholders in Msambweni to protect nests and turtles from poaching and predators. Marine turtle products have economic and social – cultural values to the local community. Poached marine turtle products are either consumed in Funzi, Bodo and Msambweni areas or traded with an estimated trade volume of USD 442 (Nzuki, 2005) per month for approximately 60 households.

The results of scaling of threats to nesting and foraging grounds indicates the need for the design of appropriate conservation measures to address both human poaching of turtle eggs and females and natural predation of clutches. Targeted awareness and conservation education programs as well the strengthening of existing TCGs to consistently conduct patrols and monitoring are more likely to reduce cases of illegal activities. Funzi beaches which are ranked highest in terms of natural predation will need to be patrolled all night through for 7days a week during the peak nesting season and threatened nests relocated to protected beach stretches.

Environmental factors such as temperature variations on beach stretches have important implications on recruitment and population dynamics of sea turtles since they affect hatchling sex and incubation period (Mrosovsky, 1980). Since pivotal temperatures for green turtles are regarded as between 28.0-30.0 ^{o}C (males and females respectively), nests laid within beach stretches of Funzi and Msambweni are most likely produce a proportional number of male to female hatchlings since many of the temperature measurements cluster around 29^{0}C. The peaks and lows on the temperature variation charts reflect in part the effect of coastal forests shading and the seasonality of the Kenyan coast (McClanahan, 1988). The two factors suggest a correlation between incubation period and temperature range exhibited by the Funzi hatchery site. In green turtles, temperature ranges of between 0.6-2.2^{o}C have been shown to lengthen incubation periods by between 3-11days (Mrosovsky, 1980). The Funzi and Msambweni beach stretches show temperature variations within this range across the two monsoon periods.

The major threats to sea grass beds within the study site were identified as fisheries, infestation by sea urchins and pollution. The main fishing grounds are located within the lagoon in Msambweni, Kidomoni Channel and the Mpunguti Marine Reserve. Fishing activities are conducted mainly using set gillnets and traditional fishing gear such as baited fish traps. However trawl nets have been reported among immigrant fishers from Pemba and beach seining activities occur within the Funzi, Bodo and Muriani channels. The use of poison was reported to occur within Msambweni area and is common with immigrant fishers. Over fished lagoons in Kenya have been shown to support higher densities of sea urchins (McClanhan & Muthiga, 1989, McClanahan &Curtis, 1991 and McClanahan, 1994) especially due to the reduction of dominant predators such as trigger fish (e.g. *Balistaphus undulatus*). Sea urchin densities per $5M^2$ haphardly placed quadrants ranged from 9 to 94 individuals within the channels to 11-52 individuals within the lagoons. Similar densities have been noted in other fishing grounds along the Kenyan coast (McClanahan, 1994). The abundance of sea urchins was noted to be highest within established fishing grounds in Msambweni and Kidomoni channel in Funzi. These areas were also characterized by lower values of sea grass cover as they were dominated by hard substrate and sand.

There are three main tourist destinations located within proximity of seagrass beds within the study sites i.e. Funzi Keys and Sea adventures on Funzi Island and Paradise Lost at Msambweni mainland, adjacent to Muriani Channel. The hotels have no proper sewage disposal facilities and raw sewage is discharged directly into the lagoons despite the existing legal instruments such the Environment Management and Coordination Act (EMCA) of 1999. Overall the legal framework in Kenya provides for the protection of sea turtles but does not provide mechanisms to ensure the conservation of critical habitats. Furthermore the penalties are flimsy i.e. only USD 267 or an imprisonment lasting two years or both and thus are not an effective deterrent. Within the framework of the new constitution for the republic of Kenya (Kenya Gazette Supplement No. 63) sea turtle nesting grounds have been privatized since public land will only be regarded as the intertidal zone (Chapter 7, Sect. 80&81).

The participatory processes initiated during this study need to be strengthened to promote the conservation and management of sea turtles within the Msambweni-Funzi-Bodo areas including advocacy for legislation and policy review. Further studies are also required to quantify the spatial extent of seagrass beds in these areas and determine the foraging patterns of sea turtles with a view to making recommendations for better fisheries management. The on-going patrols and monitoring program for nesting grounds should be broadened in scope to include assessment of fisheries interactions on basis of the capacity build during this study. The data and information collection methods need to be standardized and the process made more systematic and consistent not only for the study sites but also for the national program.

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