THREAT TO BIODIVERSITY IN THE RED SEA ALONG THE ERITREAN COAST: AN OVERVIEW

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Abstract

Marine biodiversity in Eritrea represents a major part of the overall biodiversity of the country. The diversity of the Red Sea is a subset of that found in the Indo Pacific Region. Eritrea's 3,200 km mainland coast and islands contain a mixture of semi-desert ecosystems and patches of mangroves. For many years, these ecosystems have remained relatively unchanged, due mainly to the long war in the struggle for independence. Recent studies, however, indicate that threats to the mangrove habitats have caused changes in mangrove forest cover. The Red Sea is the only major aquatic habitat in the country. A total of 500 fishes and 44 genera of hard corals have been recorded. In addition, Eritrea's coast is inhabited by possibly 5 marine turtles, 8 or more cetaceans and the dugong almost all of these species are of conservation concern globally. The conservation status of most species at all the three levels (genetic, species, and ecosystem) is not known in detail. In all cases there is a long time gap between information collected prior to 1960 and that collected since 1991, which has created a major problem distinguishing between what has been recorded as historically present and what may actually be present today.

***Key words**: Red Sea, biodiversity, Eritrea, threats, conservation*

Introduction

The Red sea is a semi enclosed tropical body of water located adjacent to the Mediterranean sea to the north and the Indian Ocean to the South. Because of its many similarities to the latter, the Red sea is sometimes considered an extension of the Indian Ocean. Laughton studied the connection that the gulf of Aden, the Red Sea and the Rift Valley of Africa have with the Carlsberg ridge in the north western Indian Ocean. At the turn of the century, the Red Sea's fish were believed to have their origin in the Indian Ocean. Recent thinking is that the fish and also the other biota of the Red sea are of pure Indo-pacific origin. It is believed that isolation in such a restricted area as the Red sea, with consistently elevated water temperature and high salinity as exist in summer, favours the development of endemic species. The biodiversity resources of Eritrea is not yet exhaustively studied and documented. Collection and documentation on natural resources was far better in the Italian times(1889-1941), and up to independence (1991) there was limited attempt made to document biodiversity information in the country. The Eritrean coastal, marine and island zone is situated in the southern sector of the Red Sea, an almost enclosed, hot, saline body of water that harbors a flora and fauna derived from the Indo Pacific Ocean at some time in the last 10-20,000 years. The diversity of the Red Sea is a subset of that found in the Indo Pacific Region. A total of 500 fishes and 38 genera of stony corals have been recorded. In addition, Eritrea's coast is inhabited by possibly 5 marine turtles, 8 or more cetaceans and the dugong almost all of these species are of conservation concern globally. The level of knowledge

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of diversity of the lower taxa is weak as attempts made to compile checklists or to assess conservation status is little.

Therefore, this paper attempts to focus on the issue of the threats which is posed to the marine life which exists along the coast of Eritrea, where very little conservation activity is in place, and the majority of the stakeholder institutions lack the adequate knowledge on the dynamics of the marine ecosystems and the appropriate conservation strategies.

Geographical Location and Climate

Eritrea is located in the Horn of Africa between 12 º 22′and 18º 02′North and between 36º26′ and 43º13′East serving as a bridge between the rest of Africa and the Middle East and the Gulf States. It is bordering with the Sudan in the west, Ethiopia in the south, Djibouti in the southeast and with the Red Sea in the east. Eritrea has a total land area of 124,300 Km^2 with a coastline (mainland coastline) of 1900 km, along the important Red Sea oil and shipping route connecting the Mediterranean Sea with the Indian Ocean.

The Eritrean territorial waters are around 120,000 km^2, stretching out to the Red Sea Central Rift. There are around 390 islands in the Eritrean Red Sea zone, the prominent being the Dahlak Archipelago. The country exhibits a varied topography, rainfall and climate with altitude that ranges from 60 meters below sea level to over 3,000 meters above sea level.

The climate of Eritrea ranges from hot and arid adjacent to the Red Sea to temperate in the highlands and sub-humid in isolated micro-catchment areas on the eastern escarpment. Most parts of the country (70%) is classified as hot to very hot with mean annual temperature of more than 27º C; about (25%) as warm to mild with a mean temperature of about 22º C, and the remaining parts (5%) as cool with a mean annual temperature of less than 19º C. The total annual rainfall increases from the north to south and varies from less than 200 mm in the northwestern lowlands to more than 700 mm in the southwestern lowlands. Besides, the amount of rainfall also increases with altitude. While the coastal lowlands are very dry, some areas on the eastern escarpment get more than 1000 mm of rain. As to areas covered by the different rainfall regimes, about 50% of the country receives less than 300 mm, 40% between 300 and 600 mm and about 10% more than 600 mm of rain per annum (FAO 1994, Haile etal. 1998).

Geology

Geologically, Eritrea can be split into two different regions. The central and northern highlands consist of complex basement formed during the Precambrian era (more than 570 million years before present), which contain some of the oldest formations (Archean) found in Africa. Similarly, a basaltic flow in the Tertiary era (Cenozoic era: 65 million years before present) formed typical flat-topped mountains in the western highlands. In Western lowland areas, the complex basement was later covered by young quaternary sediments that appear as rocky outcrops. The basement complex contains deposits of metallic minerals (iron, copper, gold, asbestos, magnesium, barite and sulfur).

The second geological region is the Red Sea coast and its associated islands that have evolved from the tertiary and quaternary sediments but in some areas, such as the Zula bay and the Bada area, these sediments are overlaid with basaltic lava flows from recent volcanic activity. These volcanic

formations are associated with the rift system (Red Sea and Afar Rift) that cuts from North to South and is marked by numerous fault lines. Hot springs with thermo-mineral waters and sulfur can be found in this area, which is typical for regions with young and active volcanism. Geological formations also reveal that oil and gas traces, evaporites and other non-metallic minerals, are associated with sedimentary formations (Mesozoic and Cenozoic). Most of the Dahlak archipelago islands are results of quaternary sediments, and in particular uplifts of fossil coral reef formations. However, Dissei Island near the Buri peninsula is an extension of the Precambrian basement of the mainland, mainly composed of granitoids. Towards south there also exist some islands which are of volcanic origin in particular the islands fronting Assab.

Ecology

The Eritrean marine and coastal environment is characterized by an array of diversified ecosystems: coral reefs, mangroves, sea grass beds, sandy and muddy flats, all important for fisheries activities and offering a significant tourism potential. The intertidal and near-shore zones support a diverse range of marine and terrestrial species and are key areas of ecological and economic importance.

Unlike most oceans of the world the Eritrean Red Sea is characterized by a lesser upwelling phenomenon and lack of permanent streams that flow into the sea. Consequently, the waters are nutrient limited with a low primary productivity. As a projection of the Indian Ocean, water exchange due to the monsoon winds is more pronounced in southern part than in the northern. This phenomenon results in a better nutrient availability, higher primary productivity and species abundance in the south. Furthermore, some species drifted from the Indian Ocean are localized only to the south. Nonetheless, due to the relatively cooler water temperature and higher sedimentation in the south, coral reefs are poorly developed and the associated communities are less diversified.

The Eritrean coastal area is best known as a highly favorable ecosystem for the development of fisheries. Essential reef areas, extensive surface and numerous shelters of the Dahlak archipelago and aggregates of islands contribute to the prospect of a prosperous fishery. Despite the few researches conducted more than 600 species of fish have been recorded in the Eritrean Red Sea.

Compilation of scientific surveys identified 154 species (Grissac and Negussie 2007) belonging to 38 genera of stony corals (Scleractinians). Eritrea's coastal waters have favorable climatic condition for reef growth with warm waters and low rainfall. Coral reefs formation along the islands coastlines are in good conditions whereas reefs along the mainland coastline are less developed mainly due to sedimentation from the rivers runoff.

Mangrove forests in Eritrea are present along about 380 km of coastline and cover an area of about 70 km^2. Their distribution is highly patchy all along the mainland and on the islands. In addition, most of the mangrove forests are found mostly in areas where some seasonal freshwater runoff occurs; and also in low lying, poorly draining areas behind dune ridges which are flooded infrequently (e.g. Lake Mandalum, near Mersa Deresa and Mersa Mubarek in the north). Towards south, dense mangrove forests are found near Assab Bay and in patches around Tio. Some offshore islands such as Museri, Norah, Harena, and Dergamman Kebir also retain dense mangrove stands.

Along with the coral and mangrove ecosystems, sea grasses also form an integral part of the coastal biodiversity. More than 12 species have been identified so far. In addition to fishes and invertebrates,

sea grass communities also support sea turtles and the globally endangered dugongs. Significant sea grass beds are found around Barasole, the western side of Mantola island in the south, Hawakil, Debel Ali, Dergamman Kebir, Baka, Delesen, north side of Harena, west of Adjuz, Norah, Baradu and Dehil islands.

Marine Biodiversity

The Eritrean Red Sea zone comprises that part of the Red Sea lying within the Eritrean territorial waters. The approximate Eritrean territorial waters are around 120,000 km^2 stretching out to the Red Sea Central Rift, where the maximum depth is several hundred metres. The territorial waters may be divided into a continental shelf region of around 56,000 km^2, and a shallow water region (<30 m. depth) of around 23,000 km^2, with the remainder being deep water (>30 m depth).

The coastline of the Eritrean side runs for about 1,900 km, stretching from the coastal village of Ras Kasar near the Sudanese border in the north to the village of Ras Dumera near Djibouti in the south (Hillman, 1998). The biodiversity richness in the Red Sea is comparatively low compared with that of the much larger Indo-Pacific region from which the Red Sea biota is derived. This is due to the short time (20,000 years) since the Red Sea was last dry; which has limited both the time for colonization from the Indian Ocean and for *in situ* evolution of new species, a fact reflected in the low overall levels of endemism found in most taxa in the Red Sea ecosystem. Nonetheless, the Eritrean marine and coastal environment is relatively rich in biodiversity, which is characterized by an array of diversified ecosystems mainly: coral reefs, mangroves, sea grass beds, sandy and muddy flats, all are important for fisheries activities and offering a significant tourism potential. The inter-tidal and near-shore zones support a diverse range of marine and terrestrial species and are key areas of ecological and economic importance.

The Eritrean Marine Biodiversity is classified into two major ecosystems namely the ***aquatic ecosystem*** below the tide line and the ***mainland and Islands Shoreline ecosystem.*** Within these ecosystems 5 main habitat types are identified, namely: Coral Reef, Sea grasses and sea weeds, Open sea/ Pelagic. Mangrove and Sandy Shores/Beaches and Mudflats.

Aquatic Ecosystem:

The Red Sea waters and shoreline form a range of marine habitats including coral reefs, seagrass beds, mangroves, salt marshes and saltflats (*sabkhas*) along the coastline, each with a representative community of species, plus deeper waters containing a variety of pelagic, demersal and benthic fish species.

Coral Reef: Compilation of scientific surveys identified 154 species belonging to 38 genera of stony corals (Scleractinians), such as *Acropona*, *Astreopora, Ctenactis, Cycloceris* etc. Coral reefs formation along the islands coastlines are in good conditions whereas reefs along the mainland coastline are less developed mainly due to sedimentation from the rivers runoff. Reefs protect coastline against wave and storm surge, prevent erosion and contribute to the formation of sandy beach and sheltered harbors. Corals are important for reef fisheries, ornamental fish collection and tourism thereby helping the economy of the coastal communities. A one year study conducted by the Ministry of Fisheries, ECMIB Project in 2005 has assessed islands around the port of Massawa area (Greene Island, Risi-Midri and Tuwalet), Dissei-Madot, Duhul Bahut, Dahlak-Nora, Ingel-Assakri area, Shumaha, southern Dahlak, Durgham, Durghela and Sarad, by establishing permanent coral

monitoring transects in Green and Dissei-Madot island areas. The result reveals that the Dissei-Madote area possesses a well developed reef which extends for about 15kms. Since the rest of the islands are found in the same zoogeographical zone, it is believed that there is no major difference in coral and fish type.

The fish type that have been identified to the family level were: Acanthuridae (Surgeonfish), Chaetodontidae (Butterfly fish), Haemulidae (Grants/Sweetlips), Labridae (Wrasses), Lutjanidae (Snappers), Pomacanthidae (Angelfish), Pomancentreidae (Damselfish), Serranidae (Grouper), Siganidae (Rabbit fish), Muraenidae), (Morey Eel), Scaridae (Parrotfish). The coral genera recorded include, *Acropora, Echinopora, Favia, Fungia, Galaxea, Goniopora, Montipora, Platygyra, Pocillopora, Porites and Stylophora.*

Threats to Coral Habitat

At present, the main threats or constraints to coral reef diversity along the Eritrean coastline are natural. These are:

• Turbidity - slows coral growth,
• Sedimentation - kills delicate foliaceous corals outright, as seen near Adjuz, Baka and Hawakil,
• Strong wind/storms - is apparent at a range of sites, including Entedebir, Norah, Museri and Madote.
• Brown algae - a threat to long-term health of the reef community if they maintain their dominance, rather than decreasing in abundance as water temperature rises in the warm season.

These threats not only affect the coral diversity, but also the economic benefits which might be derived from diving tourism, which is extremely dependent upon good visibility and a pristine-looking marine environment.

In most cases, the corals are away from human influence and hence relatively unaffected, except near the most important urban centres of Massawa and Assab. The coral reefs contribute to the livelihood of the coastal communities, through artisanal fisheries, ornamental fish collection (till 1997) and trade of other reef products.

Current threats mainly arise from rapid coastal development like fisheries and fishing infrastructures, tourism, oil exploration, sedimentation as a result of land reclamation, road construction and coastal population increases due to the establishment of new settlements. The major threats, including permanent and occasional, are presently located near existing settlements such as the city-ports of Massawa and Assab and include:

- Destructive fishing activities such as trawling in shallow waters;
- Solid waste disposal, sewage from septic tanks or local activities;
- Occasional oil spill (oil terminal, boat, petrol station or wreck dismantling),
- Effluents from desalination station or power plants (temperature and chemicals)
- Dust from industrial activities (cement dust); or,
- Curios collections (shells, corals).

In addition, corals are also threatened by natural factors such as the crown of thorns starfish, sea urchins or drupella infestation or from or human induced impacts such as bleaching related to global climate change.

Sea Grasses and Sea Weeds:

A recent sea grass biodiversity survey has been conducted in the central and southern Eritrean Red Sea by the Ministry of Fisheries and the Eritrean Coastal, Marine and Island Biodiversity project (ECMIB-UNDP 2007). The research outcome reveals the presence of 8 sea grass species in the

region. These are: *Thalassia hemprichii, Halophila ovalis, Halophila stipulacea, Enhalus acoroides, Cymodocea rotundata, Halodule uninervis, Syringodium isoetifolium, and Thalassodendron ciliatum.* The Southern Eritrean marine zone is characterized by more extensive soft bottomed continental shelves and higher rate of water influx from the Indian Ocean as compared to the Central region. These combined with other physico-chemical and ecological factors might have resulted in increasing sea grass abundance southwards.

Coastal people of the region have known certain basic facts about the ecological importance of sea grass for centuries. Rapid assessment method by ECMIB (2007) project was applied to collect data of sea grass abundance and distribution. As the methodology focused only on the shallow inter-tidal and sub-tidal waters, depth wise sea grass distribution of the region is not known.

In the assessment, sea weed species shown in the table (1) have been identified: All three major groups of Thallophyta, or algae, are well represented along the Eritrean coastline. It is likely that many more species remain to be identified.

Of these species, the most abundant are the coralline red algae, including *Corallina geonfere*, plus the brown algae *Sargassum* and *Turbinaria*, which show marked seasonal growth during the cool season (October-April). All of these species may overgrow coral reefs at times; 9 species of Chlorophyta (Green algae): *Valonia venticosa, V. aegagrophilla, Polonia fastigiata, Boergesenia fobersii, Caulerpa serrulata, C. lintillfera, C.sertularioides, Halimeda opuntia* and *H. tuna.*10 species of Phaeophyta: *Dictyota cervicornis, D. ciliolata, D. ceylanica, Cystoseira myrica, Padina gymnospora, P. australis, Turbinaria ornata, T. triquetra, Sargassum aquifolium* and *S.binderi.*Rhodophyta (Red algae/ coralline algae): *Gracilaria crassa, G. fergussoni, Gelidella, Corallina, Geonfera lubrica, and G. acerosa*.

Threats to Sea grasses and Seaweeds

The main threats to sea grasses and seaweeds are linked to human activities such as:

- Changes in water quality due to different types of pollution
- Building infrastructures at sea
- Dredging for channels access or for sand extraction
- Repetitive trawling changing the quality and stability of the sea bottom

Seabirds and Shorebirds

The Eritrean coasts and islands are well known for the large diversity of seabirds and shorebirds. The two groups are basically differentiated by their relative spatial location: seabirds spend the greater part of their lives at sea, diving to hunt for prey, where as shorebirds spend most of their time in the intertidal zone mostly feeding by scavenging fishes or invertebrates that are washed out to the shore.

Many species of seabirds and shorebirds exhibit migratory life styles. Most of them are migrating from the temperate or arctic northern hemisphere before winter in search of warmer breeding places into the tropics and southern hemisphere. Eritrea being in the subtropical region, it contains a number of habitats that are suitable for migratory and resident bird population. These include the coasts from Massawa to Assab, from Massawa to Sudan, the islands of Dahlak Archipelago, Hawakil, Anfile and Assab Bays. These islands and coastlines vary from sand bars to complex ecosystems**:** salt diaper, which consists of salt deposit and dead coral, bare sands, exposed uplifted coral, spare shrub and grassland vegetation (e.g. *Acacia, Panicum,Salicornia spp, Euphorbia spp, Atriplex*) and mangrove vegetation. All support large number of breeding seabirds.

As per 2005 and 2007 (DRAFT) ecological surveys, 78 species of seabirds and shorebirds have been identified, of which 22 are known to breed on the islands, mainly in summer. While 25 species are true seabirds belonging to different families such as tropic bird, booby, gull, tern and cormorant, the

remaining utilize the marine environment partly or completely, including families such as pelican, spoonbill, heron, flamingo, duck, plover and sandpiper. In addition more than 50 species of land birds were identified on the Eritrean islands.

Specific areas on the mainland shore and numerous islands support diversified and large numbers seabirds populations such as:

- *In Assab Bay*: Umal Bager, Delgus, Om el Assela and Gurna islands;
- *Offshore Ras Terma or Near Hanish islands*: Harbi, Sayal, Flat, NN189, NN190 and Haycock islands;
- *Around Edi*: Fanadir (near Barasole), Abeilat, Cod Ali, Sadla and NN195 islands;
- *In Hawakil Bay*: Seil, Estam Aghe, Crulli (near Tio) NN043, Umm en Nayim, Laksu, Galdina, Rakh Howth and Umm Nammus islands
- *In the Dahlak Archipelago*: Sheik el Abu, Mojeidi, Aucan, Museri, Entaasnu, Isratu, Awali Hutub, Abu Sherayu, Sarad, Dur Ghella, Dahret, Dohul Bahut and Madote islands.

Areas such as from Mersa Fatma to Tio, the coast around Barasole, islands such as Ras Fatuma, the eastern side of Dahlak El Kebir and the islands of Handa, Museri, Dhu Ladhiya, Norah, Harat, Dissie and Sheik Seid are potentially important sites as primary feeding and wintering grounds and as migratory stopover for thousands of seabirds and shorebirds such as terns, gulls, boobies, flamingos, spoonbills, herons, plovers, sandpipers, and the crab plovers.

Threats to Seabirds and Shorebirds

The potential threats to breeding seabirds are

- Fishing camps (and in particular sea cucumber - bêche de mer) with disturbance by residence, processing on beaches, habitat destruction, firewood collection, egg collection or solid wastes
- Tourism camps resulting in disturbance, solid waste in particular during breeding season Islands such as Madote, Dahret and Umm Nammus are some of the major destinations, thus limiting access to these areas during the breeding season (mainly from May to August) will help alleviate the threats.

Marine Turtles

The world oceans and seas host seven species of marine turtles representing two families, Cheloniidea and Dermochelyidea. Five of them are known to exist in the Eritrean waters: Loggerhead (*Caretta caretta*), Green (*Chelonia mydas*), Hawksbill (*Eretmochelys imbricata*), Olive Ridley (*Lepidochelys olivacea*) and Leatherback (*Dermochelys coricea*). They spend their lives at sea but return to the land to lay their eggs. Sea turtles are under threat due to natural and human interferences and are considered endangered species worldwide. Since they nest in sandy beaches they are susceptive to coastal development and human activities.

Eritrea's 55,000 km² of territorial waters bordering nearly 3,300 kms of coastline (mainland and 354 islands) provides feeding (important sea grass and seaweed meadows)and breeding habitats for the five turtle species, and nesting grounds (numerous sandy beaches and little disturbance) for the green, hawksbill and olive ridley.

Conservation and management efforts

The status of turtles in Eritrea was first assessed in 1996-1997 during the preparation of a Global Environment Facility Project. Although stronger conservation and management efforts are underway since mid 2005 along the coast and on the islands of Eritrea, the conservation status of marine turtles in Eritrea remains largely unknown. Information concerning population dynamics is incomplete, while knowledge of nesting populations and feeding habitats is patchy and of developmental habitats almost non-existent.

Research, monitoring and awareness are underway as part of the conservation programs but a significant role in turtle protection through community involvement could be the ultimate choice.

The highly relevant regional dimension to turtle movement is fundamental to conservation strategies, especially in the context of the Convention on Migratory Species, and flipper tags are used to determine turtle movements as well as inter-nesting frequency (no. of times a female nests per season) and re-migration intervals. To date (beginning 2007) about 150 turtles have been tagged. On the other side, tags have been recovered between 1992 and 2006 from nesting females tagged mainly in Oman.

Of the three species known to nest in Eritrea, the Hawksbill and Green turtles are the most common. But in 2005, an Olive Ridley turtle came to nest on the Ras Tarma beach. It was the first nesting record for this species for the whole Red Sea.

For the Hawksbill turtles, the most common species in Eritrean waters, the main nesting season for hawksbills is during the northeast monsoon (*Azieb*), from December to May, although nesting has been observed at other times of the year. Nesting has been recorded on more than 120 offshore islands, the most important being Mojeidi, Aucan, Dhul-kuff, Entaentor, Entaasnu, Urukia, Ras Fatuma and Dissei. Many nests have been also recorded on the mainland coast including Berasole, Ras Tarma, Gahro and Deleme.

During surveys of 2005 and 2006, on Mojeidi Island, more than 2000 Hawksbill nests were recorded, with a peak during February and March. On Aucan Island, 1500 Hawksbill nests were recorded during the same period. On the contrary, no nests have been recorded in Awali Shawra. Historically this was reported to be an important nesting site, but a large sea cucumber (Hedra) fishermen camp is believed to have disrupted the nesting activity.

The Green turtle is a common nesting species in Eritrea. No study has been conducted to estimate population size estimates or the total number of nesting green turtles in the whole of Eritrea. There has been nesting records in offshore islands such as on the sandy beaches of Mojeidi.

Loggerhead turtles are relatively rare in Eritrea and there is no indication that they nest. However, evidence from skull remains has been found in Islands around Dahlak archipelago and Gahro beach. The turtles are often caught in traditional fishing nests of local fishermen probably showing the Eritrean Red Sea area are important foraging grounds for this species. Reports of net captures were confirmed in the reports of the Ministry of Fisheries fishing logbook recorded by observers onboard of industrial shrimp/fish trawlers.

Very little information is available on Leatherback turtles in Eritrea because they are so rarely sighted and indigenous knowledge is limited. There have been no records of this species nesting in Eritrea. Rarely few leatherback turtles were observed washed up in offshore waters and on some fishing villages beaches (Information from fishermen). Fishermen suggest that the species is usually found deep down in the sea.

Uses and myths

Turtles and their eggs have been used for domestic consumption by local coastal communities in Eritrea (Hillman & Gebremariam, 1995). Decades ago there has also been a history of exploitation of hawksbill turtles for tortoise shell, exporting mainly to neighboring countries such as the Kingdom of Saudi Arabia or Yemen.

Although they are aware that it is illegal, many Eritreans residing in coastal villages and few navies enjoy eating turtle meat but it is occasional and the sale has rarely been considered as a valuable source of income. The meat of the green turtle is most favored, while that of hawksbill is often avoided as believed to be poisonous. Turtle predation by humans is high in Ras Terma, Barasole and Dissie which are nesting areas for turtles.

Coastal communities have a strong belief of their medical value. The blood is believed to treat skin diseases such as 'psoriasis'; the fat and the oil could be good for diabetics, flu, rheumatism, tuberculosis and asthma. Eating the dried sexual organ of a male turtle after mixing it along with honey and cheese is believed to help stimulate sexual desire.

Threats to Marine Turtles

The main threats to marine turtles are linked to the lack of awareness, the limits of enforcement and the absence of protected areas:

- Poaching by local communities for private consumption of flesh and eggs or for medical treatment
- Incidental catches by fishermen in gillnets or commercial fish or shrimps trawlers
- Disturbance of nesting habitats (fishermen camps or tourism) and foraging grounds
- Disappearance of nesting beach (natural by erosion or human through development)
- Land based development or pollution (although the use of plastic bags is forbidden in the country)

Besides predation by coastal communities turtles are also endangered by fishing activities in particular by trawlers. In surveys conducted from 1994 to 2004, it was found that trawlers catch all the species existing in the Eritrean waters; the incidences are high for Hawksbill and Green turtles (79%). Most turtles in the Eritrean waters are caught at depths between 30 and 60m. The introduction of Turtle Exclusion Devices (TEDs) on the trawling nets could minimize the effect.

Dugongs, Dolphins and Whales

Dugongs are very shy animals, rarely seen and also rarely caught (3 to 4 each year), usually accidentally in shark nets. When caught, they are eaten by the local community. The local names of Dugongs are 'Aurum' along the coast and 'Abu Tewila' in Dahlak islands. Dugongs (*Dugon dugong*) are found in Ras Tarma, Adubaro, Cod-Ali Island, Jerom, Baka, Saribo, Dergamman Kebir & Sekir, Arafile, Barasole, Atskoma, Abullen. Along the coast north of Massawa, they can be found in Mars Ibrahim, Marsa Teklay and Marsa Mubarak.

Dolphins are locally called 'Obari' or 'Abu Salama'. Different species exist, and they are the most common marine mammals in the Eritrean waters. Whales are also seen in offshore waters of Saroyta and are locally named 'Amber Bahr' or 'Bitan' in the Dahlak islands. The Common dolphin (*Delphinus delphis*) the Spinner dolphin (*Stenella longirostris*), the Bottlenosed dolphin (*Tursiops truncatus*) and the Indo-pacific Hump-backed dolphin (*Sousa plumbea*) have been observed in Eritrean waters or skeleton found on the shore.

Whales are not observed very frequently, the depth of the water being reduced near the shore, but skeleton can also be found. The Tropical whale or Bryde's whale (*Balaenoptera edeni*) and the False Killer whale (*Pseudorca crassidens*) have been reported.

Threats to Dugongs, Dolphins and Whales

For all marine mammals, two main threats have been identified:

- Collision with ships
- Poisoning during red tides

For dugongs, the occasional harvest by coastal communities seems to be the main threat.

Mangroves

Mangroves are salt tolerant trees and shrubs that form the major component of the complex tropical and subtropical ecosystem. They are frequently encountered on mudflats and banks along the shores,

at the outlet of rivers or *'wadis'*. Mangroves stand with their roots in salt water and they are subject to tides and irregular input of fresh water.

Mangroves support a complex food web and provide a unique habitat for numerous animals. They are a breeding, nursery or feeding ground for numerous species. In addition, the presence of mangroves in numerous places stabilizes the coastline by protecting against the effects of storms and wave actions. Mangroves also play an important role in the presence and functions of other ecosystems, including wetlands, salt marshes, sea grass beds and coral reefs.

Mangroves in Eritrea

About 380 km of the Eritrean mainland and islands coastlines are occupied by mangrove forests. Of the seven mangrove species present in the Red Sea area, three are present in Eritrea, on the mainland and on numerous islands namely *Avicennia marina, Rhizophora mucronata* and *Ceriops tagal*.

Estimation results indicate that the country's mangroves cover about 70 km². However this coverage is found in patches all along the Eritrean coastline and islands. Small mangrove stands are frequently found in small bays (mersas), at the mouth of temporary rivers (wadis), receiving freshwater and nutrients. They form a narrow fringe usually no more than 100 meters wide. On islands, mangroves often occur on infrequently flooded areas, which are separated from the sea by low dune ridges.

The dominant species is *Avicennia marina* (white mangrove) with some older trees reaching 10 m in height. *Rhizophora mucronata* have also been identified among mangrove communities and a small number of individuals of the species *Ceriops tagal* (yellow mangrove) are also present. Although mangroves of the Red Sea are not as abundant as those on other tropical coasts, they play similarly important ecological roles. They are nurseries for several commercial fish species, protect coral reefs by trapping sediment loads from the seasonal rainwater influx, and also act as an important breeding, nesting and wintering sites for migratory birds, both shorebirds and seabirds. The pink-backed pelican (*Pelicanus refescens*), the Western reef heron (*Egretta gularis*) and the Goliath heron (*Ardea goliath*) are among the common mangrove associated birds.

Threats to Mangroves

In spite of the ecological and manifold economic benefits, the loss and degradation of mangrove areas are vast. Mangroves are used traditionally and commercially in several activities e.g. as timber and domestic firewood that requires cutting and removal of trees. Furthermore, coastal developments causing pollution, alteration of the substrate and modifying hydrological regimes (in particular by road construction without culvert to allow the essential flow of freshwater and nutrients) are exerting serious stresses on mangroves. There is a growing evidence of continuous deforestation of mangroves in Eritrea as a result of numerous human activities animal grazing mostly by camels seems one of the most serious threats. Forests found near human settlements are also cut by people as a source of firewood. Pollution is confined to domestic solid-wastes, e.g. polythene bags and bottles, plastic and metal cans, which are disposed of in small quantities near population centres of the major coastal towns and villages. This may have serious physical impacts by covering the young seedlings and pneumatophores (erected roots that rise above the soil and promote gas and nutrient exchanges), blocking tidal channels and causing disturbance to the mangrove-associated fauna. Alteration of hydrological patterns due to coastal development projects as depicted in Massawa have also been causing significant loss of mangroves. In addition, activities resulting in oil pollution and direct discharge of sewages to the sea may also be threatening mangrove forests found around the major coastal cities. Nevertheless, as most of the Red Sea mangroves grow in a hostile environment, they are highly vulnerable to over-exploitation.

Mangrove Reforestation Program

Since mid 1990s a project named "Manzanar Project" has been taking a mangrove reforestation initiative in the Eritrean coastline. The project's aim is to plant inter-tidal zones with mangrove plants thereby enhance inshore fisheries and the coastal environment.

Over the past several years, the project has been working to develop innovative methods to create mangrove forests in places where they never grew before. In addition, it was also involved in restoring and conserving some existing mangrove forests. To date the project has piloted a 20 hectare of intertidal area in Hirgigo (*a poverty stricken coastal village located 10 km south of Massawa)* planting half a million trees to restore the severely overgrazed mangrove forests. Accordingly, the project has demonstrated a remarkable success in growing the trees with the method used (Sato, 2004).The method basically relies on low technology, and involves the input of nutrients that the sea water is deficient; iron, phosphorus and nitrogen or DAP (di-ammonium phosphate). Accordingly a local method of planting has been adopted; the mangrove seeds are planted in a tin can covered with a wire mesh, and to protect wash away by waves and tide it is tied to a physical structure (iron rod) and anchored to the ground.

Over the piloted sites the mangrove forests have contributed to the enhancement of the environment at a micro level, by providing sheltering, spawning and nursery area for many living creatures and protection from coastal erosion. Its litter production provides additional nutrient supply to the system.

An immediate economic benefit to the coastal communities is job creation. Local people (mainly women) are hired to work on every activity of the project. Through its projected activities, the project also demonstrated livestock can be grown with foliage and dried seeds of mangrove trees as the main food for the coastal people.

Mainland and Islands Shoreline Ecosystem

The Eritrean Red Sea shoreline is estimated at over 3,200 km if the mainland coast, now estimated at 1900 km, and the total island shoreline of 1300 km are added together.

Sandy Shores/Beaches and Mudflats:

A cross section of almost any stretch of coastline in Eritrea reveals a number of different shoreline habitats. These include the sand beach itself, the edge of the water at low or high tide, the exposed mud or sand at low tide, the shallow water offshore, and the open sea surface. The sand beach provides a source of detritus - pieces of dead or dying organisms that are washed ashore by the tide. The edge of the water provides small swimming organisms, plankton and larvae. The exposed mud and sand bottom provides a medium to be probed by birds with long bills for worms, crustaceans and other invertebrates. In addition, although not part of the shoreline, the shallow water contains small fish, crustaceans and invertebrates, whilst the open sea surface is the source of plankton, small shoaling fish and larger fish that feed close to the surface. These areas are therefore important feeding habitat for many bird species, especially shorebirds and seabirds. Some of this habitat, especially along the relatively isolated northern Eritrean coast and the uninhabited islands, is also important as a breeding habitat for some species, such as Crab Plover. (These beaches also provide important turtle nesting habitat).

Several areas of exposed flat shoreline have been prioritised for increased protection to enhance their biodiversity conservation value, including the Dahlak outer eastern islands which serve as an important resting ground for passing migrant birds.

Species in this habitat are not well documented. Nonetheless, the sand beaches contain pieces of dead or dying organisms that are washed ashore by the tide,-the edge of the water has small swimming

organisms, plankton and larvae, the exposed mud used by birds with long bills, worms, crustaceans and other invertebrates.

Threats to Sandy Shores/Beaches and Mudflats

The main threats to this habitat are:

• Pollution,
• Land use change,
• Sea- level rise,
• Land reclamation and uncoordinated development.

Conclusion:

With a coastline of more than 3,300 km (mainland and islands), Eritrea has a major asset and part of its future is along this coastline, as many different activities are linked to the sea, including fisheries, tourism and transport.

Commonly coast or coastal area is equated with shores of an ocean, sea, lake or any large body of water, areas surrounding such water body. For environmental sustainable management purposes coastal area means all areas that have connection to the water body. Such areas have an impact on the water body and are impacted by the water body. In the case of Eritrea, coastal area includes the entire watershed on terrestrial/land side and the territorial waters including the islands on the marine side. Owing to developmental programmes undertaken along the coast, numerous changes have occurred and it is evident that without proper regulations and management, the country can loose numerous opportunities.

Although the government through various projects and plans has drafted Coastal Policy and Integrated Coastal Area Management Plan which would serve as regulations, guides and institutional structures for sustainable management of the coastal area natural and human-made assets. To implement the policy, awareness generation at the local and institutional level has to be undertaken without which the threat to the marine and coastal environment is going to persist.

The biodiversity resources of Eritrea is not yet exhaustively studied and documented. Collection and documentation on natural resources was far better in the Italian times (1889-1941), and up to independence (1991) there was limited attempt made to document biodiversity information in the country. After independence, the Department of Environment of the Ministry of Land, Water and Environment and other line ministries have taken considerable effort on the conservation of biological diversity resources, despite the existing large shortfall in the number of personnel, institutions and financial resources, which would be required to fill this information gap.

The conservation status of most species at all the three levels (genetic, species, and ecosystem) is not known in detail.

In all cases there is a long time gap between information collected prior to 1960 and that collected since 1991, which has created a major problem distinguishing between what has been recorded as historically present and what may actually be present today. A century ago Eritrea was endowed with all sorts of natural resources, which include fertile land, enough water resources, dense forests, various wild animals and birds. Thirty years of armed struggle, combined with the persistent drought and neglect have impacted on the natural resources of the country. Its rich natural resources have been denuded and are currently left with fragile ecosystems.

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Table: 1 Seaweed species recorded from the Eritrean Red Sea Zone

Chlorophyta (green algae) 9 spp.	**Pheaophyta (brown algae) 12 spp.**	**Rhopdophyta (red algae/coralline algae) 9 spp.**
Bryopsidophyceae	Phaeophyaceae	Rhodophyaceae
Caulerpa racemosa	*Cystoseira myrica*	*Corallina geonfera*
Caulerpa selago	*Cystoseira trinodis*	*Gelidiella* sp.
Caulerpa serrulata	*Dictyota bartayresii*	*Gracilaria crassa*
Caulerpa taxifolia	*Dictyota ceylanica*	*Gracilaria edulis*
Halimeda macroloba	*Dictyota* sp.	*Gracilaria millardeti*
Halimeda renschii	*Padina gymnospora*	*Gracilaria* sp.
Cladophorophyceae	*Sargassum aquifolium*	*Polymeria* sp.
Chaetomorpha sp.	*Sargassum polycystum*	*Soliera robusta*
Valonia fastigiata	*Sargassum spathulaefolium*	*Spyridia filamenta*
Ulvophyceae	*Sargassum turneri*	
Ulva reticulate	*Turbinaria conoides*	
	Turbinaria ornata	

(**Source**: MoF 1997)

Table:2 **List of marine and shore birds species recorded in 2005 and 2006 missions**

Common Name	**Species Name**	**Status**
Red-billed Tropicbird	*Phaethon athereus*	RB (frequent)
Brown Booby	*Sula leucogaster*	RB (abundant)
Masked booby	*Sula dactylatra*	RB (uncommon)
Masked booby	*Pelecanus rufescens*	RB (abundant)
Socotra cormorant	*Phalacrocorax nigrogularis*	Suspected to breed (frequent)
Lesser Black-backed gull	*Larus fuscu*s	PM (common)
Sooty gull	*Larus hemprichi*i	RB (abundant)
White-eyed gull	*Larus leucophthalmus*	RB (common)
Black-headed gull	*Larus ridibndus*	PM (frequent)
Yellow legged gull	*Larus cachinnas*	PM (frequent)
Slender-billed gull	*Larus genei*	PM (frequent)
Lesser-Crested Tern	*Sterna bengalensis*	RB (abundant)
Greater Crested Tern	*Sterna bergii*	RB (common)
Caspian Tern	*Sterna caspia*	RB (frequent)
Gull-billed Tern	*Sterna nilotica*	PM (frequent)

Common Tern	*Sterna hirundu*	PM (common)
White-Cheeked Tern	*Sterna repressa*	RB (abundant)
Bridled Tern	*Sterna anaethetus*	MB (abundant)
Little Tern	*Sterna albifrons*	PM (common)
Saunders` Tern	*Sterna saundersi*	RB (common)
White-winged Tern	*Chlidonias leucopterus*	PM (frequent)
Brown Noddy	*Anous stolidus*	RB (abundant)
Osprey	*Pandion haliaetus*	RB (common)
Sooty Falcon (Land bird	*Falco concolor*	RB (common)
Eurasian spoonbill	*Platalea leucorodi*	RB (common)
Sacred Ibis	*Threskiornis aethiopicus*	RB (common)
Western-reef Heron	*Egretta gularis*	RB (common)
Little Egret	*Egretta garzet*ta	R (frequent)
Cattle egret	*Bubulcus ibis*	R (frequent)
Goliath Heron	*Ardea goliath*	RB (common)
Purple Heron	*Ardea purpurea*	R (frequent)
Grey Heron	*Ardea cinerea*	RB (frequent)
Black-headed Heron	*Ardea melanocep*hala	R (rare)
Squaco Heron	*Ardoela ralloides*	R (frequent)
Red Sea Green-backed Heron	*Butorides striatus*	RB (common)
Abdim`s Stork	*Ciconia abdimii*	RB (frequent)
Greater Flamingo	*Phoenicopterus ruber roseus*	IAM (abundant)
Egyptian Goose	*Alopochen aegyptiaca*	IAM /R (rare)
Northern Shoveller	*Anas clypeata*	PM (frequent)
Gargany	*Anas querquedula*	PM (rare)
Crab-plover	*Dromas ardeola*	RB (abundant)
Eurasian oystercatcher	*Haematopus ostralegus*	PM (common)
Pied Avocet	*Recurvirostra avosetta*	PM (frequent)
Black-winged Stilt	*Himantopus himantopus*	PM (frequent)
Kittlitz`s Plover	*Charadrius pecuarius*	R (uncommon)
White-fronted Plover	*Charadrius marginatus*	PM (uncommon)
Common Ringed Plover	*Charadrius hiaticula*	PM (common)
Little Ringed Plover	*Charadrius dubius*	PM (frequent)
Kentish Plover	*Charadrius alexandrinus*	RB (abundant)
Mongolian Sandplover	*Charadrius mongolus*	PM (abundant)
Greater Sandplover	*Charadrius leschenaultii*	PM (abundant)
Caspian Plover	*Charadrius asiaticus*	PM (frequent)
Grey Plover	*Pluvialis squatarola*	PM (common)
Pacific Golden plover	*Pluvialis fluva*	PM (frequent)
Green Sandpiper	*Tringa ochropus*	PM (frequent)
Common Sandpiper	*Actis hypoleucos*	PM (common)
Terek Sandpiper	*Xenus cinereus*	PM (common)
Common Greenshank	*Tringa nebularia*	PM (common)
Marsh Sandpiper	*Tringa stagnatilis*	PM (frequent)
Spotted Redshank	*Tringa erythropus*	PM (frequent)
Common Redshank	*Tringa tetanus*	PM (common)

Broad-billed Sandpiper	*Limicola falcinellus*	PM (frequent)
Little Stint	*Calidris minuta*	PM (common)
Sanderling	*Calidris alba*	PM (common)
Curlew Sandpiper	*Calidris ferrugniea*	PM (abundant)
Dunlin	*Calidris alpina*	PM (abundant)
Ruddy Turnstone	*Arenaria interpres*	PM (abundant)
Black-tailed Godwit	*Limosa limosa*	PM (frequent)
Bar-tailed Godwit	*Limosa napponica*	PM (common)
Whimbrel	*Numenius phaeopus*	PM (common)
Eurasian Curlew	*Numenius arquata*	PM (common)

Source: ***State of the Coast Eritrea, 2006-2007***

Key:

Abundant - seen any day fair to large number in preferred habitat

RB: Resident breeder **Common** - few seen almost any day

PM: Palearctic migrant **Frequen**t - quite often seen or heard

R: Resident **Uncommon** - seldom seen or heard, ten times per year

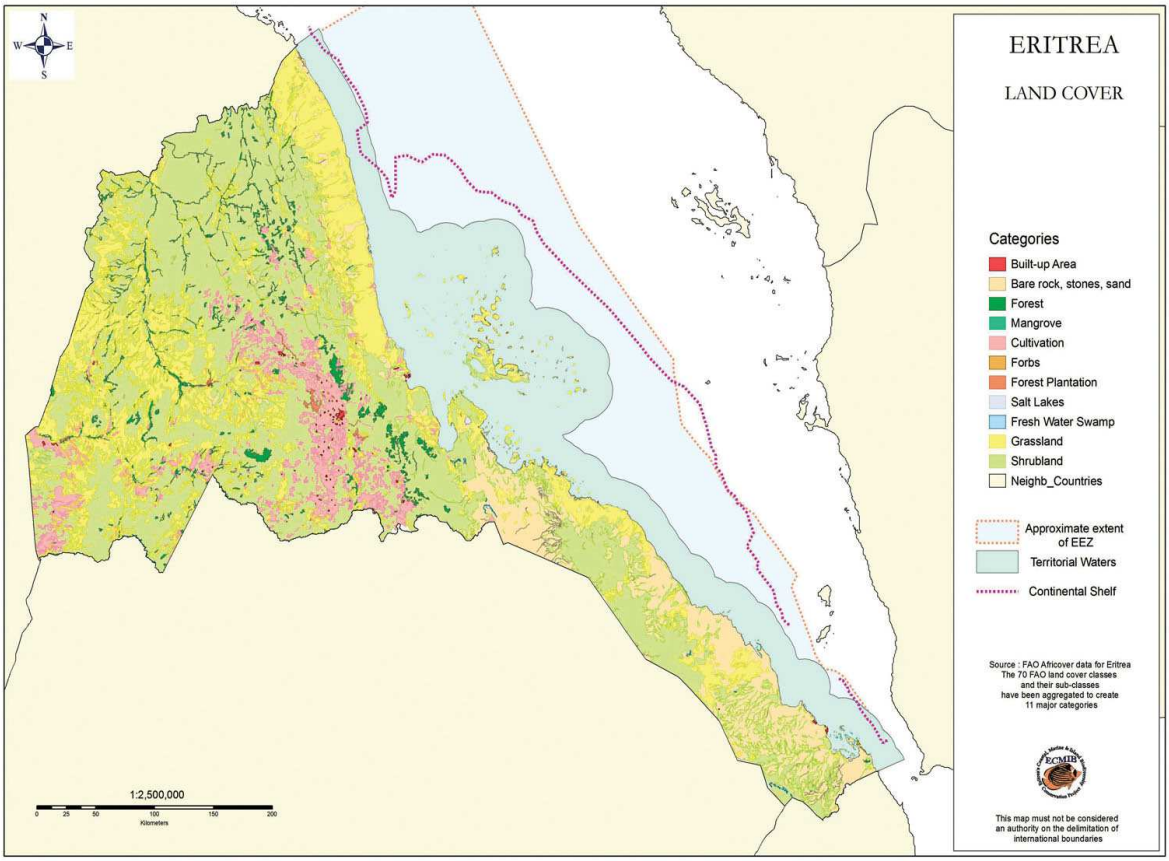
IAM: Intra-Africa Migrant **Rare** - very seldom seen or heard, less than once per year

MB: Migrant Breeder

Table: 3 Turtles found in Eritrea

Common names	**Scientific names**	**Afar**	**IUCN Category**
Green	*Chelonia mydas*		Bisa'e/ Tuhu Endangered
Hawksbil	l *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

Source: *Project Global (2007),*



Source: ECMIB (2008)