Status of Marine Turtles in Eritrea

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Executive Summary

Five species of sea turtles present in the Eritrean waters: hawksbill, green, olive Ridley, loggerhead and leatherback. The first three species are recorded to nest. All are categorized by the IUCN as endangered or critically endangered and are listed on Appendix I of CITES.

The hawksbill turtle is the most common and widely distributed. Nesting has been recorded in 109 areas along the main land from Ras Kesar to Rahaita and in remote offshore islands of Dahlak archipelago, bays of Hawakil, Assab and Barasole. The most important nesting sites are islands such as Mojeidi, Aucan, Dahret Segala, Ras Fatuma, Urubia, Rijyuma, Danabah and Dissei. Nesting commences in December and ends in June with peak from February to March. Although no animals bearing tags from other countries in the region have been recorded, the hawksbill is a migratory species that can probable harbors in Eritrea.

The green turtle is also relatively abundant and widespread species. Low density nesting has been reported along the offshore island of Dissei, Assarka White, Shumma, Umm Namus, Mojeidi and Howeit. The main nesting season is probably between January and May. Evidence from tag returns indicate turtles that nest in Oman, Pakistan and Jordan migrate to foraging grounds in Eritrea.

Little is known about the status of olive Ridley turtle although it was observed trying to nest in Ras Terma southern Eritrean Red Sea region in May 2005. This was the first nesting record in the whole Red Sea Region. No further nesting records for this species have been found. Local fishermen have reported that it is seen rarely in the water. There have been records of the animal in incidental catch of the industrial shrimp and fish trawlers.

Loggerhead turtles are relatively rare in Eritrea .There is no nesting record and no evidence from tag returns signifies that these species have important foraging grounds.

Very little information is available on leatherback turtles because they are so rarely sighted and indigenous knowledge is limited. 39 leatherback turtles were incidentally caught in commercial trawlers in 1994 – 2004. Fishermen suggest that they are deep water species.

The main threats to turtles in Eritrea include incidental catch in trawling, net entanglement, disturbance of nesting and foraging habitats, poaching of eggs and hunting. Minor threats are natural such as predation of eggs and hatchlings, erosion of beach and light disorientation of hatchling. Future threats will probably include land-based development and pollution. All these combined with limited awareness, lack of adequate protection and enforcement lead the population of turtles to decrease in the last twenty years.

The first proposed sites, Dissei and Sheik Seid islands, as marine protected areas are of limited interest for the conservation of turtles. Marine protected areas should be broadened and include the key nesting and foraging sites such as Mojeidi, Aucan, Dahret Segala, Ras Fatuma, Urubia, Rijyuma, Danabah and Selafi (Barasole).

Recommendations for research and monitoring include further studies on turtle reproduction, nest biology, foraging habitats, genetics and threats; and tagging to determine movements and breeding frequency.

Conservation and management priorities include the protection of key habitats, compulsory use of Turtle Excluder Devices (TEDs) by commercial shrimp trawlers, restriction of gillnets in key foraging grounds, prohibition of fishing in the main nesting areas during nesting season. As a support to these regulatory proposals, promotion of community participation in the management of coastal and marine resources

through recruitment of Community Turtle Monitors and their involvement in Beach Management, awareness raising, the development of a Turtle Recovery and Action Plan, the coordination of activities at national and regional levels and fund raising will be essential for the long term conservation of marine turtles.

1. Introduction

1.1. *General Back Ground*

Worldwide, there are 7 species of marine turtle, representing two families. The family Dermochelyidae includes the leatherback (*Dermochelys coriacea*) and the family Cheloniidae: green (*Chelonia mydas*), hawksbill (*Eretmochelys imbricata*), loggerhead (*Caretta caretta*), olive Ridley (*Lepidochelys olivacea*), kemp's Ridley (*Lepidochelys kempi*) and flatback (*Natator depressus*).

Marine turtles occur in tropical and sub-tropical seas throughout the world. Two species have a relatively restricted range: the Kemp's Ridley occurs in the Gulf of Mexico and eastern seaboard of the United States, and the flatback is endemic to the Australian continental shelf (Meylan & Meylan, 1999). The other five species are cosmopolitan in distribution. Primary foraging grounds are generally in warm waters on relatively shallow continental shelf areas and nesting tends to follow a tropical pattern predominantly on small islands and mainland beaches (Miller, 1997).

Turtles are ecologically and economically important. They are keystone species, important for the health of ecological system (PERSGA, 2004). Turtles and their products have been over-exploited for subsistence use and for national and international trade supplying protein (eggs, meat, and calipash), leather, oil and ornamental objects to coastal communities and to markets in Europe, America and Asia. Green turtles have been targeted for meat, eggs, oil and medicine and hawksbills to supply a world market with highly the valued tortoise shell (Frazier, 1980). However, misuse of marine turtles has resulted in severe declines of most populations around the world.

The threat to turtles from direct consumption has been exacerbated more recently from incidental captures in commercial, and to a lesser extent, artisanal marine fisheries, notably drift-netting, prawn trawling and long-lining, as well as the effects of nesting beach alteration or destruction, marine and land-based pollution, erosion, destructive fishing practices and sea level rise associated with global warming.

These combined factors have led to a dramatic decline in global turtle populations with certain species, notably leatherback and hawksbill, witnessing population declines of almost 80% in recent decades (Pritchard, 1982; Spotila et al., 1996; IUCN, 2004). All turtle species are on the IUCN Red List of Threatened Species: hawksbill and leatherback are categorized as "critically endangered", and the green, loggerhead and olive Ridley are "endangered" (IUCN, 2004). All are listed on Appendix I of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) which prohibits commercial trade.

The status of sea turtles have been warned conservation of the animal is a priority task. As conservation measures countries have signed Conventions, treats regionally and internationally prohibiting any trade, cooperating with each other in researches, conservation, monitoring and public awareness.

The most regional accurate status of sea turtle in Red Sea region was summarized by Ross and Barwani (1982). In the region five species are present; hawksbill, green, loggerhead, olive Ridley and leatherback. And only the first two species are known to nest. In the region all species are on the IUCN Red List of Threatened Species.

1.2. *Status of Marine Turtles in Eritrea (Historical review)*

The status of turtles in Eritrea was not studied in detail. Hillman and Gebremariam (1995) briefly summarized existence and nesting of turtles. The Eritrean Red Sea waters support five of the seven species of sea turtles: hawksbill, green, olive Ridley, loggerhead and leatherback. Three of them: hawksbill, green and olive Ridley are known to nest in the region (Anon, 1972; Hillman and Gebremariam, 1995; Hoofien and Yaron, 1964; Pilcher *et al*, 2006; Urban, 1970).

Turtle's meat, eggs and carapaces have been used for subsistence as a source of food, medicine and ornament. Turtle meat is highly prized by the coastal communities (Afar) and is occasionally sold in the coastal villages. In 1995 a kilo of meat was sold at 3 birr (0. 45 US $) in Assab (Ministry of Marine Resources 1995, unpublished).

At one time the Eritrean islands were important supplier to the international tortoise-shell trade. Turtles have been heavily exploited at most of the more accessible Dahlak Island. More than 100 islands were probably support more than 2000 fishermen who had harvested turtles (Anon, 1972; Frazier, 1983; Frazier and Salis, 1984). Hoofien and Yaron, (1964) reported that they had purchased two green turtle carapaces and a live hawksbill from fishermen in Nokra. Between 1968 and 1986, more than 3559 kg of tortoiseshell (hawksbill carapace) were imported to Japan. This figure equals about 1500 hawksbills harvested (Groombridge and Luxmoore, 1989).

Although Eritrea has national legislation prohibiting exploitation and is signatory to many international conventions including CITES, Convention on Migratory species ,Convention on Biodiversity, and Indian Ocean and South East Asia Marine Turtle Memorandum of understanding (IOSEA MOU) that concerning sea turtle conservation, prohibiting international trade etc, only little measures pertaining conservation, research ,monitoring and public awareness were taken.

A project, Eritrean Coastal Marine and Island Biodiversity (ECMIB) which was funded by Global Environmental Facility (GEF) and implemented by UNDP and the State of Eritrea (Ministry of Fisheries) was initiated. The project, which was a five year range, had to be started in 1998 and ended 2003; unfortunately, due to the border conflict between Eritrea and Ethiopia it could not perform at the specified time range and was extended to some years. However, again it commenced effectively at the end of 2004 and phase-out in December 2007.The main objectives of the project were: to conserve the species, summarize the status and outline possible marine protected areas of the globally significant species of fauna and flora which are threatened due to the increasing infrastructures such as development of fisheries, tourism, land filling, oil and gas exploration in the marine, coastal and island of Eritrean territory. As turtles are one of the most significant and threatened species regionally and, globally they were the main focus of the project.

1.3. *Turtle Conservation Initiatives in Eritrea*

In November 2004, the ECMIB initiated turtle conservation program with ten-day intensive training course in marine turtle biology and conservation, attended by more than 24 staff and specialists of the project and various stakeholder groups (including the Ministries of Agriculture, Fisheries, Tourism, and the Environment). From the participants, a team of four ECMIB Project staff were selected to form a core turtle research and conservation group. The main goals of the team were conserving the species, conducting research and monitoring, summarizing the status and recommendation, and outline possible marine protected areas. The team began surveys of the coastal areas and islands at the end of December 2004 with the following sub objectives:

1. Comprehensive studies on sea turtle nesting and foraging habitat
2. Studying distribution of turtles
3. Identifying the actual and potential threat to sea turtle
4. Protection of key nesting and foraging habitats
5. Find critical conservation initiatives and,
6. Raising Public awareness

2. Materials & Method

The method used throughout the study period conforms to the PERSGA/GEF survey method (2004). The brief description is presented below.

2.1. *Interviews*

Interviews were conducted wherever fishermen were encountered. Questions were translated into ‘Arabic ‘and ‘Tigrinya’ and answers were translated into English by field biologists and guiders. Basic information about sea turtle occurrence, distribution, nesting areas, nesting season, population trend, threats, uses and myths were asked.

2.2. *Beach Surveys*

Most of the coastal areas and islands of Eritrea were surveyed from 2005 to 2007. This includes 154 islands most in the Dahlak Archipelago and the whole coastal areas from Ras Kesar to Rahaita (Appendix). Beach surveys were made to locate nesting, track, estimate nests, record stranded individuals and asses threats to sea turtle. Whenever a dead turtle was found an attempt was made to determine the size, sex and possible cause of death. Turtles were identified using the Indo-Pacific Identification Guide. GPS were employed to map and locate the sites surveyed and digital camera was also applied for documentation. Most of the coastal beaches south from Massawa were driven in four wheel drive Toyota while the other coastal areas and islands were sailed by boat.

2.3. *Island Name*

The islands were named according to unpublished list of the Eritrean Ministry of Fisheries. The island of Dahret, Dergamman and Dergoman, Duluh and Dhu-lalam were added suffix number to avoid confusion but was not designated in the above source.

2.4. *Study Area*

Detailed description of the study area (the Eritrean Red Sea coast and islands) is provided by Ministry of Land, Water and Environment (1999). The brief description presented below is taken from the source.

The Eritrean marine and coastal zone is located in the Southern sector of the Red Sea, an almost enclosed, hot, saline body of water which harbors diversified flora and fauna derived from the Indo-Pacific Ocean. The coastline runs for 1900km, stretching from Ras Kesar in the north to Ras Dumera in the south and the total shoreline is estimated to be over 3200 km. There are over 390 islands recorded (some of these are extremely small). The origins of the islands are divided into three categories: the continental origin comprises 7 islands (23. 78 km^2 of average land area), volcanic 36 islands (11. 78$km^{2)}$ and the coralline 348 islands (of 9. 70 $km^{2)}$. The distribution of the islands are uneven and patchy- there are no islands along the northern coastline in the region from N 16^0 ,38^0 00 to the Sudan Boarder ;over 210 islands form the Dahlak Archipelago and the rest are scattered along the southern coast ,primarily in the Bays of Hawakil, Anfile and Assab. Along the main land coastline there are four major types of physical habitat: sandy coastal plains and shore line running from the Sudan boarder to Massawa area, coralline and rocky shore line extending from Massawa to the Edi area, sandy plain and rocky headland around the Assab area.

Eritrea's coastal and marine climate is hot and humid, with daily temperature in the range 18-40 ^{0}c. The hottest period is July and August (35-4^{0}0c) and the coldest is October- May (18-32^{0}c). Local precipitation flocculates in the range 180-250mm during the months December and January. Tides are semi-diurnal and range between 50 and 120 cm (Edward, 1987).

The Red Sea waters and shoreline form a wide range of marine habitats including coral reefs, sea grass beds, mangrove, salt marshes and salt flats each with representative community of species including more than 53 coral genera,11sea grass species ,11248 fish, 22 sea bird, 5 sea turtle , 75 cetaceans and 1dugong species.

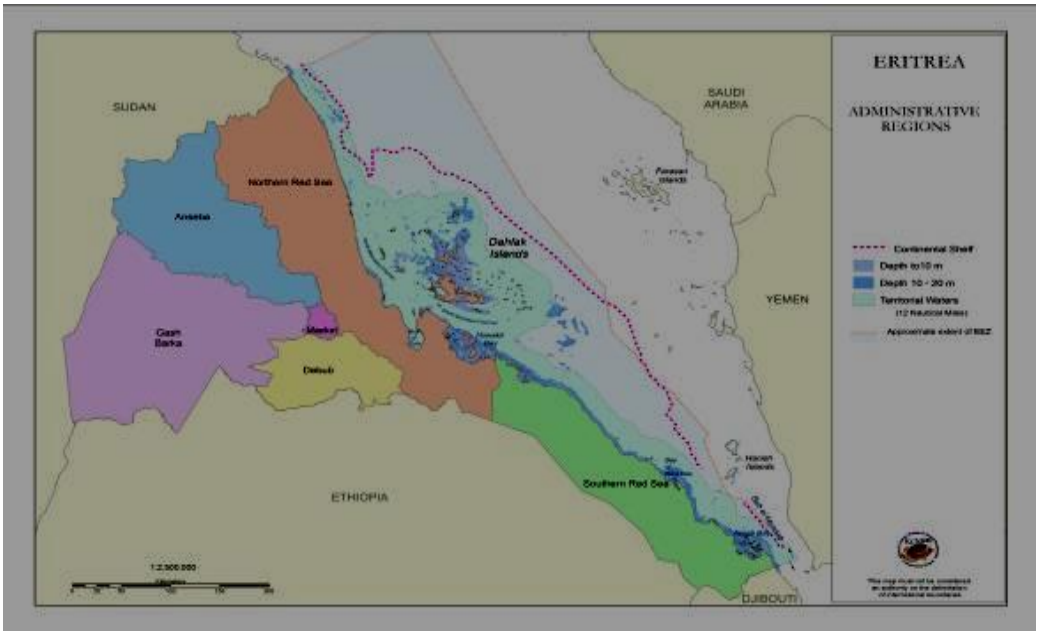

Figure 1 Map of Survey Area

Table 1 Surveyed area, field activities and staff involved

Date	**Surveyed areas**	**Objectives**	**Staff involved**
08 to 09/12/2004 25 to 27/01/2005 09 to 11/02/2005 10 to 13/04/2005 19 to 21/04/2005 18 to 22/11/2005 19 to 26/08/2005 05 to 08/10/2005 24/02 to 10/03 2006 29/09 to10/10 2006 03 to 06/01/2006	**Dahlak Archipelago** (110 sites)	Interview fishermen, record nest, assess threats, record other information Tag turtles, assess threats, nest count	Yohannes Teclemariam Mahta Goitom Tecle Mengstu Simon Woldeyohannes
31/05 to 05/06/2005	**Hawakil bay and Ghe'lalo areas** (15 sites)	interview, nest record, assess threats and record other information	Yohannes Teclemariam Mahta Goitom Tecle Mengstu Simon Woldeyohannes
26 to 29/05/2005 27 to 30/03/2005 01 to 18/05/2007	**Southern Region** (31 sites)	Interview, nest record, tag, asses threats, record foraging and other important information, raise public awareness	Yohannes Teclemariam Mahta Goitom Tecle Mengstu Simon Woldeyohannes Musie Tesfayesus
06 to 21 /05/2007	**Northern Region** (6 sites)	Nest record, assess threats, tag turtle, assess foraging	Tecle Mengstu Tewelde Hagos
18/05 to 03/06/2006 01 to 12/03/2007 26/06 to14 /07/2007	**Mojeidi and Aucan islands** (2 sites)	Tag, measure morph metrics of turtles, eggs and hatchlings	Yohannes Teclemariam Mahta Goitom Tecle Mengstu Simon Woldeyohannes Henok Abraha Arorn Gebrhiwet Aman Andebrhan Riham Debessai Filmon Yohannes
Total man/day 483	**Total sites 154**		11 staff

3. Results and Discussion

3.1. *Occurrence and Distribution*

According interviews with fishermen, field surveys and incidental catch five species of sea turtles exist in the Eritrean Red Sea. Their pelagic presence often leads to their existence in the sea where they caught incidentally in shrimp and fish trawlers (Table 3. 3). Fishermen also commented that they observe these turtles on the sea. All the five species of sea turtle have local names and are listed as endangered and critically endangered in IUCN category (Table 2).

Table 2 Common and local (Afar) names and IUCN Category of Sea turtles in Eritrea

COMMON *NAME*	SCIENTIFIC	LOCAL (AFAR) NAME	IUCN CATEGORY
Green	*Chelonia mydas*	Bisa'e/ Tuhu	Endangered
Hawksbill	*Eretmochelys imbricata*	Lida'e	Critically endangered
Olive Ridley	*Lepidochelys olivacea*	Zahlefa	Endangered
Loggerhead	*Caretta caretta*	Girfa / Sugur	Endangered
Leatherback	*Dermochelys coriacea*	Nea'ma	Critically endangered

The green and hawksbill are the most abundant and widespread. Incidental catch in trawlers show they were the most cases recorded between 1994 and 2004 (Table 4.). Field surveys and interviews also indicate the species are found everywhere; large number of carapaces particularly that of green turtle were found along the entire length of the Eritrean Red Sea. Though the data is not enough to compare the distribution of the species regional wise; hawksbill may concentrated in the Dahlak islands whereas green are abundant toward the southern region. The reason is unknown but the distribution of their food might be the factor. Hawksbill eats on sponges which are more abundant in the Dahlak islands. While green turtle eats on sea grass and macro algae that are abundant in the southern region.

The other three species are rarely found along the Eritrean region. All have been recorded as by catch in the commercial fishery (Table 3. 3). Fishermen rarely see the animals. During the surveys some evidence for the presence of loggerhead and olive Ridley were recorded. Two loggerhead skulls were found at Dehil and Kad Norah and one olive Ridley were encountered nesting at Ras Terma. There was no any carapace or remains of leather back found other than incidental catch for the evidence of occurrence. These are good clue that the three species are less abundant in the area. Previous works in the Red Sea also show they are rarely found in the Region (PERSGA/GEF, 2004).

3.2. *Nesting Species and Nesting Season*

Three species of sea turtles are recorded to nest in Eritrea, the hawksbill, green and olive Ridley. The hawksbill is the most abundant and wide spread while green is less abundant and nests are in few numbers at restricted areas where as olive Ridley is rarely found and only one trial nest has been recorded.

3.2.1. Hawksbill Turtle

It is one of the most widespread and abundant sea turtle observed. It has nesting sites in most of the Eritrean Islands and coastal beaches. From the 154 Island and coastal areas surveyed, about 71 % (Appendix ii) of sites were found to be hawksbill nesting rookeries. The rookeries extended from Hasmet (N 17. 767, E 38. 689) in the north to Gahro (N 12. 788, E 43. 067) in the south. Most of the rookeries are located in the Dahlak Archipelago between N15. 489 - N16. 319 and E 39. 567 - E40. 873.
Nesting season of hawksbill is from December to June and reaches peak during February, March and April. There is possibility that nesting of hawksbill could start before December as one fresh hawksbill nest was found in October at Segala Island. However the numbers might be very low.

Nesting time showed slight difference from region to region. In the northern part and Dahlak Archipelago it starts earlier than the Southern region of Eritrea. Hawksbill turtle may or may not show marked seasonality in nesting (Carr et al., 1966; Witzell, 1983). This is the pattern followed in the Red Sea. The nesting season of hawksbill turtles in the Red Sea is concentrated during January February and March. In Eritrea peak nesting occurs during February, March and April; Yemen December, January, and February and Sudan February and March (Hirth and Carr, 1970). The shortest season is probably a result of the rapid increasing sand temperature which passes through the range tolerated by the embryo (24-33 ^{0}c, Miller, 1985).

3.2.2. Green Turtle

Little information was collected about green turtle nesting. During the survey, only few cases were recorded. One nest on 12 March and a fresh track on 25 March were found at Dissei and Howeit Islands respectively. In addition some fishermen and coastal people from Eritrean southern Rea Sea commented that nesting of green turtle begins in August. However this was not confirmed through field survey. Urban (1970) recorded nesting of green turtle in 20 March 1969 one female nesting and signs of two other nests at Shumma; on 21 March sings of at least three fresh nests at Assarka and on 22 March ten fresh and two older nests at Umm Namus. Nesting of green turtle might be commenced in February and continues through May in low frequency. Similar result was obtained in the Red Sea. In the southern Red Sea scattered, infrequent nesting by green turtles begins in March; but nesting in the Northern section begins in April-May. Nesting in both areas continues at low levels through September (Miller, 1989).

3.2.3. Olive Ridley

This species is rarely found in Eritrea. Few cases were caught in commercial (Table3. 3) trawling and only one individual was found to nest in May 2005, during a field excursion undertaken by a team of 15 people including Nicolas Pilcher (IUCN member), the turtle team, ECMIB staffs, representatives of partner agencies (Ministries of Agriculture, Tourism and Fisheries), and various support personnel. The turtle team recorded a regional first with the nesting attempt by an olive Ridley turtle at Ras Terma (Eritrean southern Red Sea coast). This is the first time the species has ever been documented nesting on the whole Red Sea coast. The turtle was tagged (IF2030, IF2031), measured (CCL =75 cm, CCW =72 cm, SCL =67. 8 cm, SCW =65 cm) and weighed (50 kg).

Previous work in Eritrea (Hillman & Gebremariam 1995; Howe *et al*. 2003) and in the region (Frazier & Salas 1984; Gasparetti *et al*. 1993; Miller 1989; Pilcher & Al-Merghani 2000), and a regional review (Ross & Barwani 1982) have indicated the presence of the olive Ridley turtle in the Red Sea but none of these authors suggested that nesting has ever been documented (Pilcher *et al*., 2006).

3.2.4. Other Species

The other two species are rarely documented and nesting is not recorded in Eritrea. Loggerhead turtles are relatively rare and there is no indication that they nest. On other hand very little information is available on leatherback turtles because they are so rarely sighted and indigenous knowledge is limited.

3.3. *Nesting Areas*

Between December 2004 and July 2007, 154 areas were surveyed (Appendix ii). Out of them, 109 (71%) were found to be nesting sites. The areas were classified in to four categories based on the average number of nest per year. Nest counted more than two nesting season were averaged. The categories are major (more than 100 nests), moderate (50-99), minor (49-1) and no nesting sites. The symbol (*) on the top separate the survey time in year (* =one year, ** = two and *** = three).

Major nesting sites encompassed 5.2% (8 sites). These were Mojeidi*** (783 nests), Aucan*** (570), Dahret Segala* (500), Ras Fatuma** (380), Urubia** (290), Rijyuma* (175), Danabah* (121) and Dissei** (107).

Moderate nesting sites included 3.2% (5). These were Hatitaw*(75), Sheikh el Abu* (71), Selafi** (55), Entvedul*(55), Mustamila*(54).

Minor and sites of no turtle nest recorded were 53.2% (82) and 29.2 % (45) respectively. The remaining 9.1% (14) sites were nest present but were not counted.

This result shows large number of offshore islands and few coastal areas were used by turtles nesting. Most of the areas are off Shore Island of the Dahlak Archipelago (Appendix ii). Nesting intensity decreased toward the north and south parts of Eritrean Red Sea. Even though scattered low density nests occur on the main land and nearby islands, it was reasonable to postulate nesting frequencies and densities were high on the off shore islands. (Walczak, 1977) provide a brief summary of marine turtles nesting in Yemen. He identified several nesting areas and noted that the best nesting areas seem to be the uninhabited low –lying coral islands located near to Zuqar Islands and the Hanish archipelago. On the other hand hawksbill turtle in Eritrea tends to nest in low density at several scattered locations. Similar results were obtained in the Red Sea Region by Pricard (1979), Witzel (1983) and Miller (1989). This typical nesting pattern remains unclear; however it may be man-induced. There are some indications that mainland nesting has suffered from harvesting of adults and eggs and more recently, from development at some beaches (Miller, 1989).

Green turtles typically nest in large number at specific sites in most places of their range (Hirth, 1971). This is the pattern followed in the Red sea but in contrast to that, though data is deficiency, green turtle in Eritrea nests in low density at several areas.

The major nesting areas for hawksbill turtle in the Eritrean portion of the Red Sea are Mojeidi, Aucan, Dahret Segala, Ras Fatuma, Urubia, Rijyuma, Danabah and Dissei according the decreasing order. Though the main nesting of green turtle has not been identified however, Dissei, Assarka White, Shumma, Umm Namus, Mojeidi and Howeit are the only known nesting sites. Certainly, the Eritrean islands provide nesting sites for a substantial portion of the total number of hawksbill turtle nesting in the Red Sea region. On the other hand area like Mojeidi Island could be one of the significant hawksbill rookeries in the Red Sea region and probably in the world.

3.4. *Foraging Grounds*

Detailed surveys regarding foraging areas were not conducted. Due to the logistics involved with conducting field works, studies at foraging grounds were limited. The data presented here are obtained through questionnaires and observations.

Hawksbill and Green turtles occur along the entire length of the Eritrean Red Sea from Ras Kesar in the north to Rahaita in the south. Area of shallow reef complex, sea grass and macro algae beds in the region host both species. They were observed before nesting season started and after it terminated. Fishermen were also commented that the two species are presented throughout the year. This indicates turtles forage in many parties of coastal and off shores areas. Some of the main possible turtle foraging grounds are Kiloma, Ras Terma, Barasole, Tio, Ajuz, Dissei, Norah, Entaentor, Hasmet, and Mersa Taklai.

3.5. *Tagging*

During the survey time 2005-2007, 153 turtles were tagged. One olive Ridley turtle have been tagged on Ras Terma (Pilcher *et al*. 2005). A small hawksbill turtle which was caught entangled in fishing net around Massawa after resting it for one day was tagged in 11 May 2005. Another two hawksbills were tagged on 11 April 2006 and 5 January 2007 during nesting on Dissei Island. During the nesting assessment in the southern region one hawksbill was tagged in 12 May 2007 on Ras Fatuma. On the nesting assessment conducted in Mojeidi Island during May 2006, March and June 2007, 148 hawksbill turtles were tagged during their nesting activities.

3.6. *Movements or Migration*

Fishermen from different areas have reported that turtles with Oman, Pakistan and Jordan tags were often caught entangled in fishing nets (Table 3). Tagged turtles were also incidentally caught in trawlers. Two green turtles were incidentally caught in shrimp/fish trawlers during the trawling operation 1994-2004 (Table3. 3).

Table 3 Recovered Tagged Turtles in

Species	**Tag number**	**Tagging location**	**Tagging date**	**Recovery date**	**Recovery area (location)**	**Remark**
Green	R. 28852	Oman Ras AlHadd	09/07/91	030/4/93	Assab (N13. 035,E42. 744)	Dead
Green	R. 30877	Oman Ras AlHadd	13/10/92	25/11/95	Assab (N13. 035,E42. 744)	Dead
Green	R. 30198	Oman Ras AlHadd	29/06/92	No date	Assab (N13. 035,E42. 744)	Dead
Green	W4801/4802	Pakistan (Karachi Hawakes)	12/12/95	04/97	Barasole (N13. 650,E42. 150)	Dead
Green	R. 45782	Oman	No date	20/11/02	(15. 125,E40. 492)	incidental catch, live, released

Table 4 Table Summary of sea turtle caught by shrimp and fish trawlers from 1994 to 2004

Year	Species of Marine Turtles						Total caught	Tagged turtles	Condition of turtles		Survival rate %
	CM	EI	CC	LO	DC	UN			Alive	Dead	
1994	0	0	0	0	0	26	26	0	0	0	0
1995	0	0	0	0	0	0	164	0	0	0	0
1996	262	86	22	1	2	78	451	0	292	159	63. 3
1997	0	0	0	0	0	0	0	0	0	0	0
1998	0	0	0	0	0	0	0	0	0	0	0
-1999	193	3	0	0	10	141	347	0	278	69	80. 1
2000	989	38	4	2	16	520	1569	0	1303	266	83. 0
2001	204	3	4	0	3	0	386	0	302	84	78. 2
2002	57	1	0	0	0	0	170	1 Green	114	56	67. 0
2003	64	2	0	0	8	0	165	0	120	45	72. 7
2004	50	0	0	0	0	14	64	1 Green	53	11	82. 8
Total	1819	133	30	3	39	1128	3342	2 Green	2462	690	78. 0

Data Source: Fisheries Statistics Unit, Research & Statistics Division, Ministry of Fisheries, Massawa CM = Green turtle, EI = Hawksbill, CC = Loggerhead, LO = Olive Ridley, DC = Leatherback, UN = Unidentified

Green turtles typically migrate from the foraging areas to nesting site and back again during the nesting season. Long distance recoveries of individuals include some that have traveled more than 2000kms from the site of tagging to the point of recapture (Meylan, 1982; Hirth and Carr, 1970). The five tag recoveries in Eritrea were from Oman and Pakistan, approximately 1500km west of their rookery. In order for the turtles to migrate it would have to swim a minimum 1500km around the Indian Ocean.

3.7. *Threats of Sea Turtle*

3.7.1. Fishery Related Threats

3.7.1.1. *Incidental Catch in Commercial Trawlers*

A ten years (1994 - 2004) incidentally caught turtles data shows significant number of turtles were caught. Five species of sea turtles were incidentally caught in the Eritrean Red Sea. Green and Hawksbill are the most incidentally caught and the other comprised low number. The percentage survival rate of the incidentally caught turtles are 79 % (Table 4). The number of turtles caught were higher in the months of May, June, July and November as the fishing intensity is more in these periods of the years but due to the closure season the turtle incidental catch was found low during the months of August and September. Since trawlers were operated mainly in neither shallow nor deep most of the turtles were caught in the 31-60 meter depth range.

Interviews with inspectors on boards also provided a basis estimating the number of turtles in the Eritrean waters (around Hermil, Hawakil bay and other fishing grounds). About 8 people were interviewed (crews and inspectors). They commented turtles were captured regularly in the trawling operations and some of them were died as a result of being in the trawl net or possibly due to suffocation.

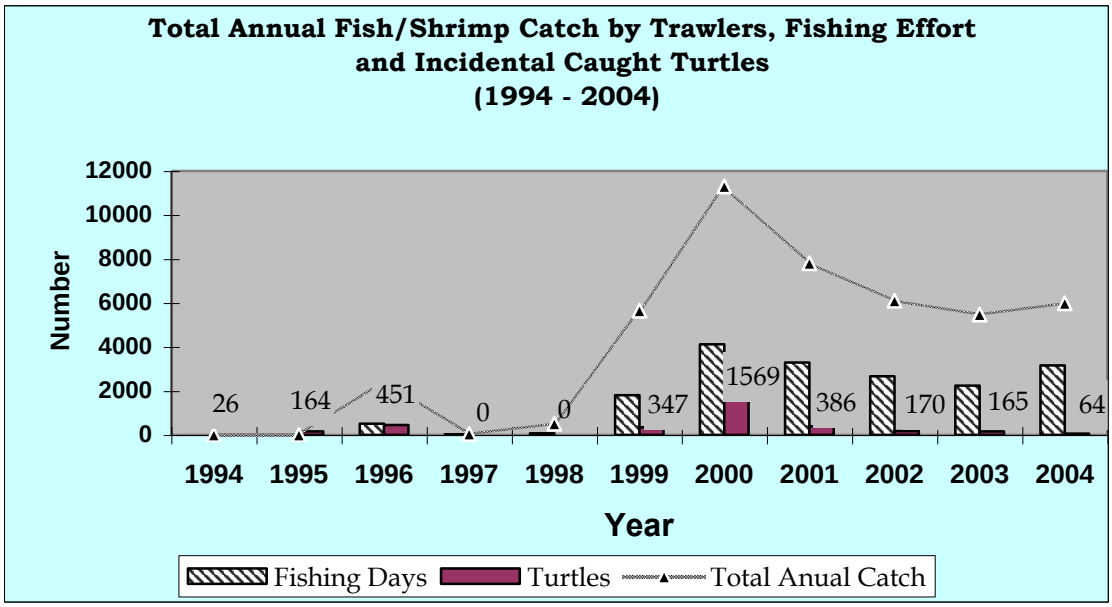

Figure 2 Bottom Trawlers Incident turtles caught Vs fishing effort and total annual fish/shrimp caught (1994 – 2004)

In addition to that, the Eritrean sea turtle team conducted a field trip with four Egyptian fish and shrimp trawling vessels to assess the incidental catch of sea turtles at the fishing ground. The field survey was lasted for about 35-42 days. Within these few days 21 sea turtles (11 green, 9 hawksbill) were incidentally caught in the four fishing vessels Out of these one green turtle was found dead and four were drowned. Averagely 70 to 80 fishing vessels were participating in the whole waters during the time. Certainly huge numbers of turtles have been caught incidentally. Generally, incidental catch in commercial trawling is the major threat of sea turtle in the Eritrean waters.

3.7.1.2. *Other Fishing Gears*

Entanglement in fishing nets or gears is also a serious problem for sea turtle. Entanglement may occur when sea turtles accidentally swim into the fishing nets or when they attached to the accumulated encrusting old floating debris.

In Eritrea there are two main problems of artisanal fisheries to the management conservation of turtles; high entanglement rate in nets and coincidences of fishing with nesting season of turtle. Entanglement of turtles in gill nets is not documented well. However, based on the interviews, there are about 2-4 turtles entangled per month during the fishing season December to May. Though the exact number of boats operating on fishing is difficult to known, there are about 2200 boats potentially can involve in fishing. Most of the boats employ nets (gillnet). If all or most are operating in fishing, high number of turtles could be entangled. As the mortality rate is unknown, it is hard to estimate the number of turtles either drown or died. But certainly there is high mortality rate of entangled turtles; as majority of the nets are displayed for about 4 hours that turtles could not survive.

Another problem of artisanal fisheries is coincidence of the fishing time with nesting season of turtles. The main fishing season in the region is from December to May which it is coincided with the turtle nesting season December – June. This may affect turtle population in many ways. First there will be high number of adult female turtles entangled. If the mortality rate is high, significant female turtles could be removed

from the population; removing female turtles mean impeding the population. Second females could be disturbed and may interrupt to nest. Theses combined with other factors of turtle mortality may decrease the overall population. Further assessment is necessary and is very important (recommended) to evaluate and assess mortality rate in net entanglement.

Logline and hook & line are also common methods of fishing in the region. Turtles are rarely caught (one – two per month) in longline. Low mortality rate combined with few number of boats employed made it a minor threat. There was no any case of turtle caught in hook and line and none of the interviewed fishermen were encountered of such cases. Thus hook and line is very minor threat to sea turtle.

3.7.2. Human Related Threats

3.7.2.1. *Egg poaching*

Traditionally, turtle egg collection has been ubiquitous along the Eritrean coast. Turtle tracks left in the sand during nesting show clearly the location of the nest and the eggs are normally found using a sharpened stick. Evidence of egg collection has been observed. Few nests (152) were dug out during the survey. As compared with total nest (7830) it is small (2 %), but in area like Barasole (Selafi) 90% in 2005 and 35% in 2007 of the nest counted were pouched. Selafi, Dilemmi, Ras Terma and Dissei were the most accessed and eggs were poached in large number. Generally eggs were poached in subsistence level throughout the Eritrean coasts and islands.

3.7.2.2. *Predating of Eggs and Hatchlings*

Turtle eggs and hatchlings are particularly vulnerable to predators. Many animals seem to be aware of the nesting cycle of marine turtles, and eagerly gather to ravish nests once the turtles have made them.

There was little record of direct observation of egg or hatchling predation though in most of the areas hundreds even thousands of potentially predators like birds (gulls and terns), ghost crabs and foxes inhabited. However, during the survey foxes and ghost crabs were observed preying on hatchlings and eggs in Selafi (Barasole) and Ras Terma. And gulls prey on Hatchlings in Fatuma and Urubia. In addition Crabs (ghost crab) and hermit crab (*Coenobta sp*.), mice and gulls were observed to capture, kill and consume hatchling of hawksbills on Mojeidi Island. While the first three predators were minor however gulls put heavy pressure during the day and night. Over sixty hatchlings from 10 clutches were preyed by gulls. 25 were during the day from 18:00- 20:00 and the remaining during night between 00:00and 4:00.

Except in Selafi, Ras Terma and Mojeidi where there may have high predation of eggs and hatchlings in the other areas it is less but, further research is needed to know the extent of predation.

3.7.2.3. *Exploitation of Adult turtles, Uses and Myths*

Marine turtles are at risk from a variety of human activities. Other than incidental catch, the major threats include intensive harvesting for meat, eggs, shells and skin. The harvest is for personal consumption or sometimes for local market.

In Eritrea turtles and their products are traditionally used for medicinal, nutrition and economic purposes. Turtle meat was on sale in Assab fish markets. Turtles are hunted using steel spear heads attached to long

wooden shafts with a lead rope or killed during nesting on beach. Over 200 Green and 125 hawksbill turtles were found killed during the survey time 2005-2007. Majority of the turtles were hunted by coastal people, and sea cucumber fishermen. Especially at areas where there were sea cucumber fishermen camps and near artisanal fishing grounds. Most of the carapaces had signs indicating they have been killed by humans.

Flesh of Green is more preferred than hawksbill. Fishermen warned that hawksbill turtles are sometimes poisonous. To avoid poisoning, the fishermen cut the heart and taste the blood; if the blood tastes bitter they avoid eating.

Medicinal and ornamental purposes are other uses of turtles. Fats, oil and blood of sea turtles are believed to treat some diseases such as diabetics, flue, rheumatism, TB and asthma. Eating dried sexual organ of a male turtle after mixing it along with honey and butter is also believed to help stimulate sexual instincts of humans.

3.7.3. Other Threats

In Eritrea the survival of sea turtle is threatened not only by incidental catch, direct and indirect harvest of adults, poaching and predation of eggs and hatchlings but also by the degradation or loss of nesting habitat, human disturbance (fishing camps) and tourism development added some threats to turtle.

Nesting beach and feeding area is very important habitat for turtle conservation. These areas may be degraded by wave action. Natural beach erosion and accretion can lead to turtles experiencing difficulties nesting and eggs can be uncovered, inundated or swept away (Witherington, 1999). There is very low of incidence of beach erosion in Eritrea. In few areas erosion of nesting beach by wave action were observed. Such sites include the beaches of Ras Terma, Aucan and Mojeidi.
Fishing camps (Appendix ii) particularly sea cucumber fisheries were present in many of the Dahlak, Hawakil and Assab bay islands. Sea cucumber fishermen threaten sea turtles and their habitat in many ways. They occupy the nesting beach, destroy halophytes and vegetations which are suitable for turtle nesting; put artificial light that disorient hatchlings and disturb nesting turtles. They also kill nesting turtles and collect their eggs. Key nesting areas where sea cucumber camped were Mojeidi, Aucan and Dahret Segala.

At this time coastal development is at the infant stage, however on Dissei one of the main nesting sites, recreational development is under way. The Dahlak hotel extension under construction on Dissei could affect the nearby nesting sites. Artificial lighting near nesting beaches deters sea turtles from nesting and interferes with the ability of hatchlings to move from their nests to the sea. In part, hatchlings reach the sea by orienting toward the brightest horizon. The brightness of artificial lighting can miss direct hatchlings away from the sea and leave them vulnerable to dehydration, exhaustion, and predation. As a consequence, any artificial lighting visible from a nesting beach can cause high hatchling mortality.

Tourism installations and the occupation of nesting beaches by human in general impact directly reproductive procedures and either inhibit female turtles from nesting or increase mortality of eggs and hatchlings. Development of beach furniture takes up vital space from emerging turtles and disturbs natural incubation of eggs.

Turtles are also threaded by natural phenomenon like dehydration and diseases. Little is known about the effect of natural phenomenon in Eritrea. Five female hawksbill turtles in Aucan and one in Mojeidi were found dead of dehydration in 2006 and 2007. Navy personnel rescued one hawksbill turtle that was drowned on the beach of Mojeidi. On Mojeidi 8 turtles that lay eggs at the late mooring (5-6) were disoriented by the bright Horizon and exposed to dehydration. During full moon 3 hawksbills were also

disoriented and spent much time to find the sea after laying eggs (Mahta, Pesr observation). The turtle team was rescued four drowned turtles in 2007. In other nesting areas observations were not taken but death due to dehydration likely are occurred. Many turtles may die of desiccation in the region.

25 Hawksbill turtles had recently stranded were found dead at the beach of Danabah about 3. 5 km north east of Barasole in May 2007. All were adult turtles with curved carapace length between 68 and 78 cm. Most of the turtles were too decomposed to allow all measurements and only carapace measurement could be taken. All the turtles had no any sign of external injury. However, in three stranded turtles probably had dead before 24 hours had whitish spot on their muscles. It was difficult to identify the cause but likely it was due to disease. Howe *et al* (2003) not conclusively but reported that turtles were dead of disease in the southern Eritrean coast. Despite the fact that further assessment is needed, disease is to some extent is a threat to turtles in the area.

3.7.4. Future Threats

3.7.4.1. *Land-based Activities and Pollution*

At present rapid coastal population growth, urban expansion and industrial and recreational development leading to high levels of pollution and declining water quality are very little. The discharge of untreated or semi-treated sewage, industrial effluents and agrochemicals can lead to sedimentation and eutrophication which can in turn cause seagrass and coral reef mortality thus threatening turtle foraging habitats (Gibson & Smith, 1999). In Eritrea, heavy sedimentation and high levels of epiphytic macroalgae is not studied. In addition the effect of sewage, heavy metals and chemicals on marine turtles has not been assessed. The effect of eutropication is much dangerous in water body like the Red Sea since it is a semi –closed, there is low water circulation (mixing) thus industrial effluent can take longer time to dissolve. Consequently corals and seagrass beds are likely to destroy and thus indirectly exaggerate turtle threats. This time there is low land based activities, industrial development and no oil exploration; with the growth of population and increase of infrastructures, pollution and land bases activities will probably be the main threats to sea turtle. Care should be taken in managing such activities .Any discharge in general, and industrial effluents and agrochemical wastages in particular must not be discharged to the sea otherwise have to be treated.

3.8. *Community Knowledge of Population Trends*

Fifty fishermen were asked whether population of turtles changed within 10/20 years. Out of these 20 (40%) said decreased, 12 (24 %) increased and 18 (36 %) no change.

Although there are no historical records to compare present level (from the investigation with the community) it appears that turtles are decreasing their number. Fishermen claimed before many years (10-20) they were able to catch turtles easily within few period of time, but this time they spent much time to catch even a turtle. This is a clear indication that the population of sea turtle is decreased. This downward trend was may be attributed to incidental catch in shrimp/fish trawlers and gillnets, poaching of eggs, hunting of turtles and natural causes.

4. Recommendations

Due to their life cycle, nesting biology and longevity, studies on marine turtles ideally need to be a decade or more in duration to provide a dependable source of information on population numbers and trends and for effective recovery and management. Therefore, long-term planning and commitment is necessary in the planning of turtle conservation, research and management efforts.

4.1. *Research and Monitoring*

In the survey done, information concerning turtle populations is incomplete. Knowledge of developmental and foraging habitats is poorly assessed and little is known about the extent and level of human actions on turtle populations at different states in their life cycle. This information is fundamental to the conservation and management of different breeding populations and in prioritizing resources and personnel in their protection and in the conservation of critical habitats.

4.1.1. Studies on Reproduction and Nest Biology**:**

Initiate monitoring at key nesting sites (e. g. Aucan, Ras Fatuma, Urubia, Selafi (Barasole), Dissei and Ras Terma) and continue monitoring at Mojeidi the site where conservation programmes already exist to:

- Document nesting activity including, species nesting, intensity and nesting trends;
- Calculate hatch success;
- Record annual mortality.

4.1.2. Studies on Foraging Habitats:

To identify and map critical foraging habitats, particularly focusing in unprotected areas like Selafi in the Barasole bay.

4.1.3. Tagging

Tagging should be continue in Mojeidi and should be initiated in other key nesting (e. g. Aucan, Ras Fatuma, Urubia, Selafi, Dissei and Ras Terma) to:

- Identify turtle movement patterns;
- Identify important foraging & developmental grounds;
- Determine inter-nesting and remigration intervals (to calculate size and status of turtle populations).

4.1.4. Quantify Threats:

Conduct detailed quantitative studies on:

- Incidental turtle catch in gillnets and commercial trawlers;
- The effect of trawling on seagrass beds and coral reef habitat;
- The impact of land-based activities on critical turtle habitats;
- The threat of human and non-human predation on nests.

4.1.5. Population Identification:

Currently, no *genetic studies* are being conducted in Eritrea. It is recommended that similar studies be initiated elsewhere along the coast of Eritrea to:

- determine the degree of female natal homing;
- identify discrete breeding populations on the nesting beaches and in corresponding feeding habitats.

4.2. *Conservation and Management*

4.2.1. Habitat Protection

Some key turtle nesting sites in Eritrea namely Selafi (Barasole) Ras Terma and Dissei are threatened by collection of eggs and effect of lighting and should be protected.

4.2.2. Declare Marine Protected Areas:

There is no any marine protected area in Eritrea, Dissei- Madote and Sheik Said have been proposed as marine protected areas. This is good initiative however; the areas are one tenth of the key nesting and foraging areas of turtles that should be protected. The protected areas should broadened and include the key foraging and nesting sites. Such sites may include Selafi, (both nesting and foraging ground); Ras Fatuma, Urubia both are (key nesting and probably foraging); Mojeidi, Aucan, Dahret Segala (key nesting sites probably the most significant rookeries in the Red Sea Region).

4.2.3. Reduce the Threat of Incidental Catch:

Restricting fishing activity in areas where sea turtles concentrate e. g. all foreign trawlers and all the local trawler and long liners should be forced to fish in authorized zones i. e. 4 miles from island and 8 miles from the main land for which the chance for sea turtle to be caught is very low. Implementation of turtle excluding devices (TED's) could be also a solution.

4.2.4. Strengthen National Legislation Relating to Turtles:

Tighten the current legislation to include conservation of critical turtle habitats and strengthen regulations related to marine turtles such as specifying that live endangered species caught in all fishing gears (not only trawlers) must be returned to the water immediately, and that all trawlers must be fitted with Turtle Excluder Devices before a license will be issued; 2. Strengthen capacity of government conservation authorities to enforce relevant legislation through training and provision of transport (vehicles, boats) and communication equipment.

4.2.5. Promote Community Participation in Turtle Management**:**

The Ministry of Fisheries should make effort to enhance public awareness through the cooperatives of the fishermen set every coastal village and islands including fishing camps. Since sustainability of sea turtle conservation efforts depends mainly up on the participation and education of the local people it is crucial to incorporate local people in the monitoring and management programme. Educational programme could be the best method to apply to halt the dangerous situation.

4.2.6. Encourage Funding for Marine Turtle Conservation

• Seek to secure long-term funding for turtle conservation activities in Eritrea;
• Incorporate turtle conservation activities within existing work plans of government institutions and non-government organizations (NGOs).

5. Turtle Conservation, Management Options and Lessons Learned

5.1. *Habitat Protection*

Management of both terrestrial (nesting) and marine (foraging, developmental, and migratory) habitats is critical to the survival of marine turtles. Two broad types of marine habitat are important to marine turtles: seagrasses and coral reefs. Once these habitats are destroyed, by fishing activity (trawling, long lining, seine netting, dynamiting), anchoring, pollution and beach development they require many decades to fully recover.

The most obvious management option is to identify and protect critical habitats, through establishment of sanctuaries, reserves or parks. With regard to beaches, measures to reduce disturbance to nesting turtles include closing beaches to vehicular and foot traffic during the main nesting season and minimizing the effect of artificial beach lighting by shielding lights or turning them off during the nesting-hatching season (Witherington, 1999).

Globally, several marine protected areas have been declared specifically for the protection of marine turtles and/or their habitats. For example, Gahirmatha Marine Sanctuary was declared to protect olive Ridleys and their breeding habitats in Orissa, India; in Costa Rica the Ostional Wildlife Refuge was created only for protecting olive Ridleys (*arribadas*) and Playa Grande National Park was established to conserve leatherbacks; and in Baja California, Mexico, several marine protected areas play a prominent role in turtle conservation.

In Eritrea there are no marine protected areas. However, the islands of Sheik Said and Dissei are proposed by the Ministry of Fisheries as marine protected areas. This may however protect turtle nesting beaches and foraging (seagrass and coral reef habitats). But the areas are limited and only can support one tenth of the key areas that should be protected. So other sites should be proposed. Such sites should include Mojeidi, Aucan, Ras Fatuma, Urubia, Selafi and Dahret Segala.

Another increasingly popular approach to the protection and sustainable management of coastal is integrated coastal zone management which provides a framework within which many different sectors can work together and plan for multiple use of coastal areas, developing marine protected area networks, promoting environmental education, identifying needs for legislation and policies and conducting research and monitoring programmes (Gibson & Smith, 1999).

5.2. *Nest Protection (eggs & hatchlings)*

Various management options are available for reducing threats to turtle eggs and hatchlings from human and non-human predation, erosion and coastal development. The least intrusive, lowest risk and least expensive technique is to protect the eggs *in situ*. This involves patrolling nesting beaches, disguising nests (e. g. covering turtle tracks and digging false nests) and protecting eggs from natural predators by placing netting or mesh over the nest.

Translocating nests which are at risk from inundation, predation or erosion is another relatively low risk option and can be highly effective as shown in the US Virgin Islands where annual reproductive success of the leatherback population has doubled using this technique.

Relocation of eggs to an enclosed hatchery is another option but is not generally recommended unless *in situ* protection is impossible or if egg depredation by people or animals is so intense that mortality reaches 100% (Mortimer, 1999). Hatchery programmes have some serious limitations which include: high costs (human and financial); relatively low success rates; skewed sex ratios; and high rates of hatchling mortality if not properly released.

Head-starting, whereby hatchlings are raised to a size at which they are deemed to be less vulnerable to predation, has become a common practice among commercial turtle farmers and some government conservation agencies. However, unless a less intrusive technique is available, head-starting is not generally recommended as it can lead to an increase in mortality from aggressive behaviour and disease (Ehrenfeld, 1995).

5.3. *Incidental Catch*

Management options to reduce incidental take of marine turtles in fisheries, notably trawlers and gillnets, include the use of excluder devices, reducing tow or soak times, and restricting use of threatening fishing gears in important turtle habitats.

Bycatch reduction devices (BRDs) are physical modifications to fishing gear that reduce the catch of non-target organisms. These devices can alleviate waste and reduce mortality in many fisheries, thus increasing yield and stability. Examples of BRDs include Turtle Excluder Devices (TEDs), which are designed to allow sea turtles and debris to escape from prawn nets. TEDs are panels of large mesh webbing or metal grids inserted into the funnel-shaped trawl nets. As the net is dragged along the bottom, prawns and other small animals pass through the TED and into the cod end of the net. However, turtles, sharks and fish too large to pass through the panels are deflected out an escape hatch. Currently in Eritrea, commercial trawlers are not obliged to fit excluder devices to their nets. It is an immediate and compulsory to initiate TED.

Results from a study on TED use by semi-industrial trawlers on Sofala Bank in Mozambique indicated that employment of TEDS in the semi-industrial fleet could prevent the incidental capture of up to 5,000 turtles a year (Gove *et al.,* 2001). The study also indicated that TEDS do not have impact on the quantity of shrimp caught or the time spent in sorting catches, but may improve the quality and commercial value of catch by preventing damage by large marine organisms such as rays, excluded by the TED. Larger size TEDs (mesh size 130. 9 x 99. 8cm) was shown to be most appropriate for trawling in central Mozambique. In the US, fitting TEDs in shrimp trawlers has been in force since 1998, and has proved successful in Florida where there have been no reported losses in shrimp catches.

Measures to reduce the incidental take of turtles in gillnets include: setting nets in areas where turtles are unlikely to occur; restricting use of nets in important turtle habitats; limiting the number, length and depth of the nets; using mesh sizes that are less likely to catch turtles; and reducing the soak time of nets (Oravetz, 1999).

5.4. *Conservation Education*

Around the globe, many people are unaware of the threats to turtles or of the ways in which their actions may be affecting their long-term survival. Education and awareness about the value of coastal resources and the survival of endangered species at all levels, ranging from policy-makers to school children, can

therefore play a critical role in marine turtle conservation (Gibson & Smith, 1999). Public awareness campaigns should accompany conservation action, target relevant stakeholders and embrace all the available avenues of communication including print and electronic media, school curricula, local gatherings such as festivals, fisher meetings and public displays (Eckert, 1999).

Turtle education campaigns have already proved highly valuable as conservation tools in Southern Eritrean Red Sea. In the village of Barasole egg poaching was reduced to significant level after the people have been aware. Survey in 20005 indicates 90% of the nests were dugout and this number was reduced to 35% in 2007.

5.5. *Community-based Conservation (CBC)*

Involvement of, and support by, local communities that interact with turtles and their habitats is fundamental for realistic, long-term turtle conservation and bottom-up approaches to conservation are becoming increasingly popular (Frazier, 1999). There are few standard procedures to CBC but generally it requires social integration and cultural sensitivity, time, community participation, development of acceptable alternatives and training.

On Zanzibar and Mafia, involvement of local communities in nest protection, monitoring, data collection and awareness raising has played a key role in reducing threats to turtles. The provision of financial incentives is a conservation option, and is practiced in some areas in the region. There are of course negative effect associated with incentive-driven conservation, the most important of which is financial sustainability. However, in areas where mortality (through turtle and egg poaching) has reached critical levels, financial rewards may be the only realistic short-term solution. In the longer-term it may be possible to generate revenue to fund turtle conservation through turtle tourism and park entry fees (Muir, 2005).

On Zanzibar, cash incentives have been found to be counter-productive to obtaining committed public participation (Khatib *et al*., 1996). However, in Mafia and Mtwara modest incentives, averaging US$7 and US$3 per nest respectively, have proven highly effective in involving local communities and in protecting nests. As regards sustainability, at Watamu in Kenya for example, a highly successful “Adopt a Turtle Nest” scheme has been developed whereby tourists are invited to adopt a nest for $14. In return for their donation, adopters receive a certificate and details on the hatching success of the adopted nest. Tourists also pay ($7) for observing turtles being released from fishing nets (Muir, 2005).

In Eritrea community based management should be initiated as a pilot project at the village of Barasole as:
1. The area is both nesting and foraging ground for turtles
2. The area comprises two key nesting sites, Selafi and Danabah about 200m and 3. 5 km north and north east of the village respectively
3. The area is the most threatened for egg poaching, hatchling predation and turtle hunting
4. Such a program will be more cost effective for the conservation of turtles as compared to other villages like Dissei Island or Deleme.

5.6. *Regional Cooperation*

Marine turtles are a shared global resource that cannot be managed by a single range state in isolation. Management actions for turtle conservation need to account for all stages of their lives which are spent in

different habitats and spread across international boundaries. Due to their diverse life history and migratory nature, a regional focus to turtle conservation is essential to cover the ranges of distinct breeding groups or populations. Without regional cooperation, conservation effort in one country may be negated by activities affecting the same population in another range country. Transnational cooperation and management has been developed in the South Pacific, Caribbean, Southeast Asia and Indian Ocean, and Philippines.

Eritrea should cooperate with the regional, international countries and organizations like PERSGA (Regional Organization for the Conservation of Environment of the Red Sea and Gulf of Aden), IOSEA (Indian Ocean and South East Asia).Particularly cooperation with the regional countries make conservation easier and effective.

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7. Appendix

Appendix i Sea Turtle Incidental catch of Soft bottom trawling (1996-2004)

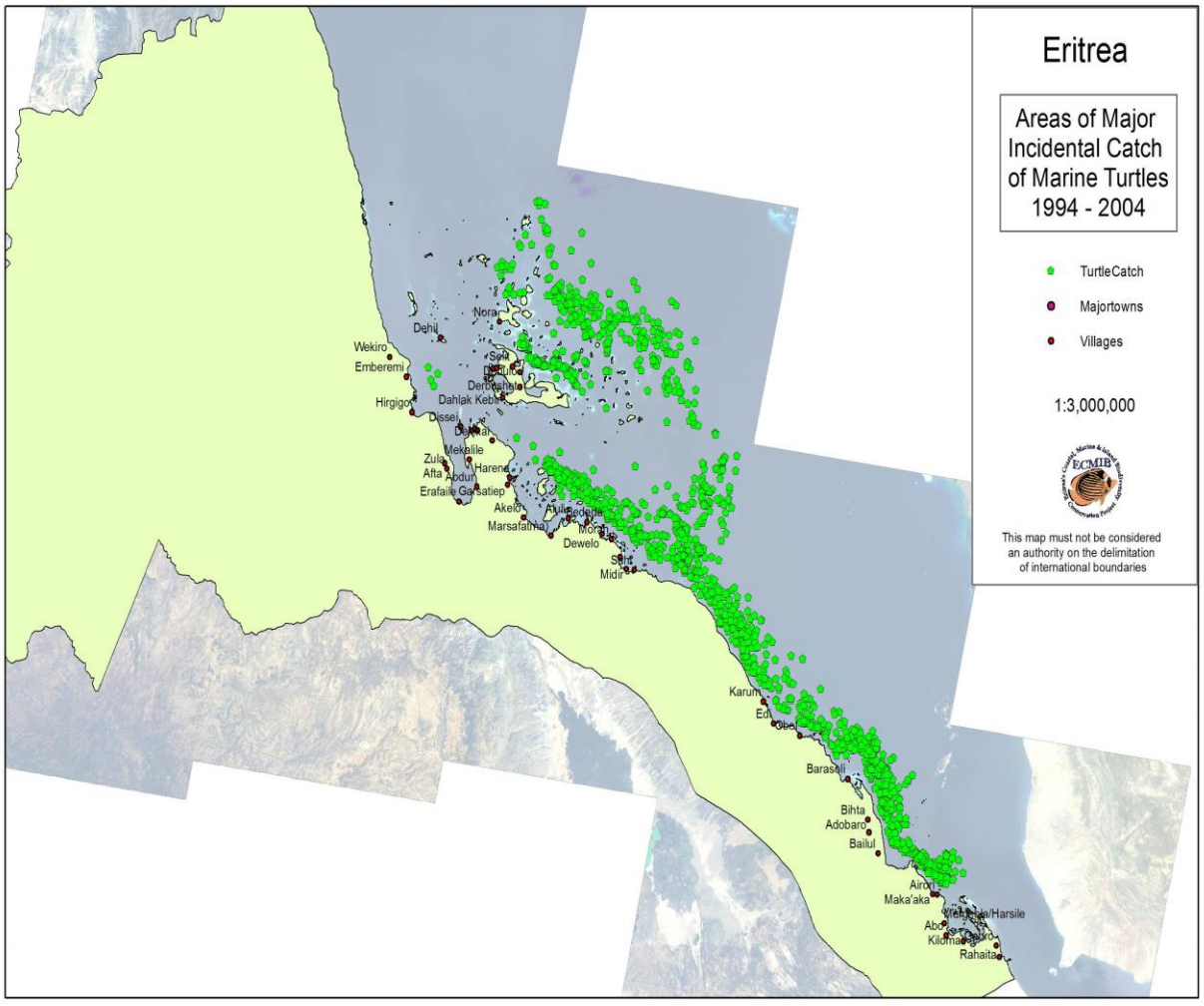

Figure 3 Map of the major incidental catch of sea turtles (1994 – 2004)

Appendix ii survey sites and nest count

Table 5 survey sites and nest counts

Appendix survey sites and nest count (2005-2007): key Nest Presence (NP), Fishing Camp (FC), Nest Counted (NC), Surveyed Period(SP, 5= 2005, 6= 2006, 7= 2007)								
List	**Site name/island**	**Latitude**	**Longitude**	**Area**	**NP**	**FC**	**NC**	**SP**
1.	Ras kesar	17.982	38.566	North coast	no	no	0	7
2.	Berite	17.960	38.620	Nother coast	no	yes	0	7
3.	Hesmet	17.742	38.725	Nother coast	yes	yes	not counted	7
4.	Marsa Teklai	17.533	38.861	North coast	no	no	0	7
5.	Garzai	17.169	39.000	North coast	yes	no	not counted	7
6.	Entaidell	16.820	40.160	Dahlak Archipelago	yes	no	10	5
7.	Difnein	16.616	39.324	Nother (island)	yes	no	25	7
8.	Kandellai	16.613	39.153	North coast	yes	no	not counted	7
9.	Hermil	16.509	40.168	Dahlak Archipelago	yes	no	10	5
10.	Entesila	16.505	39.318	Nother (island)	no	no	0	7
11.	Hermilseil	16.489	40.182	Dahlak Archipelago	yes	no	6	5
12.	Asbab	16.433	40.083	Dahlak Archipelago	yes	yes	30	5
13.	Kadhu	16.346	39.574	Dahlak Archipelago	no	no	0	5
14.	NN138	16.344	39.512	Dahlak Archipelago	no	yes	0	5
15.	Hukale	16.338	40.083	Dahlak Archipelago	yes	no	10	5
16.	Isratu	16.336	39.911	Dahlak Archipelago	yes	no	10	5,6
17.	Entaasnu	16.332	40.232	Dahlak Archipelago	yes	yes	30	5
18.	Wusta	16.322	39.811	Dahlak Archipelago	yes	no	10	5,6
19.	NN137	16.318	39.753	Dahlak Archipelago	no	no	0	5
20.	Tanam	16.301	39.755	Dahlak Archipelago	yes	yes	2	5,6
21.	Ghabbihu	16.261	40.224	Dahlak Archipelago	yes	no	10	5
22.	Entvedul	16.214	40.014	Dahlak Archipelago	yes	no	55	6
23.	Jerom	16.210	39.773	Dahlak Archipelago	yes	no	2	5,6
24.	Adasiseil	16.175	39.939	Dahlak Archipelago	yes	no	27	5,6
25.	Norahadasi	16.174	39.981	Dahlak Archipelago	yes	yes	22	6
26.	Dahret (near malakl)	16.172	40.036	Dahlak Archipelago	no	no	0	6
27.	Dhu-lalaml	16.169	40.067	Dahlak Archipelago	yes	no	18	5,6
28.	Dahret (near entvedul)	16.169	40.033	Dahlak Archipelago	yes	no	12	6
29.	Ashgan	16.145	39.969	Dahlak Archipelago	yes	no	not counted	
30.	Kadjerom	16.143	39.742	Dahlak Archipelago	yes	no	5	5
31.	Naheleg	16.142	40.159	Dahlak Archipelago	no	no	0	5,6
32.	Entaentor	16.131	39.855	Dahlak Archipelago	yes	no	34	6
33.	NN	16.111	41.072	Dahlak Archipelago	yes	no	4	6
34.	Harat	16.096	39.470	Dahlak Archipelago	yes	no	19	5,6
35.	Kadnorah	16.096	39.985	Dahlak Archipelago	yes	no	10	6
36.	Sehleit	16.081	40.056	Dahlak Archipelago	no	no	0	5
37.	Ummessahring	16.056	39.891	Dahlak Archipelago	yes	no	5	5
38.	Norahseil	16.049	39.974	Dahlak Archipelago	yes	yes	11	7
39.	Entufash	16.046	39.765	Dahlak Archipelago	yes	no	10	5
40.	Sheikhelabu	16.032	39.441	Dahlak Archipelago	yes	no	71	6
41.	Kadentoghodof	16.031	39.844	Dahlak Archipelago	yes	yes	6	5
42.	AbayNora	16.017	39.997	Dahlak Archipelago	no	no	0	6

43.	Entoghodof	16.016	39.858	Dahlak Archipelago	yes	no	5	5
44.	Raselgad	16.014	40.006	Dahlak Archipelago	no	no	0	5
45.	Bettaseil	16.002	39.923	Dahlak Archipelago	yes	no	1	5,6
46.	Adbarakebir	15.997	39.833	Dahlak Archipelago	no	yes	0	5
47.	Dhulfidol	15.992	40.288	Dahlak Archipelago	yes	no	6	5
48.	Darsolum	15.975	39.946	Dahlak Archipelago	yes	no	2	5
49.	Dhu-lalam(near Entvedul)	15.962	40.142	Dahlak Archipelago	no	yes	0	6
50.	Dhuladhiya	15.949	40.041	Dahlak Archipelago	no	yes	0	5
51.	Baradu	15.949	39.604	Dahlak Archipelago	no	no	0	5,6
52.	Dhulalam (near Maraban)	15.949	40.154	Dahlak Archipelago	no	no	0	5,6
53.	Dohulbahut	15.948	39.538	Dahlak Archipelago	yes	no	30	5,6
54.	Eucus	15.934	39.871	Dahlak Archipelago	yes	no	7	5,6
55.	Duliacus	15.916	39.898	Dahlak Archipelago	yes	no	3	5
56.	Dehil	15.912	39.639	Dahlak Archipelago	yes	no	3	5,6
57.	Martaban	15.909	40.182	Dahlak Archipelago	no	no	0	6
58.	Dalcus	15.908	39.875	Dahlak Archipelago	yes	yes	6	5
59.	Dahret(dehil)	15.904	39.579	Dahlak Archipelago	yes	no	4	5
60.	Darrotun	15.903	39.937	Dahlak Archipelago	yes	no	12	6
61.	Auatibseghir	15.903	40.577	Dahlak Archipelago	yes	yes	8	5
62.	Derom	15.892	40.367	Dahlak Archipelago	yes	no	5	5
63.	Auatibkebir	15.882	40.617	Dahlak Archipelago	yes	no	25	5
64.	Dergomankebir	15.861	40.123	Dahlak Archipelago	no	yes	0	5
65.	Dahret Bulke	15.855	40.294	Dahlak Archipelago	yes	yes	6	5
66.	Dhulkuff	15.854	40.506	Dahlak Archipelago	yes	no	30	5
67.	Dhurijrij	15.853	39.838	Dahlak Archipelago	yes	no	15	6
68.	Sikanseil	15.844	40.191	Dahlak Archipelago	no	no	0	5
69.	Sarad	15.835	39.919	Dahlak Archipelago	yes	no	10	6
70.	Dulbia	15.831	40.583	Dahlak Archipelago	yes	no	5	5
71.	NN130	15.823	39.909	Dahlak Archipelago	yes	no	4	5,6
72.	Dhannafarik	15.820	40.368	Dahlak Archipelago	yes	no	not counted	5
73.	Sayin	15.819	40.271	Dahlak Archipelago	yes	yes	5	5
74.	Bilha	15.812	40.686	Dahlak Archipelago	yes	no	5	5
75.	Gharib	15.790	40.448	Dahlak Archipelago	yes	yes	10	5
76.	Durgaam	15.787	39.758	Dahlak Archipelago	yes	yes	18	5,6
77.	Durghella	15.781	39.795	Dahlak Archipelago	no	yes	0	5,6
78.	Dasko Melil	15.767	39.978	Dahlak Archipelago	no	no	0	5
79.	Jimhile	15.764	39.950	Dahlak Archipelago	no	no	0	5
80.	NN112	15.760	40.467	Dahlak Archipelago	no	no	0	5
81.	Dulacal	15.757	40.497	Dahlak Archipelago	yes	no	10	5
82.	Arabiseil	15.747	40.319	Dahlak Archipelago	yes	no	not counted	5
83.	Segala	15.744	40.746	Dahlak Archipelago	yes	no	10	5
84.	Dahret Segala	15.743	40.724	Dahlak Archipelago	yes	no	500	5
85.	Debelo(Dubu'ulo)	15.741	40.126	Dahlak Archipelago	no	no	0	5
86.	Dhunishab	15.727	40.564	Dahlak Archipelago	yes	no	2	5
87.	Dahlakkebir	15.724	40.081	Dahlak Archipelago	no	yes	0	5,6
88.	Raka	15.715	40.677	Dahlak Archipelago	yes	no	20	7
89.	Rijyuma	15.713	40.649	Dahlak Archipelago	yes	no	175	7
90.	Senach	15.707	40.475	Dahlak Archipelago	yes	no	6	6
91.	Yermalkau	15.706	40.394	Dahlak Archipelago	yes	no	2	6
92.	Erwa	15.701	40.185	Dahlak Archipelago	yes	yes	not	6

							counted	
93	Derbushet	15.675	40.137	Dahlak Archipelago	no	yes	0	5
94	Mustamila	15.651	40.718	Dahlak Archipelago	yes	no	54	7
95	Rasshoke	15.650	40.404	Dahlak Archipelago	yes	no	8	6
96	Enteara	15.643	39.897	Dahlak Archipelago	yes	no	4	6
97	Zauber	15.638	40.786	Dahlak Archipelago	no	no	0	5
98	Darraka	15.608	40.467	Dahlak Archipelago	yes	yes	4	5,6
99	Darrakaelbahr	15.605	40.537	Dahlak Archipelago	yes	no	not counted	5,6
10	Tor	15.600	40.645	Dahlak Archipelago	yes	no	16	5,6
10	Sheikhsaid	15.595	39.479	Hergigo Bay(island)	yes	yes	5	6
10	NN081	15.588	40.131	Dahlak Archipelago	yes	no	5	6
10	Erfan	15.585	40.027	Dahlak Archipelago	yes	no	11	6
10	Madote	15.579	39.762	Buri Peninsula(island)	yes	no	4	5,6
10	Salima	15.576	40.811	Dahlak Archipelago	yes	no	10	5
10	Hatitaw	15.574	40.700	Dahlak Archipelago	yes	no	75	7
10	Shumma	15.540	39.996	Buri Peninsula(island)	yes	no	31	5,6
10	AssarkaBlack	15.536	39.915	Buri Peninsula(island)	no	no	0	5,6,7
10	Howeit	15.531	40.508	Dahlak Archipelago	yes	no	18	5,6
11	AssarkaWhite	15.527	39.929	Buri Peninsula(island)	yes	no	3	5,6,7
11	Aucan	15.509	40.808	Dahlak Archipelago	yes	yes	570	5,6,7
11	Mojeidi	15.505	40.873	Dahlak Archipelago	yes	yes	783	5,6,7
11	NN087	15.502	40.334	Dahlak Archipelago	yes	no	10	6
11	Dilemmi	15.500	39.897	Buri Peninsula(coast)	yes	no	10	5,7
11	Museri	15.489	40.359	Dahlak Archipelago	no	yes	0	7
11	Dhulkurush	15.489	40.750	Dahlak Archipelago	yes	yes	5	5
11	NN093	15.483	40.342	Dahlak Archipelago	no	no	0	6
11	Anberseil	15.474	40.471	Dahlak Archipelago	yes	no	6	5
11	Seli't			Dahlak Archipelago	no	no	0	5
12	Dissei	15.466	39.751	Buri Peninsula(island)	yes	no	107	5,6,7
12	Ingel	15.457	39.874	Buri Peninsula(coast)	no	no	0	5,6
12	Duluh	15.409	39.962	Buri Peninsula(coast)	no	no	0	5
12	Ummnamus	15.399	40.046	Buri Peninsula(island)	yes	no	33	5,7
12	Dahlied	15.274	40.170	Hawakil Bay(island)	yes	no	10	5
12	Rakhhowth	15.272	40.102	Hawakil Bay(island)	yes	yes	not counted	5
12	Dar Dase	15.243	40.082	Hawakil Bay(island)	yes	no	not counted	5
12	Adjuz	15.234	40.254	Hawakil Bay(island)	yes	no	25	5
12	Harena	15.194	40.089	Hawakil Bay(coast)	yes	no	not counted	5
12	Dergammansekhir	15.158	40.345	Hawakil Bay(island)	yes	no	not counted	5
13	Dergammankebir	15.131	40.321	Hawakil Bay(coast)	yes	no	1	5
13	Gel'alo	15.117	40.047	Ghel'alo(coast)	no	no	0	5
13	Baka	15.017	40.309	Hawakil Bay(island)	yes	no	not counted	7
13	Mersafatuma	14.940	40.250	Hawakil Bay(coast)	no	no	0	5
13	T'io	14.700	40.957	Tio (south Coast)	no	no	0	5,
13	Derebsasa	14.690	40.960	Anfile Bay(island)	yes	yes	4	7
13	Saroyta	14.523	41.295	Saroyta (south Coast)	no	yes	0	5
13	Kurum	14.056	41.633	Edi Bay(island)	no	yes	0	5
13	Edi	13.931	41.688	Edi Bay(island)	no	no	0	5,7
13	Abeilat	13.888	41.984	Edi Bay(island)	yes	yes	48	7

14	Fanaadirne	13.755	42.166	Barasole Bay(island)	no	no	0	7
14	Tekay	13.674	42.213	Barasole Bay(island)	yes	yes	18	5,7
14	Danabah	13.659	42.180	Barasole Bay(island)	yes	yes	121	7
14	Barasole(Selafi)	13.647	42.148	Barasole Bay(island)	yes	no	55	5,7
14	Beilul	13.214	42.388	Beilul Bay(south coast)	no	no	0	5
14	Ras Terma	13.168	42.589	Beilul Bay(south coast)	yes	no	33	5,6,7
14	Sanahor	13.078	42.715	Assab Bay	no	no	0	7
14	Ras Fatuma	13.026	42.859	Assab Bay(island)	yes	no	380	5,7
14	Umelshaura	13.002	42.797	Assab Bay(island)	yes	no	37	7
14	Urubia	12.989	42.837	Assab Bay(island)	yes	yes	290	5,7
15	Huiheb	12.973	42.884	Assab Bay(island)	yes	no	32	5,7
15	Haleb	12.916	42.944	Assab Bay(island)	no	no	0	7
15	Om el Lauranci	12.904	42.869	Assab Bay(island)	no	no	0	7
15	Gahro	12.788	43.067	Gahro south Coast	yes	no	26	5
15	Rahaita	12.733	43.097	Rahaita south Coast	yes	no	not counted	5

Appendix iii Map of Sea Turtle Nesting Survey 2005-2007

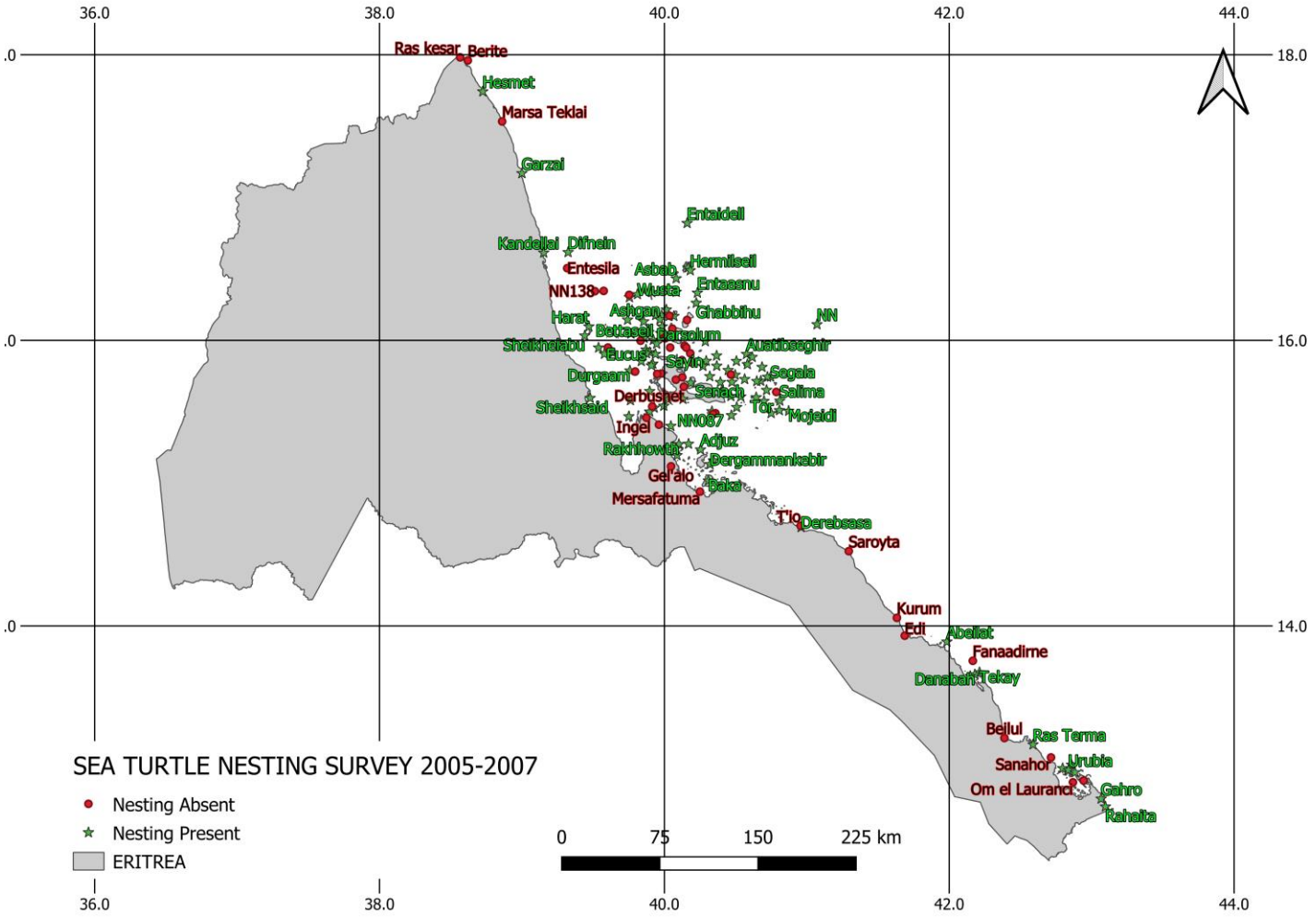

Figure 4 Map of Sea Turtle Nesting Survey (2005-2007)

Appendix iv some photos of Sea Turtle Conservation and Uses

1. Uses and Exploitation

Painted Carapaces on wale at Assab (2006)

Painted Carapaces on wale at Assab (2006)

Slaughtering of Green Turtle at Tio 2005)

Turtle meat on Sale at Tio (2005)

2. Fisheries Related Threats

Incidentally Caught Turtles in Trawlers

Stranded Green Turtle at Gahro coast

Industrial Trawlers at Gibi Landing Site (2006)

Longliners at Landing Site Massawa (2007)

3. Natural Threats

Beach Erosion at Mojeidi Island (2007)

Dehydrated Hawksbill at Mojeidi island (2007)

Gulls Preying on hatchling at Mojeidi Island (2007)

4. Conservation Measures

Public Awareness at Assab (2006)

Turtle Fun Run at Assab (year of turtle 2006)

Egg Translocation from induction

Public Awareness at Barasole village (2006)

Training for Onboard Inspectors at Dissei island (2007)

Turtle Tagging at Mojeidi island (2007)

5. Records

First record of an Olive Ridley nest
at Ras Terma coast (2005) southern Red Sea region

Mojeidi Island nesting site (2007)

Hatchling Protection from predators at Mojeidi island (2007)

Loggerhead Skull at Kad Norah island (2006)

Turtle Laying Eggs Mojeidi Island (2007)