| | |
|---|---|
| Title | A Preliminary Assessment of the Green Sea Turtle Chelonia mydas Population and its Foraging Grounds in Kilifi Creek, Kenya |
| Author(s) | FULANDA, Bernerd; OHTOMI, Jun; MUENI, Elizabeth; NZUKI, Simmons; MUASA, John; MUTHAMA, Charles; HOSSAIN, Yeamin Md. |
| Citation | 南太平洋研究=South Pacific Study, 28(1): 31-41 |
| Issue Date | 2007 |
| URL | http://hdl.handle.net/10232/9540 |

South Pacific Studies Vol. 28, No. 1, 2007

# A Preliminary Assessment of the Green Sea Turtle *Chelonia mydas* Population and its Foraging Grounds in Kilifi Creek, Kenya

FULANDA Bernerd[1, 2], OHTOMI Jun[2*], MUENI Elizabeth[3], NZUKI Simmons[4], MUASA John[4], MUTHAMA Charles[1] and Md. HOSSAIN Yeamin [2]

*1:Kenya Marine & Fisheries Research Institute, Marine & Coastal HQ, Mombasa P.0. Box 81651, Mombasa-80100, Kenya*
*2:Faculty of Fisheries, Kagoshima University, 4-50-20 Shimoarata, Kagoshima 890-0056, Japan*
*3:Fisheries Department, Coast & Marine HQ, Mombasa, Kenya, P.O. Box 90423, Mombasa-80100, Kenya*
*4:Kenya Sea Turtle Conservation Committee (KESCOM), P.O. Box 84688, Mombasa-80100, Kenya*

**Abstract**

This paper presents a preliminary assessment of the green sea turtle *Chelonia mydas* population and its foraging grounds in Kilifi Creek (3° 38′ 11″ S and 39° 52′ 51″ E), Kenya. Estimation of occurrence and body size of *C. mydas* and characterization of foraging grounds were conducted from May 2004 to March 2005 by surface sightings and SCUBA diving. A total of 64 specimens were measured for curved carapace length (CCL), curved carapace width, plastron length and plastron width. Percent biotic cover of the foraging grounds was estimated using standard quick assessment methods. The results indicated that the population of *C. mydas* in Kilifi Creek, though small, was active and widely varied, comprising of juveniles (<60cm CCL), sub-adults (60-85cm CCL) and adults (>85cm CCL) with mean ± SD of 69 ± 17cm(CCL). This convergency of developing, foraging, and nesting individuals calls for enhanced efforts to protect the foraging grounds within the Kilifi Creek. Habitat characterization revealed dominance of *Thelassodendron ciliatum* and *Thalassia hemphrechii* seagrass. However, sponge anchoring *Acropora* corals were also well developed, indicating potential for sponge-feeding *Eretmochelys imbricata* turtles. Further studies should establish other adjacent foraging grounds and their protection focal points in the long term conservation of sea turtles in Kenya.

**Key words:** body size, *Chelonia mydas,* foraging grounds, Kenya, Kilifi Creek, sea turtle

---

Received: November 23th, 2006
Accepted: March 19th, 2007
*Corresponding author: Jun OHTOMI, Faculty of Fisheries, Kagoshima University, 4-50-20 Shimoarata, Kagoshima 890-0056, Japan, Tel: +81-99-286-4152, Fax: +81-99-286-4133,
Email: ohtomi@fish.kagoshima-u.ac.jp*

## Introduction

Kenya's coastline stretches an estimated 600km from 1°42′S to 4°40′E (OKEMWA *et al*. 2004). It is influenced by four oceanic currents; the South Equatorial Current, the East African Coastal Current, the Equatorial Counter Current and the Somali Current (McCLANAHAN 1988, RICHMOND 1997). A total of 140 species of corals have been identified in Kenya (SAMOILYS 1988, SHEPPARD 1999). Seagrass beds occur along the entire coastline associated with the coral reefs, with 12 species of seagrass recorded (UNEP 1998). Five species of sea turtles have been documented within Kenyan waters; green turtle *Chelonia mydas*, hawksbill turtle *Eretmochelys imbricata*, olive ridley turtle *Lepidochelys olivacea*, loggerhead turtle *Caretta caretta*, and leatherback turtle *Dermochelys coriacea* (WAMUKOYA 1996). The first three species are also known to nest in Kenya (WAMUKOYA 1996). *C. mydas*, the largest shelled sea turtle, is classified as a threatened (Red-list) species under the International Union for the Conservation of Nature and Natural Resources (IUCN) (SEMINOFF 2004).

The threats to sea turtle populations along the Kenya coast are highly diverse. Nesting sites are increasingly under threat from beach erosion and hotel developments which have greatly altered the natural shoreline (UNEP 1998, KAIRU 1997). Secondly, the artisanal fishery involving an estimated 80% of fishers along the coast who utilize the marine resources as a sole source of livelihood presents a further threat due to the poaching of sea turtles for their culturally and nutritionally valued meat and oil products (OKEMWA *et al*. 2004). The situation is further aggravated by the declining catches within the artisanal fishery (FRAZIER 1980, WAMUKOYA *et al*. 1997). The degradation of foraging grounds and entanglement of sea turtles in fishing nets, though ignored, also present a major challenge in the conservation of these marine species.

The potential sea turtle rookeries along the Kenyan coast, are estimated at 200km (FRAZIER 1975). However, statistics from the Kenya Sea Turtle Conservation Committee (KESCOM) show declining sea turtle populations along this coast reduced recruitment rates and nesting, attributed to increased fishing and poaching mortalities (NZUKI 2002). Numerous efforts have been done to conserve resident, migrant, nesting and foraging sea turtles within the Western Indian Ocean (WIO) region with numerous studies on population dynamics, by-catch in the trawl fishery and assessment of nesting females (WAMUKOYA 1996, WAMUKOYA and SALM 1997, OKEMWA 2002, FULANDA 2003, OKEMWA *et al*. 2004). However, little focus has been directed towards assessing population density and size distributions of sea turtles in specific foraging grounds (WAMUKOYA *et al*. 1995). Consequently, sea turtle conservation has been focused mainly on protection of nesting sites and reducing accidental mortalities in fishing nets. The identification of key foraging grounds is crucial in defining sound conservation strategies bearing in mind that the key foraging grounds appear to be distributed in the near shore coastal marine ecosystems harboring most life stages of the sea turtles (WAMUKOYA *et al*. 1997, SALM 1994).

Variations in body-size distributions of sea turtles within foraging grounds often indicates the presence of developmental, foraging and migrating cohorts hence the importance of such areas in the conservation of sea turtles (LUTCAVAGE and LUTZ 1997). This is because individuals sharing foraging grounds often derive from different nesting beaches, using these grounds only as migratory pathways. This study aimed to make a quick assessment of *C. mydas* population and characterize its foraging grounds in Kilifi Creek, Kenya, adding to the existing knowledge on these threatened species for purpose of conservation.

## Materials and Methods

This study was carried out within the coastal marine ecosystems off Kilifi Creek in Kenya, 3° 38′11″ S to 3° 42′ 57″ S, and 39° 52′ 51″ E to 39° 54′ 16″ E (Fig.1) from May 2004 to March 2005. Three sites; Bofa-Mnarani (northernmost, with direct view of the creek), Takaungu-Mlangoni reef (at the centre, characterized by gentle shelf-slope) and Vuma site (south of the creek) were surveyed (Fig.1).

The selection of these sites was based on an earlier survey on sea turtle nesting

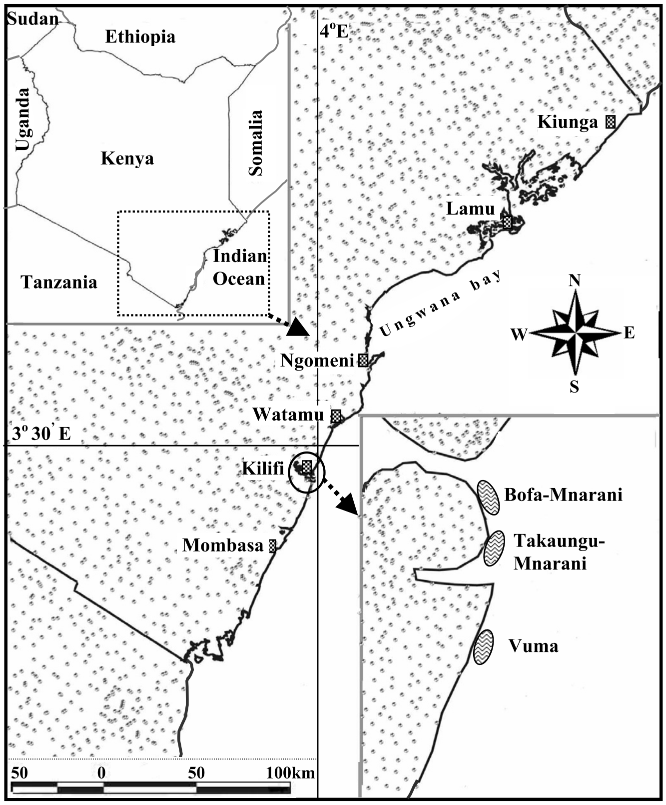


Fig. 1 A map showing the study sites of Bofa-Mnarani, Takaungu-Mlangoni and Vuma in Kilifi Creek, Kenya.

sites (WAMUKOYA *et al*. 1995, NZUKI 2002) and interviews with the local fishers as well as environmental conservation groups. The survey employed a participatory approach, targeting areas adjacent to the key nesting beaches along the Kilifi Creek based on existing information and previous sightings by the fishers.

Livelihood activities within the study area are varied but marine fisheries is the main base for the economies along the entire coast, supporting an estimated 2.7 million inhabitants (HORRIL and KAMAU 2001). However, the fishing activities are highly seasonal with strong dependency on the monsoon winds. Lower fish landings are recorded during the rough SEM season when fishing is restricted to the near shore areas (MCCLANAHAN and OBURA 1994). The Kilifi Creek is located on the main navigation route to and from the fishing grounds and is also an important fishing area for small-raft artisanal fishers. Previous research by KESCOM has mapped the sandy beaches adjacent to the current study sites as important nesting areas for sea turtles (NZUKI 2002).

The Kilifi Creek sites were accessed using a boat and specific foraging grounds identified at the start of the survey in May 2004, based on initial turtle sightings as well as through interviews with fishers and community fisheries resource management groups. The selected study sites were geo-referenced using a hand held GPS (Model; Garmin A91000 eTrex). During the field study period, May 2004 to March 2005, a daily schedule involved a two hour on-boat sighting survey to seek foraging and idling turtles, followed by two hours of combined snorkel and SCUBA dive surveys to estimate body-size measurements of the individuals and characterize the foraging grounds.

Upon sightings, four divers would conduct an underwater survey to identify the sea turtle species and take length-width measurements of the specimens. To achieve this, the targeted individual turtle was assessed from behind and held between the neck, flippers and carapace by two divers. Swimming along with the turtle, the divers took body size measurements using a flexible vinyl measuring tape, according to the methods described by ECKERT *et al*. (1999). Curved carapace length (CCL) was measured mid-dorsally from the anterior margin of the nuchal lamina to the tip of the most posterior marginal (supra-caudals) while plastron length (PL) was measured along the midline from the anterior edge to the posterior edge of the underlying bone (ECKERT *et al*. 1999, BOLTEN 1999). The widths of both carapace and plastron were measured at the widest point of the dorsal and ventral sides respectively. In some cases where capturing the turtle was difficult, the turtle was directed into a cast net and measurements taken over the net to calm the individual. Measured specimens were notched on the third right marginal of the shell using a triangular file. Subsequent identification for capture therefore depended on the presence or absence of a notch ensuring that no individuals were re-sampled.

The measurement of body size was followed by characterization of the grounds where the individual sea turtles had been found foraging or idling. This involved an initial identification of food items of sea turtles such as seagrass, epiphytic algae and coral species within the survey sites. Estimation of biotic cover and species composition among seagrass, epiphytic algae and coral communities were conducted by SCUBA diving based on standard methods for quick assessment of potential foraging grounds (SAITO and ATOBE 1970, ROGERS *et al*. 1983, BOLTEN *et al*. 1996, BOLTEN 1999). A 1-m$^2$ quadrat with 25 sectors was used to estimate % seagrass, epiphytic algae and coral cover. For each site, a total of 14 transects at 10m intervals were conducted resulting in 1,050 sectors for the three study sites. The biotic cover by number of sectors and the dominance of each species in each of the 25 sectors were recorded on slates and all the data for the three study areas pooled together for analyses. The % biotic cover for a dominant species in the study sites was calculated as:-

% cover of species A = 100 x No. of sectors dominated by species A / 1050

Along the East African coast, the onset of the South East monsoon (SEM) weather, characterized by high tides, heavy rainfall and strong currents occurs during March to April (RICHMOND 1997). Consequently, both on-board surface surveys and diving were faced with a lot of difficulties during the start of SEM season in March, restricting the surveys to the near-shore areas of the creek.

## Results and Discussion

The total area surveyed in this study was estimated at 1.5 km$^2$ along the 16km-coastal stretch in the Kilifi Creek. A total of 66 specimens of *C. mydas* were recorded during the study period as shown in Table 1. However, body size measurements for CCL, CCW, PL and PW were estimated only on 64 of the sighted sea turtles due to the rough SEM weather in March 2005 and strong currents in the Kilifi Creek. Moving the sea turtles out of their foraging grounds was avoided as it would stress the individuals. The results showed wide variation in the body size *C. mydas* in Kilifi Creek, comprising of juveniles (<60cm CCL), sub-adults (60cm-85cm CCL) and adults (>85cm CCL), an indication that the population, though small, was still active (HIRTH 1980). The mean ± standard deviation of the body size measurements of the 64 individuals were estimated as 69 ± 17cm (CCL), 62 ± 16cm (CCW), 54 ± 13cm (PL) and 52 ± 13cm (PW). The length-frequency distribution of the measured specimens is shown in Fig. 2. These wide variations in body sizes of *C. mydas* in the Kilifi Creek suggest that the study sites are convergent developmental, foraging, pre- and post-nesting habitats as well as migratory pathways for this species within the WIO eco-region. Positive correlations were observed between CCL and PL ($n$ = 64, $r^2$ = 0.992) and between CCW and PW ($n$ = 64, $r^2$= 0.962) as shown in Fig. 3 and 4 respectively.

Six key species of seagrass were identified within the study sites; *Thelassodendron ciliatum, Thalassia hemphrechii, Siringodium isoetifolium, Zostera capensis, Halodule univervis and Cymodecea serrulatta*. The first two species, *T. ciliatum* and *T. hemphrechii,* were dominant, accounting for about 63% and 57% of the estimated sea-

Table 1. Summary of sightings in the preliminary survey of green sea turtle Chelonia mydas population and its foraging grounds at Bofa-Mnarani, Takaungu-Mlangoni and Vuma in Kilifi Creek, Kenya.

| Month | Duration of survey (day) | No. of individuals sampled |
|---|---|---|
| May 2004 | 4 | 17 |
| June | 3 | 7 |
| July | 2 | 7 |
| Aug. | 0 | _ |
| Sep. | 2 | 6 |
| Oct. | 2 | 0*[1] |
| Nov. | 2 | 7 |
| Dec. | 0 | _ |
| Jan. 2005 | 0 | _ |
| Feb. | 2 | 0*[2] |
| Mar. | 3 | 20 + 2*[3] |
| Total | 20 | 66 |

*[1] -Characterization of foraging grounds and geo-referencing of study sites.

*[2] -Characterization of foraging grounds, and meeting with community resource management groups and fishers

*[3] -Body size measurements of two specimens were not taken due to strong currents and rough weather associated with the February-May South east monsoon weather.

grass cover in the three sites based on the characterization using quantrats. Five species of corals, belonging to the genera *Acropora, Echinopora, Pocillopora, Porites,* and *Montipora* were recorded, with *Acropora* species dominating the coral cover. However, identification of the corals to species level was not done since they only serve to anchor epiphytic algae and sponges which are the major food items for sea turtles. Among the three sites, Bofa-Mnarani had notably well developed coral gardens compared to Takaungu-Mlangoni and Vuma. The presence of the well developed corals allows for the anchorage and growth of sponges hence the grounds are noted as potential foraging grounds for the sponge feeding *E. imbricata* species. However, despite the relatively well developed corals in Bofa-Mnarani, the morphology of the Kilifi Creek, characterized by strong currents and waves reduces its potential for *C. mydas* foraging. The Takaungu-Mlangoni and Vuma sites, which are well sheltered therefore present more potential foraging grounds. This is further enhanced by the dominance of the *T. ciliatum* seagrass species which is a major food item for *C. mydas*. Fewer shoreline developments and beach use especially in the Takaungu-Mlangoni site also gives these foraging grounds an added advantage over the Bofa-Mnarani and Vuma sites, which recorded increasing tourist and quarrying related activities. This reduces the area of undisturbed nesting beaches available for sea turtles (MORTINER 1982). This survey also

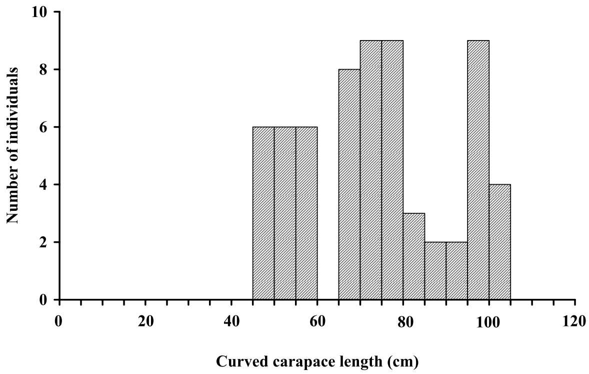


Fig. 2 Length-frequency distribution in curved carapace length (CCL) of green sea turtle *Chelonia mydas* sampled in Kilifi Creek, Kenya. Specimens sampled at Bofa-Mnarani, Takaungu-Mlangoni and Vuma were merged.

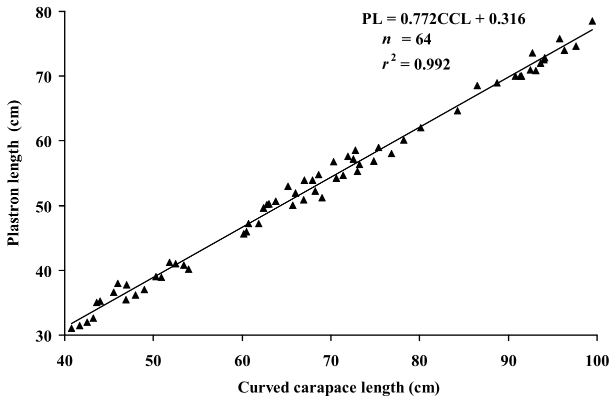


Fig. 3 Relationship between curved carapace length (CCL) and plastron length (PL) for green sea turtle *Chelonia mydas* in Kilifi Creek, Kenya. Specimens sampled at Bofa-Mnarani, Takaungu-Mlangoni and Vuma were merged.

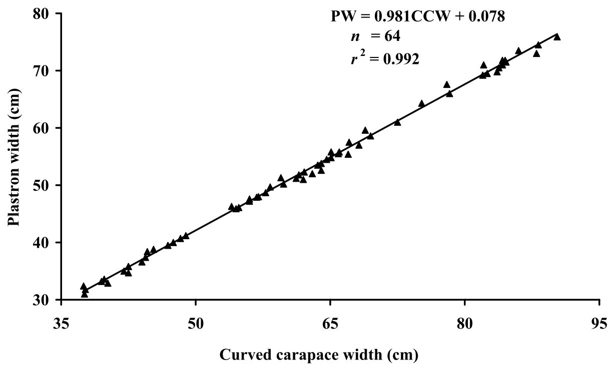


Fig. 4 Relationship between curved carapace width (CCW) and plastron width (PW) for green sea turtle *Chelonia mydas* in Kilifi Creek, Kenya. Specimens sampled at Bofa-Mnarani, Takaungu-Mlangoni and Vuma were merged.

noted that the foraging grounds for *C. mydas* appear remotely located far from the near shore areas, lying within the deep habitats. However, many individuals sought extended refuge within creeks during stormy weather. Comparing the sightings within the three study sites, it is evident that shoreline developments had an influence on the preferred convergency grounds for the sea turtles

The key foraging grounds within the Kilifi Creek were estimated at about 6km$^2$ along the 16km coastline, broken into three patches on the Bofa-Mnarani, Takaungu-Mlangoni and Vuma sites. The observations of the current study show that the influence of currents, nature of the reefs and access to nesting sites also appeared to influence the size of foraging population in a particular ground. Fewer sightings were recorded within the stormy Vuma site. The well sheltered Bofa-Mnarani and part of the Takaungu Mlangoni site recorded higher sightings and hence present key focal areas in the definition of conservation strategies for the sea turtles in the Creek. Further studies should be conducted in the fishing grounds adjacent to sea turtle rockeries along the entire 200km stretch on the Kenya coast and map out other key foraging grounds within these areas.

Interviews with the fishers indicated that sea turtle mortalities within the Kilifi Creek were attributable to direct poaching and cases of entanglement in set-nets were rare. During the entire survey period, capture of sea turtles by use of set-nets was not observed. Any reported moralities would therefore be attributed to spear gun fishing or injuries from boat engine propellers. The absence of bigger-sized nets in the study sites due to the lack of capital among the fishers for acquisition of longer and deep-set fishing nets also supports these observations.

## Conclusion

From the current study, the Kilifi creek presents key convergent grounds mainly for the *C. mydas*. However, the key foraging grounds appear patchy, covering only an estimated 6km$^2$ of the fishing grounds. The well sheltered Bofa-Mnarani and part of the Takaungu Mlangoni site presented relatively richer foraging grounds, hence the need to carry out further surveys to establish other sea turtle species which may be converging in these grounds. In overall, this study presents a new front in defining conservation strategies for sea turtles in Kenya and the wider EAME region, targeting both foraging and nesting grounds as focal points to protect these endangered marine species.

## Acknowledgements

The authors would like to thank the OAK Mini Grant Foundation for the financial support towards the study. Special thanks go to Dr. Larry Crowder and Sloan Freeman for coordination and guidance during the study. Extended gratitude go to the Department of fisheries, Kenya Marine & Fisheries Research Institute (KMFRI) and Kenya Sea Turtle conservation committee (KESCOM) for the research backup and equipment and to all fishers and conservation groups in the study areas in Kilifi. Special thanks go to Dr Nyawira Muthiga of World Conservation Society, Mombasa, for advice and guidance during the survey period and provision of GPS equipment, and to all who made the study a success.

## References

BOLTEN, A.B. 1999. Techniques for Measuring Sea Turtles. In: Research and Management Techniques for the Conservation of Sea Turtles. (Ed. Eckert, K.L., Bjorndal, K.A., Abreu-Grobois, F.A. and Donnelly, M.), 110-114, IUCN/SSC Marine Turtle Specialist Group Publication No 4, Washington, D.C, USA.

BOLTEN, S., CHIPPONE, M., DELGADO, G.A. and SULLIVAN, K.M. 1996. Manual Assessment and Monitoring Methods. 187 pp., Parque Nacional del Este, Dominican Republic, Florida and Caribbean Marine Conservation Science Center, Miami, USA.

ECKERT, K.L., BJORNDAL, K.A., ABREU-GROBOIS, F.A. and DONNELLY, M. (ed.) 1999. Research and Management Techniques for the Conservation of Sea Turtles. 235 pp., IUCN/SSC Marine Turtle Specialist Group Publication No. 4, Washington D.C, USA

FULANDA, B. 2003. Shrimp Trawling in the Ungwana Bay: A Threat to Fisheries Resources In: Recent Advances in Coastal Ecology- Studies from Kenya (Ed. HOORWEG, J. and MUTHIGA, N.), 233-242, African Studies Centre, Research 70/2003, Leiden, Ipskamp BV, Enschede, The Netherlands.

FRAZIER, J. 1975. The Status and Knowledge on Marine Turtles in Western Indian Ocean, East Africa Wildlife Society Report, Nairobi, Kenya.

FRAZIER, J. 1980. Exploitation of marine turtles in the Indian Ocean. Human Ecology, 8, 329-370. J. Frazier, National Zoological Park, Smithsonian Institution. Washington, D.C., 20008 USA.

HIRTH, H. F. 1980. Some aspects of the nesting behavior and reproductive biology of sea turtles. Amer. Zool., 20: 507-523.

HORRIL, C. and KAMAU, I. (ed.) 2001. Proceedings of the Eastern African Marine Ecoregion Visioning Workshop, 21st-24th April, 2001, Mombasa, Kenya

KAIRU, K. K. 1997. Vulnerability of the Kenyan Shoreline to Coastal Instability. In: Sustainable Coastal Development through Integrated Planning and Management Focused on Mitigating the Impacts of Coastline Instability. White sands Hotel, Mombasa, 23rd-25th June 1997. UNESCO, Nairobi, Kenya. pp13-25.

LUTCAVAGE, M. and LUTZ, P.L. 1997. The Diving Physiology of Sea Turtles. In: The Biology of Sea Turtles (Ed. LUTZ, P.L. and MUSICK, J.), 277-296, C.R.C. Press.

MCCLANAHAN, T.R. 1988. The Seasonality of East Africa's coastal waters, Mar. Ecol.Prog. Ser., 44: 191-199

MCCLANAHAN, T. R and OBURA, D., 1994. Status of Kenyan coral reefs. Coastal Management 23: 57-76.

MORTIMER, J. A. 1982. Factors Influencing Beach Selection by Nesting Sea Turtles. In: Biology and Conservation of Sea Turtles (Ed. BJORNDAL, K.A.), 45-51, Smithsonian Institution Press, Washington, D.C, USA.

NZUKI, S. 2002. Turtle Conservation Groups (TCGs) in Kenya: A needs Assessment Survey Report, KESCOM Technical Report 4, Mombasa, Kenya

OKEMWA, G. 2002. Nesting and Mortality Patterns of Sea Turtles along the Kenyan Coast (1997-2000). KESCOM Technical Report 4, Mombasa, Kenya.

OKEMWA, G., NZUKI, S. and MUENI, E. 2004. The Status and Conservation of Sea Turtles along the Kenya Coast. Marine Turtle Newsletter, 105: 1-7.

RICHMOND, M.D. (ed.) 1997. A Guide to the Seashores of Eastern Africa and the Western Indian Ocean Islands. 448 pp., SIDA/Department for Research Corporation SAREC, Sweden.

ROGERS, C.S., GILNAK, M. and FITZ III, H.C. 1983. Monitoring of coral reefs with linear transects: A study of storm damage. J. of Exp. Mar. Bio. and Ecol., 66:285-300.

SAITO, Y. and ATOBE, S. 1970. Phytosociological Study of Intertidal Marine Algae. I. Usujiri Benten-Jima, Hokkaido. Bulletin of Faculty of Fisheries, Hokkaido University, 21:37-69.

SALM, R. 1994. Coral's Hidden Riches. People & the Planet, 3(1): 19-21.

SAMOILYS, M. 1988. Abundance and Species Richness of Coral Reef Fish on the Kenya Coast: The Effects of Protective Management and Fishing. Proc. 6th Int. Coral Reef Symp., 2: 261-266.

SEMINOFF, J.A. 2004. *Chelonia mydas*. In: IUCN 2006. 2006 IUCN Red List of Threatened Species.

SHEPPARD, C. 1999. Biodiversity Patterns in Indian Ocean Corals, and Effects of Taxonomic error in Data. Biodiversity and Conservation, 7: 847-868.

UNEP, 1998. Eastern Africa Atlas of Coastal Resources: Kenya. 119 pp., United National Environment Programme, Nairobi, Kenya.

WAMUKOYA, G. 1996. Kenya to Minimize Turtle Mortality in Shrimp Fishery. Marine turtle Newsletter, 73:17-18

WAMUKOYA, G.M., MIRANGI, J. and OTTICHILO, W.K. 1995. Marine Aerial Survey: Sea Turtles and Marine mammals. Kenya Wildlife Service Technical Report. No. 3: 48 pp, KWS, Nairobi, Kenya.

WAMUKOYA, G. M., OTTICHILO, W. K. and SALM, R. V. 1997. Aerial Survey of Dugongs *Dugong dugon* in Ungwana Bay and the Lamu Archip*elago*, Kenya. Kenya

Wildlife Service Tech. Report No. 2:13pp, KWS, Nairobi, Kenya.
WAMUKOYA, G.M. and SALM, R.V. 1997 (ed.) 1997. Proceedings of the Western Indian Ocean Turtle Excluder Device (TED) Training Workshop, Mombassa, Kenya. 30 pp., IUCN. Nairobi, Kenya.