Figure 7.10 Aerial View of the Rocky Reef close to Mancabale, Ponta Mituasi

Source: Guissamulo, 2009

7.3.3 *Estuaries and Mangroves*

Eleven estuaries occur along the coastline within the study area, with the major estuary being of the Mepote River at Lurio. The estuaries include:

- the Lurio River;
- the Mepote River;
- the Mecufi in Ponta Muarro (Megaruma River mouth);
- the Missangage River;
- the Naeco River (along with Missangage River, which discharges at the south of Baia de Almeida, near Chaonde);
- the Culumpa River;
- the estuary at Meteca River (which discharges at Enseada de Simuco);
- the estuary at the mouth of River Merrengue at Angra de Semedo (Marrengue village);
- the River Muendaze at Mecuburi; and
- two small estuaries in the south.

Mangrove forests tend to grow in estuaries and along low energy shorelines. They are well-developed along the northern sections of the Mozambican coast, especially between the Tanzanian border and the town of Pemba, where the coast is protected by coral reefs and small offshore islands. Mangroves also occur along the shores of bays and along salt-water creeks throughout the study area. Although several small mangrove stands (size not exceeding 3 km^2) are distributed at some of the smaller river mouths, mangrove forests occur mainly at the mouths of the Mecúfi and Lurio Rivers, at Ponta Metacaua and Ponta Maunhane.

A large mangrove stand, located at the Mecúfi Village (*Figure 7.12*), is the most diverse known in the area, with the following species: *Sonneratia alba, Avicennia marina, Rhizophora mucronata, Bruguiera gymnorrhyza* and *Ceriops tagal*. The second largest mangrove stand in the study area is found at the Lurio River estuary (*Figure 7.11*). The species composition is unknown but the stand is believed to be dominated by *Sonneratia alba, Avicennia marina* and *Bruguiera gymnorrhyza*. Mangroves also cover the upper area of the shallow rocky bank at the Ponta Metacaua (*Figure 7.13*). A small stand occurs in the north at about 15 km south of the Ponta Maunhane (at Pemba). Other small mangrove stands also occur at north west part of Enseada de Simuco, north west coast of Angra do Semedo, the western end of the Bay of Memba and at the river mouth of Enseada de Bocage. Other mangrove species known to exist within the northern Cabo Delgado include *Lumnitzera racemosa*, *Xylocarpus granatum* and *Pemphis acidula*.

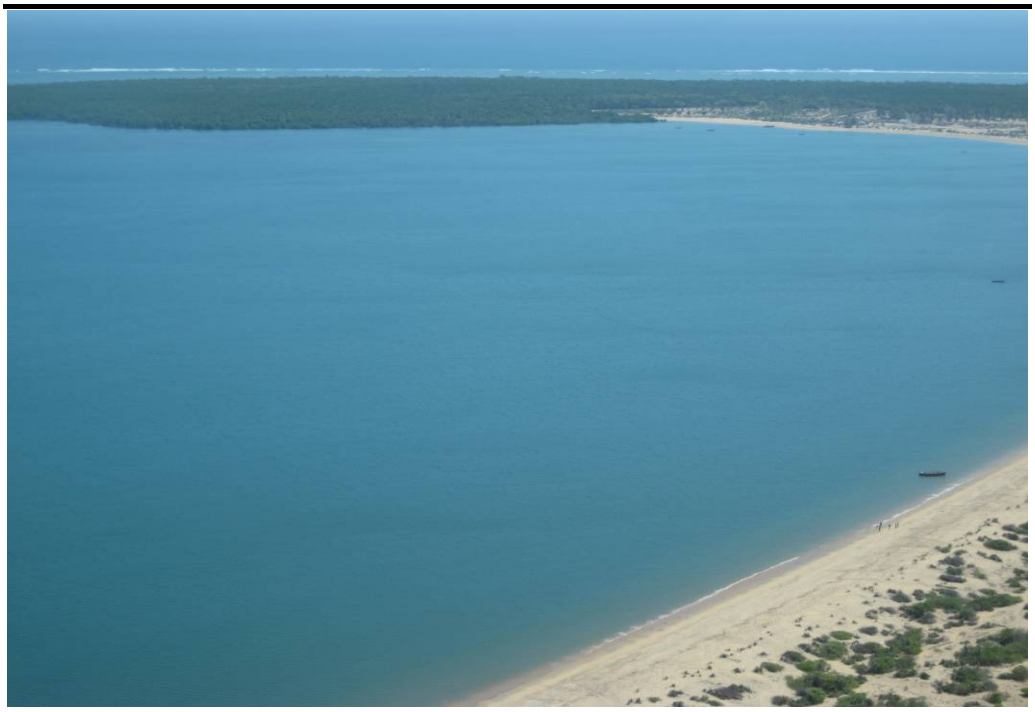
Figure 7.11 Mouth of the Lurio River with Mangrove Areas (circled)

Source: Guissamulo, 2009

Figure 7.12 Mangrove Area at Mecufi

Source: Guissamulo, 2009

Figure 7.13 Mangrove Areas at Ponta Metacaua



Source: Guissamulo, 2009

The most common mangrove species are *S.alba, A.marina, B.gymnorrhyza, C.tagal* and *R.mucronata*. Generally, *S.alba* is the seaward pioneer adapted to the open coastal and coral platforms occupying sites that are deeply flooded by seawater every day. *P.acidula* is a beach tree that thrives on old coral within reach of the waves, often intruding into the *S.alba* fringe in areas of coral outcrops. *B.gymnorrhiza* and *X.granatum* dominate sites that are higher in the tidal regime (drier) and *C.tagal* often form broad thickets that border areas of dwarf *A.marina*.

The mangroves provide habitat for a variety of bird species, with fourteen species reported to use the mangroves as feeding and breeding habitat including: black egret (*Egretta ardesaica*), little egret (*E. garzetta)*, western reef heron (*E. gularis*); goliath (*Ardea goliath),* black- headed heron (*A. melanocephala*), white stork (*Ciconia ciconia),* black stork (*C. nigra*), sacred ibis (*Threskiornis aethiopicus*), mangrove kingfisher (*Halcion senegaloides*), brown hooded kingfisher (*H. albiventris*), African fish eagle (*Haliaeetus vocifer*), African hawk eagle (*Hiearaoetus faciatus*), lesser flamingo (*Phoenicopterus minor)* and greater flamingo (*P. ruber*) (1).

In addition, the mangroves provide important habitat for a variety of crustaceans, fish, and molluscs. Crustaceans comprise fiddler crabs (*Uca* sp.) and the mud crab (*Scylla serrata*). Mollusc species include mud creepers (*Terebralia palustris*), pencil bait (*Solen capensis*), mud snails (*Cerithidea decollate*) and giant knobbed ceriths (*Cerithium nodolosum*) (2).

7.3.4 Seagrass Beds

The coastal area is subject to a large tidal range which creates extensive intertidal zones that are suitable for seagrass beds (and associated fauna). Seagrass beds (*Figure 7.14*) tend to occur in sheltered waters with suitable substrate (sand/mud) such as embayments (eg Mocimboa Bay, Tungue Bay and Quionga Bay) (3).

(1) Impacto and Mark Wood Consultants, 2006
(2) Impacto and Mark Wood Consultants, 2006
(3) Telford, 1998

Figure 7.14 Aerial View of Seagrass Beds close to the Concession Area

Source: Guissamulo, 2009

Seagrasses are common in the following areas: between Ponta Mauchane and Chicapa, at Mecufi and the bay south of Ponta Serissa , at the bay of Almeida, at Enseada de Simuco, Angra de Simuco and the Bay of Memba. A number of seagrass species from several genera have been recorded along the Cabo Delgado coastline (1), with the sub-tidal *Enhalus acoroides* and *Thalassodendron ciliatum* being the dominate seagrass species. There are also small areas of the fine, cylindrical seagrass *Syringodium isoetifolium*.

Seagrass beds and macroalgae provide food, shelter and serve as nursery grounds for a diverse range of commercially exploited species such as fish, crustaceans, gastropods and sea cucumbers. The seagrasses are also important feeding habitats for the dugong (*Dugong dugon*) and the green turtle (*Chelonia mydas*).

(1) Whittington et al, 2000

7.3.5 *Seaweed (Macroalgae)*

Seaweed diversity has only been described for the coast of Mecufi, south of Cabo Delgado Province, although the data is regarded as indicative of the study area. The Mecúfi District coast, located in the north-western portion of Area 3, has 125 known seaweed species, consisting of 46 green algae species (Chlorophyta), 22 brown algae species (Phaeophyta) and 57 red algae species (Rhodophyta). Seventy-two species (or 58 percent) are considered new in Mozambique (1). Seaweed species are often associated with seagrass meadows and typically include species of *Ulva*, *Codium* and *Caulerpa*.

7.3.6 *Coral Reefs*

The Quirimbas Archipelago, just north of the study area, is one of the largest and most pristine continuous fringing reefs in Mozambique (2) and is composed of approximately 50 species of corals. Coral reefs have, however, not been documented extensively along the coast adjacent to the concession area, but they are known to occur at a number of sites. These include Ponta Maunhane (off the Lighthouse at Pemba), Murrebue (near Ponta Mesaulane), Mecufi (the largest bank at south of Lurio Bay, Ponta Metacaua) and Baixo Pinda, east of the Bay of Memba. While most coral reefs are fringing reefs, ie following the contour of the coastline, there are few reefs which are isolated and atoll-like. These include the Baixo Indujo which exposes at low tide and three other small shallow reefs (in 10 - 15 m water depth) located between Ponta Maria Luiza (south of the Bay of Almeida) and Ponta Quissiquix (at Enseada de Simuco).

The reef at Baixo Pinta (south east of the Bay of Memba) is considered the largest, most diverse reef in the region, followed by the reef at Ponta Metacaua to Baixo Indujo (offshore of the Bay of Almeida). The current condition of the Baixo Pinda reef is unconfirmed, but it may have been negatively affected by recent *El Nino* events and the commercial coral extraction and shell collection activities by companies based in Nicola and Mossuril. The reef and fish species diversity have not yet been documented (3).

The reef situated east of Pemba (Ponta Maunhane) consists of two large coral outcrops exposed to offshore waters with dominant hard corals (foliose and sub-massive) (4). This reef is heavily fished and in 1999, was reported to have a good hard coral cover consisting of 69.7 percent rock, 2.9 percent algae and

(1) Bandeira *et al*, 2001
(2) CBTBG, 2004
(3) Rodrigues et al, 1999
(4) Rodrigues et al, 1999

16.9 percent dead coral, and was recovering from bleaching (1). The most common species of corals are *Echinophora hirsutissima*, *Astreopora muriophthalma*, *Goniastrea rectiformis*, *Porites* spp., *Seriatophora hystrix*, *Favia stelligera* and *Acropora lattistela*. Several rare Indo-Pacific coral species also occur in the area, including *Acanthastrea ishigakiensis*, *Acropora ocellata*, *Acropora willisae*, *Goniopora tenuidens*, *Montipora peltiformis*, *Porites lichen* and *Turbinaria mesenterina*.

The coral reef fish community is reportedly healthy, dominated by carnivores (72 percent) but also including herbivores (13 percent) and corallivores (8 percent) with all groups represented by all size classes. About 14 fish species were recorded in the Ponta Maunhane reef, by family, included the Chaetodontidae (26 percent), Pomacanthidae (one percent), Acanthuridae (21 percent), Haemulidae (21 percent), Mullidae (20 percent) and the Lutjanidae (49 percent), of which the dory snapper *Lutjanus fulviflama* was the most abundant.

Typically, inshore of the fringing coral reefs are areas of mixed seagrass and patch reef communities that are important nursery areas for juvenile reef fishes and invertebrates. Coral reefs in the survey area are consequently important to artisanal fishers and represent a major contributor to the livelihood of the many small coastal communities along the coast of northern Mozambique. Coral reefs also represent one of the main attractions for tourism industry in Mozambique. Overfishing of coral reefs using methods such as small mesh nets, spear guns and line fishing are of particular concern, and the Cabo Delgado Biodiversity Tourism Project is engaging with local communities within the province in an attempt to reduce these types of impacts (2).

7.4 MARINE FAUNA

7.4.1 *Invertebrates*

Invertebrates include all fauna species that do not have a backbone (eg sponges, jellyfish, corals, worms, molluscs, and crustaceans). Invertebrates are known to dominate the shallow pelagic and demersal habitats (eg crustaceans, squid and octopus, gastropod molluscs, sea urchins, hard and soft corals, and jellyfish) (3). Within the study area, little is known about the invertebrate species that occur within the different marine habitats, with the exception of

(1) Rodrigues et al, 1999
(2) Julie Garnier and Christopher Cox personal communication in Anardarko, 2006
(3) Richmond, 1998

corals and crustaceans. Corals have already been discussed in the coral reef section above (*Section 7.3.6)*.

Crustaceans are a diverse group of invertebrates represented by species that live in most marine habitats. Within the survey area, crustaceans include land hermit crabs (*Coenobita rugosus*) that occur high up in the dunes amongst the vegetation, ghost crabs (*Ocypode* spp.) that occur within the upper intertidal zone of sandy beaches and soldier crabs (*Dotilla frenestrata)* that occur in the lower intertidal areas where they emerge from the sand in large 'armies' to process the moist sediments for food. The subtidal sand flats are also frequented by swimming crabs (*Portunus pelagicus*), hermit crabs (*Dardanus megistos*) and in deeper subtidal areas by burrowing shame-faced crabs (*Calappa hepatica*) (1).

Intertidal rocky shores, seagrass meadows and coral reefs also provide habitat for various crustacean species, including crabs, shrimp and prawns that are common prey species for commercial fish. Estuaries and mangroves are important breeding grounds for commercially valuable shrimp and prawn species such as *Penaeus indicus*, *Penaus semisulcatus*, *Peneaus monodon*, *Penaeus japonicus*, *Penaeus canaliculatus*, *Acete erythraeus*, *Trachypenaeus curvrostris* and *Metapenaeus monoceros* (2). River mouths are particularly important nursery areas for the post-larvae and juveniles whereas the sub-adults and adults are more commonly distributed on sandy mud and/or muddy sand sediments in 20 - 50 m water depth on the inner continental shelf (3).

Finally, two common lobster species (*Scyllarides elisabethae* and *Schillarides* sp.) occur in deeper demersal habitats along the continental shelf.

Two mollusc species of commercial importance known to occur in the survey area are the squid, *Loligo vulgaris*, and the calamari, *Sepia pharaonis,* which are found in the epipelagic environment in the vicinity of nearshore coral reefs and seagrass meadows (4). A variety of shellfish species would also be expected to occur in the sandy – muddy environments along the coast.

7.4.2 Fish

The Regional marine fish fauna is quite diverse and over 2000 fish species occur in the Western Indian Ocean (5). The nearshore shallow habitats have

(1) Richmond, 1997
(2) Brinca and Sousa, 1984 and Richmond, 1997
(3) FAO, 1979
(4) Richmond, 1997
(5) Richmond, 1997

the highest diversity of species, mainly coral reef and rocky reef associated species but also seagrass, mangrove and estuary associated species. These represent an important food source for the deep sea fish species that occur in the project area. There is little information available on the fish fauna of the littoral and deep waters of northern Mozambique apart from hydrographic and fishing potential research data gathered by a joint Mozambican and Norwegian team in 1977 and 1978.

Marine fish species from the following groups are discussed in this report:

- demersal fish;
- small pelagic fish;
- larger pelagic fish;
- mesopelagic fish; and
- coral reef and seagrass associated fish.

Demersal fish

The demersal fish live on or near the seabed. Species occurring within the study area are likely to include the spot snapper (*Lutjanos bohar*), the mottled brown seabass (*Promicrops lanceolatus*), the moontail seabass (*Variola louti*), the long-face emperor (*Lethrinus kallopterus*), moray eels (*Lycodontis* spp.) as well as various shark species (*Carcharinus* spp.).

Small Pelagic Fishes

Pelagic fish live within the water column and the smaller species often occur in large schools. Small pelagic fish within the study area are likely to include scad (*Decapterus* spp.) and barracuda (*Sphyraena* spp.), round scad (*Decaptenus maruadsi*) and ponyfish (*Leiognathus* spp.). Shoals of scad (probably round scad) have been sighted near Pemba.

Larger Pelagic Species

A number of larger pelagic species are likely to occur within the study area. Both adult and juvenile Spanish mackerel (*Scomberomorus commerson*) have been recorded off Cabo Delgado, indicating that there are also spawning activities within the area [(1)]. Schools of yellowfin tuna (*Thunnus albacares*), dusky shark (*Carchorhirius obscuras*) and blackspot shark (*C. sealei*) were also observed off the coast of Cabo Delgado. Other pelagic fishes known to be present in the area include marlins, sailfishes, whale sharks and rays [(2)].

(1) Saetre and Silva, 1972
(2) Richmond, 1998

A number of pelagic predatory species occur in the coastal waters including the Indo-pacific sailfish (*Istiophorus platypterus*), marlins (*Makaira indica*, *M. mazara*, *Tetrapterus angustirostris*, *T. audax*), wahoo (*Acanthocium solandri*), albacore (*Thunnus alalunga*), yellowfin tuna (*T. albacares*), skipjack tuna (*Katswomus pelamis*), bonitos (*Gymnosarda unicolor*), narrow banded Spanish mackerel (*Scomberomorus japonicus*), swordfish (*Xiphias gladius*), great barracuda (*Sphyraena barracuda*), giant trevally (*Caranx ignobilis*) and the blue fin trevally (*Caranx melampygus*) (1). Marlin, sailfish, wahoo, and dorado are important for sport fishing between September and April.

Elasmobranch species (ie rays and sharks) are the most common species in the demersal and pelagic habitat inside the project area. Although shark and ray species have not been documented in the concession area, the benthic and mesopelagic environment of the deep sea areas is expected to be frequented by sharks. During pelagic and deep water trawls carried out in northern Mozambique during the cruise of the research vessel *Fridjot Nansen*, five shark species (*Carcharhinus falciformes*, *Carcharhinus sorrah*, *Carcharhinus*. sp., *Heteronarce garmani* and *Sphyrna leweni*, and two rays species (*Mobula*. sp. and *Raja lanceolata*) were recorded (2).

Rays from the Rhinobatidae, Mobulidae, Dasyatidae, Miliiobatidae families and Stomiiformes order have been observed in coastal waters within the project area. The order Stomiiformes (mesopelagic and bathypelagic species) is composed of nine families, 50 genera and 300 species) (3). Manta rays (*Manta* spp.) are also known to frequent the pelagic environment in the survey area.

Carnivorous shark species inhabit the pelagic and mesopelagic environment, as well as the deep areas of the ocean, predating on large fishes. Sharks of Family Hexanchidae, Family Heterodontiformes (bullhead sharks), Order Squaliformes (Family Squalidae) and Order Carcharhiniformes and Order Squatiniformes are common in these environments. Pelagic shark species likely to occur in the study area include the whale shark (*Rhincodon typus*), that is cosmopolitan but tends to frequent highly productive nearshore areas where good sources of food (ie plankton) are found in areas of upwelling. Other sharks that are found in the waters of the coast of Cabo Delgado include the blacktip shark (*Carcharhinus limbatus*), hammerhead sharks (*Sphyrna* spp.) and the tiger shark (*Galeocerdo cuvier*).

(1) IMPACTO and Mark Woods (2006)
(2) Olsen et al, 2009
(3) Smith and Heemstra, 1995

Mesopelagic Species (200 to 1000m water depth)

Mesopelagic species live in the deep ocean waters where ambient light levels are very low or non-existent and therefore many species have specialised feeding techniques. Lantern fish (Family Myctophiformes) use special glands in their skin to produce light which attracts prey species. The spinycheek lanternfish (*Benthoseme fibulatum*) and spiny lanternfish (*Myctophum spinosum)* are the most common mesopelagic species occurring off Cabo Delgado. There are 28 genera and 125 species of lantern fish in the Western Indian Ocean (1).

The coelacanth (*Latimeria chalumnae*) has been recorded off the Comoros Islands to the east of Cabo Delgado Province, south of the survey area off Zambezi Province and to the north off Tanzania. *L.chalumnae* lives in deep waters where it shelters in submarine caves during the day and forages at night, eating squid and other fish species. The coelacanth can grow to 180 cm in length (up to 100 kg), is considered an ancient fish species ('living fossil') that is unique among fish in having a swimbladder filled with fat rather than gas. Although research so far shows that coelacanths occur at water depths of 100 - 700 m, they may also occur in deeper waters and are likely to occur in marine waters off Cabo Delgado. The IUCN classifies coelacanths as a Critically Endangered species and it is listed on the IUCN Red List of Threatened Species (2).

Fish associated with coral reefs

The fish species diversity associated with coral reefs is high with approximately 601 species (comprising 27 families) in Mozambique waters (3). The coral reef fish community at Ponta Maunhane (east of Pemba) is reportedly healthy, dominated by carnivores (72 percent) but also including herbivores (13 percent) and corallivores (8 percent) with all groups represented by all size classes. About 14 fish species were recorded in the Ponta Maunhane reef, by family, included the Chaetodontidae (26 percent), Pomacanthidae (1 percent), Acanthuridae (21 percent), Haemulidae (21 percent), Mullidae (20 percent) and the Lutjanidae (49 percent), of which the dory snapper *Lutjanus fulviflama* was the most abundant.

(1) Smith and Heemstra, 1995
(2) IUCN, 2007
(3) Perreira ,2000

Fish associated with seagrass beds

Inspections of seine net catches and basket traps have identified 195 species (from 52 families) of fish that are associated with seagrass beds (1). The family Lethrinidae accounted for the largest proportion of fish (31.5 percent) followed by Siganidae (22 percent) and Scaridae (11 percent). In addition, 29 species of wrasse (Labridae) were identified, accounting for more than 9 percent of all fish caught. Almost 70 percent of the catch was comprised of the following five species: *Siganus sutor* (Siganidae, 25.1 percent), *Lethrinus lentjan* (Lenthrinidae, 23.9 percent), *Leptoscarus vaigiensis* (Scaridae, 8.8 percent), *Lethrinus variegatus* (Lethrinidae, 8 percent) and *Gerres oyena* (Gerreidae, 3.5 percent).

7.4.3 Sea Turtles

Five sea turtle species are known to occur in the Mozambique Channel (including the project area) and all are listed as endangered or critically endangered on the 2007 International Union for the Conservation of Nature and Natural Resources (IUCN) Red List of Threatened Species (2). A list of sea turtle species and their current IUCN status is provided in *Table 7.2* below.

Table 7.2 Sea turtle species found in the Mozambique Channel

Common Name	Scientific Name	IUCN status
Green Turtle	*Chelonia mydas*	Endangered
Hawksbill Turtle	*Eretmochelys imbricate*	Critically Endangered
Leatherback Turtle	*Dermochelys coriacea*	Critically Endangered
Loggerhead Turtle	*Caretta caretta*	Endangered
Olive Ridley Turtle	*Lepidochelys olivacea*	Endangered

Source: Márquez, 1990

Adult loggerhead, green, hawksbill, and olive ridley turtles feed in a variety of habitats, including seagrasses, coral reefs, mud flats, and mangroves, whereas adult leatherback turtles generally feed in deeper waters (3). Although there is incomplete information on the location of nesting sites in northern Mozambique, it is known that all the above turtle species (excluding leatherbacks) and particularly hawksbills, nest on sandy beach habitats along the Mozambican coast.

Each of these species is described below in further detail.

(1) Gell, 1997
(2) IUCN, 2007
(3) Zoological Society of London, 2007

Green Turtle (Chelonia mydas)

Green turtles are widely distributed in tropical and subtropical waters near continental coasts and around islands. Green turtles are herbivorous (1) and solitary but occasionally feed together in shallow waters with abundant seagrasses and algae. Green turtles may migrate several thousand kilometres between their feeding grounds and nesting areas.

At least two subspecies of green turtle are known to be present within the Mozambican Channel (*Figure 7.15*). The subspecies are defined by geographic distribution as well as some minor morphological and behavioural characteristics. Green turtles are considered the most common turtle along the Mozambican coast (2) and are listed by the IUCN as Endangered.

The Green Turtle uses nesting sites north of the Tropic of Capricorn, in the Quewene Peninsula and the Quirimbas Archipelago (3), located to the north of the project area. Nesting within these areas is reported on Rongui and Vamizi Islands between January - July and November - July, respectively (4).

Loggerhead Turtle (Caretta caretta)

Loggerhead turtles are widely distributed throughout coastal tropical and sub-tropical waters, and are also known to move into temperate waters. Loggerhead turtles undertake long migrations between their nesting and feeding areas using warm currents.

Adults and adolescents primarily inhabit shallow waters while hatchlings and juveniles are associated with oceanic current convergence zones, leading a pelagic-nektonic existence for their first year (5). Loggerhead turtle nesting is usually in spring and summer (October to February) within specific nesting areas in the south-western Indian Ocean.

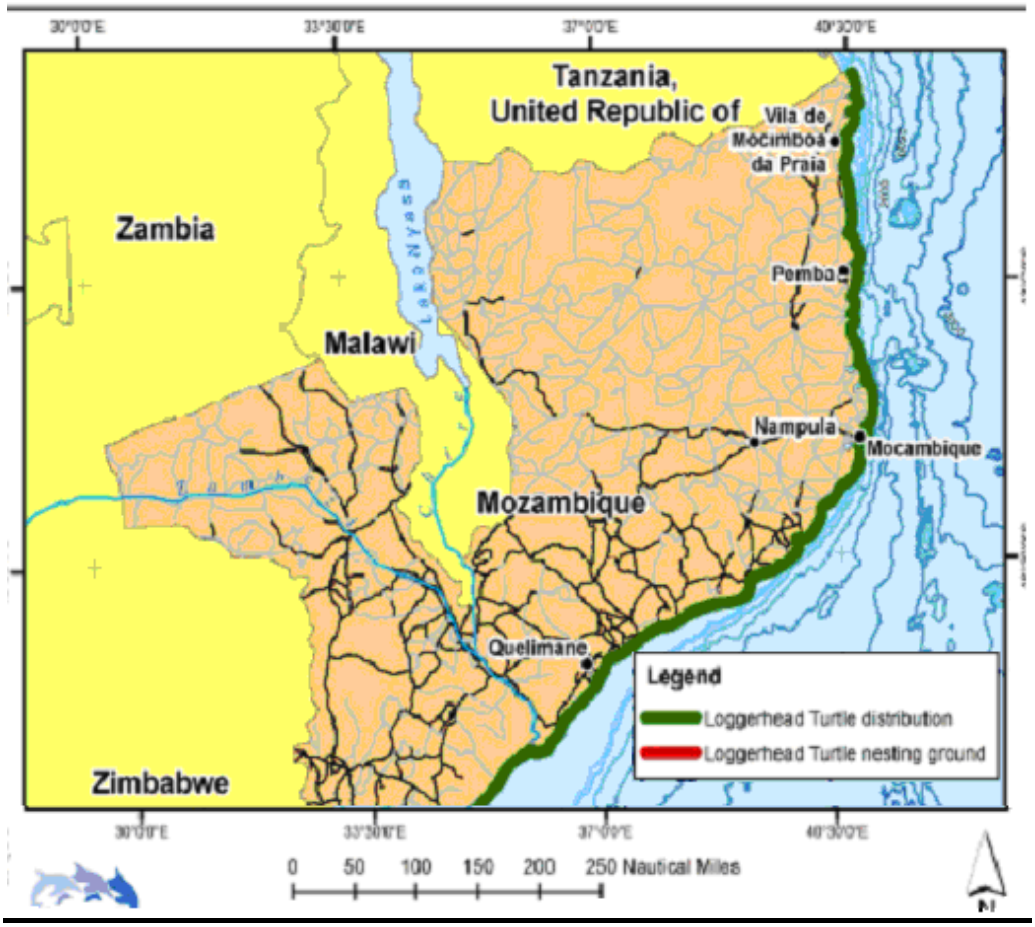
Although more common south of the survey area, loggerhead turtles are found along the entire Mozambican coastline (*Figure 7.16*) and have nesting sites along the coast from the Bazaruto Archipelago to Ponta do Ouro (6). This species is carnivorous, primarily feeding on benthic fauna such as molluscs and crustaceans. The loggerhead turtle is currently listed as an IUCN Endangered species.

(1) Ernst and Barbour, 1989; Márquez, 1990; Hirth, 1997; NOAA OPR, 2007b
(2) Hughes, 1971
(3) Gove and Magane, 1996
(4) Barr and Garnier, 2005
(5) NOAA OPR, 2007a, Márquez, 1990 and Ernst and Barbour, 1989
(6) Hughes, 1971 and Gove and Magane, 1996

Figure 7.15 Distribution of Green Turtles in Northern Mozambican Waters

Source: Impacto and CSA International, 2006

Figure 7.16 Distribution of Loggerhead Turtles in Northern Mozambican Waters



Source: Impacto and CSA International, 2006

Hawksbill Turtle (Eretmochelys imbricata)

The Hawksbill turtle is the most tropical of all the turtle species found within the study area, and is more commonly found close to reefs and within shallow waters such as coastal lagoons and bays with seagrasses and algae. Some individuals (especially juveniles) seem to exhibit residential, non-migratory behaviour in shallow coastal waters. Adult Hawksbill turtles move both short and long distances between feeding grounds and nesting areas.

Hawksbill turtles are omnivorous and feed on diverse benthic fauna such as corals, tunicates, sponges and algae [(1)]. Hawksbill turtles are found along the entire coastline of Mozambique, and are most abundant in the northern parts

(1) Ernst and Barbour, 1989, Márquez, 1990, NOAA OPM, 2007d

close to shallow coral reefs [1] (*Figure 7.17*) Their primary nesting sites are on islands (and sometimes on mainland beaches) in the northern part of Mozambique, including the Quirimbas Archipelago.

Hawksbill turtles are currently listed by the IUCN as Critically Endangered [2].

Olive Ridley Turtle (Lepidochelys olivacea)

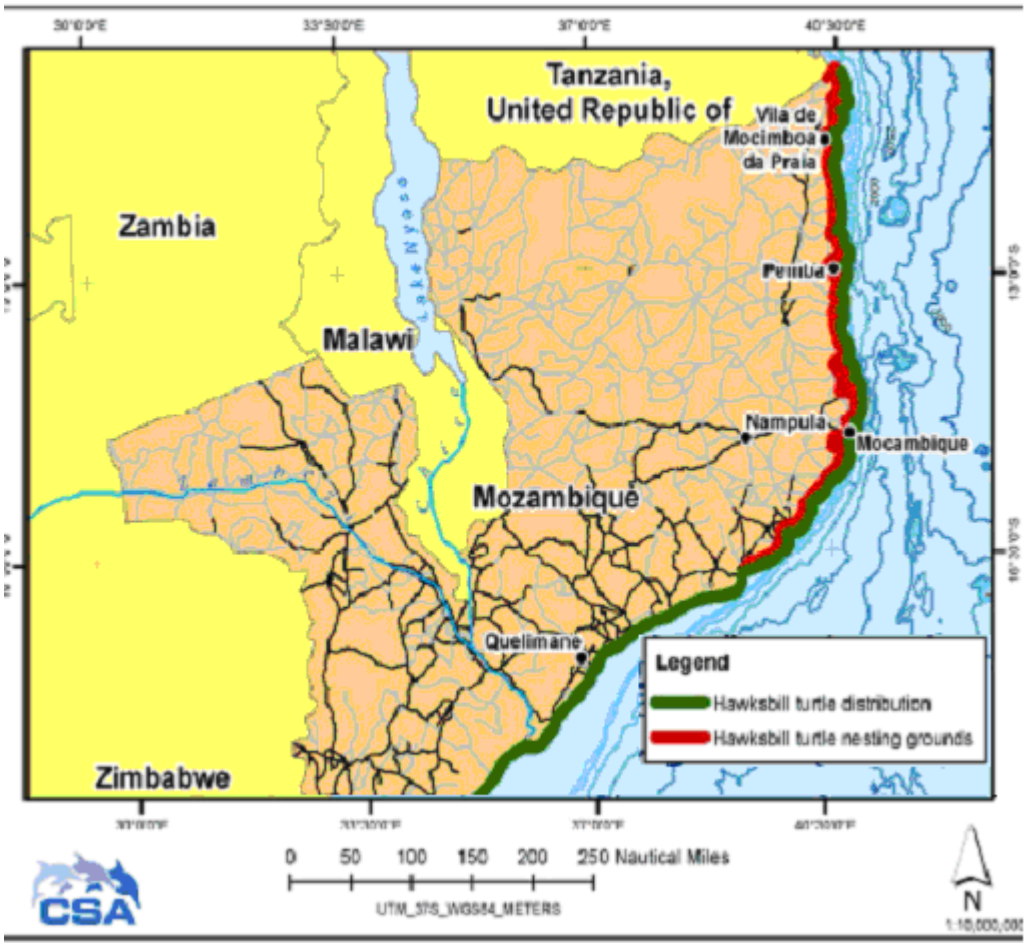
Olive ridley turtles occur both in tropical environments and are observed travelling in large flotillas between breeding and feeding areas, particularly in the eastern Pacific and Indian Oceans. The turtles travel along the continental shelf, and congregate in large numbers at special nesting areas at the beginning of summer. This kind of nesting aggregation (arribazon) is a unique characteristic shared with the Kemp's Ridley (*Lepidochelys kempii*) turtles.

Olive ridley turtles are omnivorous and feed on fish, salps, benthic invertebrates, and algae [3] and are considered common in Mozambican waters north of Pebane [4]. Olive ridley turtles nest both on islands and the mainland of the northern part of Mozambique with a similar nesting distribution as the Hawksbill turtle [5]

Olive ridley turtles are currently listed by the IUCN as Endangered [6].

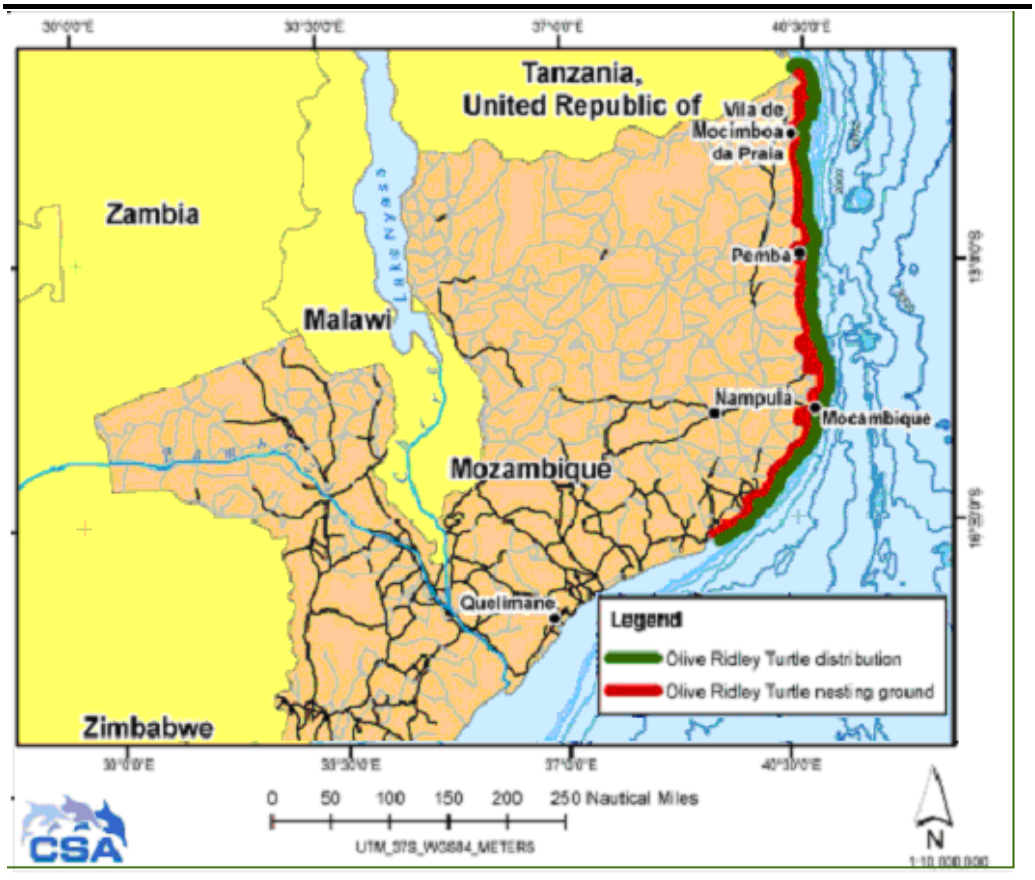
(1) Hughes, 1971
(2) IUCN, 2007
(3) Ernst and Barbour, 1989, Márquez, 1990 and NOAA OPM, 2007e
(4) Hughes, 1971
(5) Hughes, 1971
(6) IUCN, 2007

Figure 7.17 Distribution of Hawksbill Turtles in Northern Mozambican Waters



Source: Impacto and CSA International, 2006

Figure 7.18 Distribution of Olive Ridley Turtle in Northern Mozambican Waters



Source: Impacto and CSA International, 2006

Leatherback Turtle (Dermochelys coriacea)

The leatherback turtle is one of the largest living reptiles and is easily distinguishable from all other sea turtle species by its size and different anatomical and physiological features. These unique features include vascularised growth cartilages which form a chondro-osseous skeleton composed of small polygonal bone pieces supported by thick and oily cartilaginous dermal tissue and the ability to control body temperature in a way similar to marine mammals.

Adult leatherback turtles are therefore more able to adapt to cold water than other sea turtles and are the most widely distributed turtle species. Leatherback turtles are primarily pelagic, and approach coastal waters only

during the breeding season or to feed on high concentrations of pelagic fish (eg tuna), jellyfish and other soft-bodied invertebrates [1].

Records of leatherback turtles in Mozambique are limited to the southern coast, from the Bazaruto Archipelago National Park (BANP) to Ponta do Ouro. Nesting in Mozambique also occurs on mainland beaches [2]. Leatherback turtles do not traditionally occur within the project area.

Leatherback turtles are currently listed by the IUCN as Critically Endangered [3].

7.4.4 Aerial Survey Results

An aerial survey undertaken over the concession areas in November, 2009 indicated low turtle densities with most sightings being green turtles (*Chelonia mydas*) and olive ridley turtles (*Lepidochelys olivacea*). Other studies, however, have shown that sea turtles are particularly common in some areas of the Quirimbas Archipelago (around Vamizi Island), and in some parts of the Quirimbas National Park. Turtles are not known to be abundant off the continental shelf (ie continental slopes and abyssal environments) and most of the proposed seismic survey area consists of deep water environments (between 1000 and 2000 m). The low number of sightings during the aerial survey may be due to the turtles spending most of their time underwater rather than at the surface, and low visibility due to marginal weather conditions at the time of the survey.

Sea turtle species differ in their nesting areas along the coast of Mozambique; green turtles and olive ridley turtles nest in shallow sandy beaches along the northern coast and there is higher incidence of nests and nesting turtles being killed in areas where there is limited presence of maritime authorities. Green, olive ridley and hawskbill turtles may nest on beaches of the coast within the concession areas. The nesting rates of species in the survey area are unknown.

Turtles are known to be common in the survey area before and during the nesting seasons, which peak between March and August each year. The November 2009 aerial survey occurred outside the nesting season which undoubtedly contributed to the low abundance of sea turtles observed. Adult turtles do migrate to feeding habitats which may be away from the nesting

(1) Ernst and Barbour, 1989, Márquez, 1990 and NOAA OPR, 2007c
(2) Hughes, 1971
(3) IUCN, 2007

areas. Most turtles live and forage in the nearshore shallow habitats such as coral and rocky reefs or on seagrass meadows.

Sea turtle feeding habitats are non-existent within the main area of the concession areas due to the deep water; however, turtles do cross deep water areas to access shallow feeding/ nesting areas. Potential feeding locations in the vicinity of the survey area include the Paisley seamount, Europa Island, Bassas das índias Reef, Comores Archipelago and west coast of Madagascar. Detailed information on turtle movements along the Mozambique coast is lacking but a monitored green turtle which nested in the northern island of Quirimbas Archipelago moved northwards to the coast of Kenya where it remained for at least one year (1)

7.4.5 Dugong

The dugong (*Dugong dugon*) is one of four living species of marine mammals within the Order Sirenia, which are the only totally aquatic, herbivorous marine mammals (2). Dugongs are found in tropical and shallow waters of the Indian and Pacific Oceans, and are one of the most endangered marine mammal species in the Western Indian Ocean, making its conservation a priority. Over much of its present range, it is represented by relict populations separated by large areas where it is considered extinct or close to extinction (3). Although dugong periodically gather in large herds at optimal feeding grounds, they usually occur in small groups of up to six individuals (4). Dugong feed on various types of benthic vegetation, primarily seagrasses (5). Recent surveys suggest that dugong are generally scarce within Mozambique, and are found primarily in southern areas within the nearshore habitats of Maputo Bay (near Inhaca Island), Inhambane Bay, at Pomene, around the Bazaruto Archipelago and close to the coast between Inhassoro and the Save River (6).

Intensive fishing with gill nets over the past 60 years and the use of other hunting methods appear to have drastically reduced the population of dugong at Pemba Bay and at the coast of Nicola and Angoche (7). No information exists on the occurrence of dugong in Areas 3 and 6 of the

(1) Guissamulo, 2009
(2) Jefferson et al, 1993
(3) Nishiwaki and Marsh, 1985
(4) Jefferson et al, 1993
(5) Reeves et al, 2002
(6) WWF Eastern African Marine Ecoregion, 2004 and Guissamulo, 2007
(7) Hughes, 1971

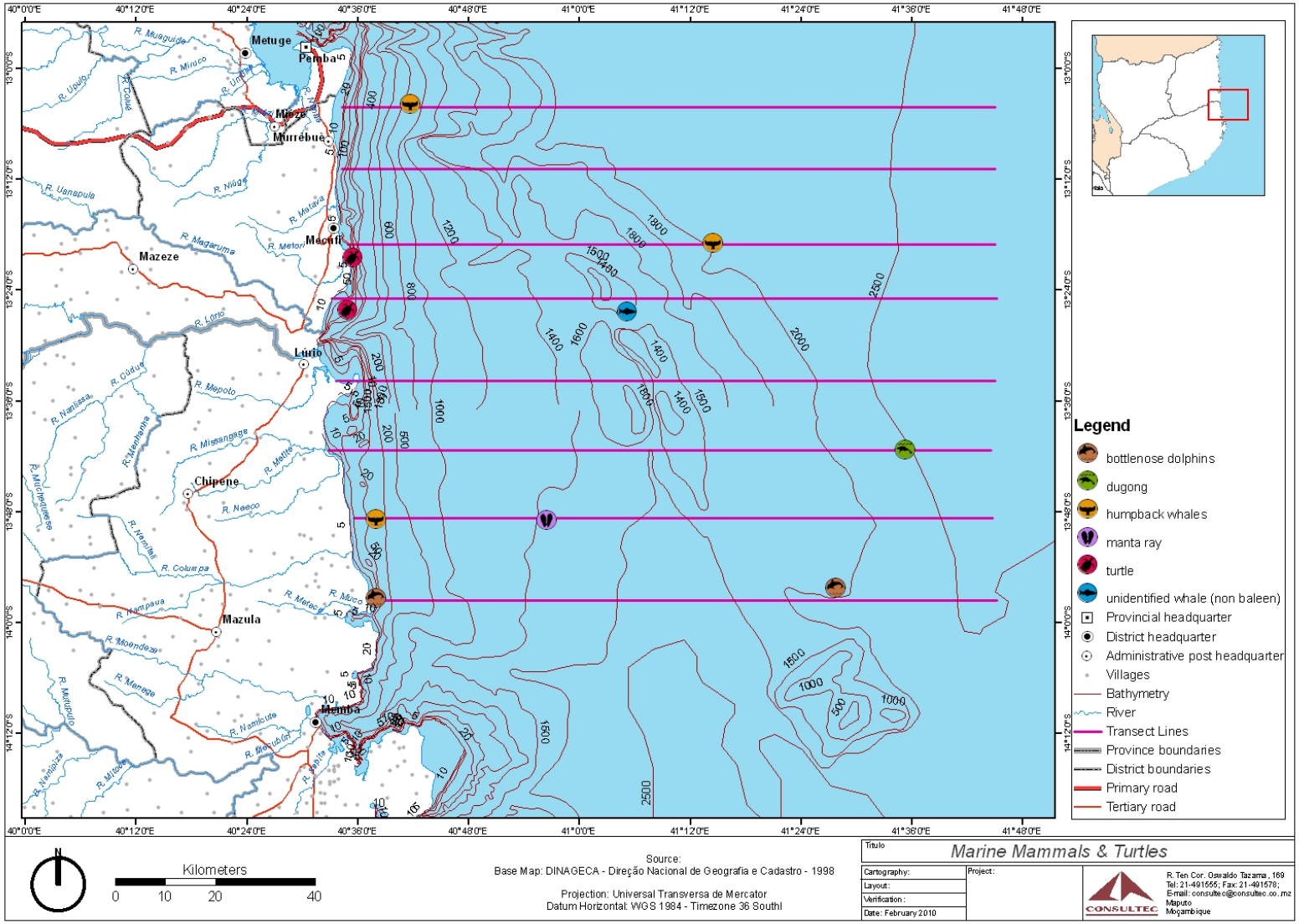
Rovuma Basin, but based on existing habitat, it is likely that dugong are most abundant north of Nicola towards the Quirimbas Archipelago (1).

Dugong are currently listed as Vulnerable by the IUCN (2) and are listed in Mozambique as a declining species (3). This is due to factors including killing for subsistence purposes, accidental netting, water pollution as a result of agricultural practices, natural disasters such as large storms and other human induced disturbances associated with recreation and tourism (eg boat strikes).

During the aerial survey carried out on 24 November 2009, a lone dugong was seen offshore at the south east of the Rovuma Areas 3 and 6 concession areas, near the Paisley Seamount (coordinates 14.09ºS and 41.51ºE) (*Figure 7.19)*. The depth of water at this seamount is about 250 m (too deep for seagrass) while the surrounding areas are over 2000 m. The lone dugong seen offshore was possibly travelling between feeding areas, although the nearest potential feeding habitat is at Baixo Pinda and Memba Bays 100km to the west. The dugong is suspected to have come from Madagascar (4). The occurrence of dugong in offshore areas indicates that they are able to travel across large stretches of open sea away from feeding habitats.

(1) Hughes, 1971 and Smith and Lobão Tello, 1976
(2) IUCN, 2007
(3) Marsh, 2006
(4) Jeremy Kizska, pers. comm.

Figure 7.19 Map of Marine Aerial Survey



Dugong are not known to migrate extensively over large areas, but may undertake seasonal movements between shallow waters and the open ocean for thermoregulation and in response to decreasing temperatures. In addition, intense fishing activity in nearshore areas may displace dugong forcing them to seek new feeding areas.

7.4.6 *Cetaceans (Whales and Dolphins)*

Marine cetaceans in the survey area include large migrating whale species (ie humpback, minke and sei whales), deep sea resident and vagrant whale species (ie several species of beaked whales, sperm whales and pilot whales), pelagic dolphin species (ie Risso's dolphins, melon headed whales, false killer whales) and resident dolphin species (ie spinner dolphins, bottlenose dolphins, Indo-Pacific humpback dolphins).

Although there is known to be a wide range of marine mammals found in Mozambican waters, there is little information on the actual numbers and distribution of cetaceans, except for historic sighting data and commercial whaling records (1). The Indian Ocean bottlenose dolphin (*Tursiops aduncus*) and the Indo-Pacific humpback dolphin (*Sousa chinensis*) are most commonly seen in the region throughout the year.

The presence of whales in Mozambique waters is normally associated with reproduction periods and seasonal migrations. Three migratory whale species are regularly observed along the Mozambique coastline between June and September: minke whales (*Balaenoptera acutorostrata*), sperm whales (*B.novaeangliae*) and southern right whales (*Eubalena australis*). Other species are less commonly observed but have been recorded in the region: sei whales (*B.borealis*), blue whales (*B. musculus*), and fin whales (*B. physalus*), whereas humpback whales (*Megaptera novaeangliae*) are known to use the Mozambique Channel during migrations. Despite the migration of whales through the concession areas between July and November, part of the humpback whale population, consisting mainly of females with newborn calves, may remain in the area during the early summer instead of migrating back to the Antarctic region (2). During breeding periods, whales tend to swim over the continental shelf (ie closer to shore), whereas migration routes are typically in deeper waters.

Marine mammals observed in the concession areas during an aerial survey undertaken in November 2009 included humpback whales (some with

(1) Wray and Martin, 1983
(2) von Luders et al, 2008 and Donovan and Taylor, 2009

newborns or calves) and schools of bottlenose dolphins that were mostly nearshore, at the west of the concession areas (*Figure 7.19*). A 12 hour marine mammal survey carried out during the peak of whale migration (19 August 2009) in the south of the concession areas showed that humpback whales were abundant towards the shore in the areas shallower than 100 m [(1)].

In addition, seismic surveys carried out in the Quirimbas Archipelago region (300 km north of the proposed PCMRB survey area) between 25 January and 17 May, 2008 and 31 March and 4 May, 2009, reported the occurrence of six cetacean species: spinner dolphins, bottlenose dolphins, melon headed whales, Risso's dolphin, pilot whales, sperm whales and humpback whales [(2)]. Based on these reports it can be assumed that marine mammal species diversity is likely to be high in the proposed survey area. Species likely to exist within the seismic survey area are described in further detail below.

Mysticete (Baleen) Whales

Humpback Whale (*Megaptera novaeangliae*)

The humpback whales leave their summer feeding grounds in cold (Antarctic) waters and migrate to shallow tropical waters, where they calve, during winter [(3)]. These areas include shallow waters off Mozambique, Madagascar, and the Central Mozambique Channel Islands [(4)], where the humpback whale has been reliably reported. Although historic sightings indicate that the distribution of humpback whales is not influenced by water depth, sighting densities along the southern Mozambique coast suggest that the animals prefer waters outside of the influence of the warm, southward-flowing Mozambique Current [(5)].

The humpback whale population has undergone some recovery since commercial whaling ceased in 1969 [(6)] and the population in 2003 was estimated to be approximately 6,000 individuals [(7)]. Humpback whales are currently listed by the IUCN as Vulnerable [(8)].

(1) Olsen, 2009
(2) von Luders et al, 2008 and Donovan and Taylor, 2009
(3) Winn and Reichley, 1985
(4) Best et al, 1998 and Findlay et al, 1994
(5) Best et al, 1998 and Findlay et al, 1994
(6) Findlay and Best, 1996
(7) Findlay et al, 2004
(8) IUCN, 2007

Minke Whale (*Balaenoptera* spp.)

The minke whale is the only other species of mysticete whale that has been reliably sighted within the Mozambique Channel (1). Minke whales have a very complex population structure and the taxonomy of the minke whale is unclear. The dwarf minke whale is the smaller subspecies of the northern hemisphere common minke whale (*B.acutorostrata*), and the Antarctic minke whale (*B. bonaerensis*) is recognized as a distinct species (2).

Minke whales are sighted within the Mozambican Channel between June and September. There is no differentiation between minke whale species reported in the Mozambique Channel. Minke whales are listed by the IUCN as Least Concern species (3).

Odontocete (Toothed) Whales and Dolphins

Seventeen species of odontocete whales and dolphins are believed to occur within the Mozambique Channel, and at least 11 species reliably recorded in the northern sections of the channel (4). These species include the sperm whale (*B.novaeangliae*), common bottlenose dolphin (*Tursiops truncatus*), Indo-Pacific bottlenose dolphin (*T. aduncus*), common dolphin (*Delphinus delphis*), false killer whale (*Pseudorca crassidens*), Indo-Pacific hump-backed dolphin (*Sousa chinensis*), melon-headed whale (*Peponocephala electra*), Risso's dolphin (*Grampus griseus*), rough-toothed dolphin (*Steno bredanensis*), short-finned pilot whale (*Globicephala macrorhynchus*), spinner dolphin (*Stenella longirostris*), spotted dolphin (*S.attenuata*) and striped dolphin (*S.coeruleoalba*).

The IUCN lists the sperm whale as Vulnerable and all other odontocete species as either Least Concern or Data Deficient (5).

Distributions of odontocete whale and dolphin species depend strongly on water depth and submarine topography. Three species that occur within the Mozambique Channel are also found in the continental shelf waters at less than 200 m depth. These include common and Indo-Pacific bottlenose dolphins and the Indo-Pacific hump-backed dolphin. The other species usually prefer deeper waters of the continental slope and edge of the continental shelf, foraging in deep water and only spending short periods of time close to the surface. Some species such as Risso's dolphin travel and

(1) Findlay et al, 1994
(2) Reeves et al, 2002
(3) IUCN, 2007
(4) Peddemors et al, 1997
(5) IUCN, 2007c

forage in large groups, while others such as the pygmy sperm whale prefer to move and feed alone or in small groups.

The distribution of potential prey on the continental shelf also influences the location and distribution of the Odontocete whales and dolphins. This is also influenced by the location of nutrient rich areas (eg river outflows) and ocean convergence zones [1].

7.4.7 *Seabirds*

Several marine bird species are found in the project area due to the proximity of Quirimbas National Park (as feeding and roosting habitat), and are often associated with schools of tuna and dolphins when feeding. Some species are inshore foragers and are rarely found further than 5 km from the coast.

Nine families of seabirds [2] occupy offshore and coastal waters of northern Mozambique. Some seabird species primarily inhabit offshore continental slope habitats (eg albatross, petrels, boobies, gannets, and tropicbirds) although most seabird species in the Mozambique Channel inhabit waters of the continental shelf and shelf edge and adjacent coastal and inshore habitats [3].

Large numbers of terns (Sternidae), particularly common tern (*Sterna hirundo*), lesser crested tern (*S. bengalensis*), swift tern (*S. bergii*) and sooty tern (*S. fuscata*) [4] are found within the Bazaruto Archipelago. Terns are the most common avian species in the region, and move as far south as the Primeiras and Segundas Archipelago in Nampula province. *S.fuscata* and *S.caspia* (Caspian terns) are common in the marine and adjacent coastal area, feeding on anchovies and sardines and are also found in deep water areas in association with schools of tuna.

Very little information is available about migratory seabirds in the region, although it is known that many species use sandy shores in the Quirimbas National Park as cover and feeding areas. A number of coastal birds are also commonly found in the mangrove areas.

The wandering albatross (*Diomedea exulans*) and cape gannet (*Morus capensis*) are currently listed by the IUCN as Vulnerable, and Jouanin's petrel (*Bulweria*

(1) Davis et al, 2002
(2) broadly defined as species that spend a large portion of their lives on or over seawater
(3) Newman, 2002, Sinclair and Ryan, 2003
(4) Dodman et al, 1997

fallax) and African skimmer (*Rynchops flavirostris*) are listed as Near Threatened [(1)] .

7.5 PROTECTED AREAS AND SPECIES OF PARTICULAR IMPORTANCE

7.5.1 Protected Areas

No formal protected areas exist near or within the proposed seismic survey area and it is unknown whether there are any community based managed areas within the project area. The Quirimbas National Park is, however, located north of Pemba and the Baixo Pinda Forest Reserve is located south of Memba, to the north and south of the concession areas, respectively.

The Quirimbas National Park contains the Quirimbas Archipelago, comprising islands, banks, and reefs and an associated rich complex of patch reefs, seagrass, and sand/ mud flat habitats that stretch a distance of approximately 400 km from the Tanzanian border at the mouth of the Rovuma River southward to Pemba, just to the north of the study area.

Regarding marine habitats of particular importance, the Paisley seamount is part of an underwater 'oasis' in the open ocean. This seamount is the most significant after the São Lázaro Bank, which is a protected area. Sea mounts are places of increased species diversity of both pelagic and benthic habitats because the topography induces upwelling of cold nutrient-rich water. These seamount areas are therefore expected to have a concentration of high biodiversity of marine mammals, sea turtles, fish communities and invertebrate communities and may therefore require special attention (avoidance?) during the seismic survey.

7.5.2 Species of Particular Importance

Species of particular importance in the proposed seismic survey region include the coelacanth fish (*Latimeria chalumnae*), pelagic gamefish species, whale sharks, manta rays, turtles, baleen whales, coastal and ocean dolphin species, beaked whales and dugong.

The coelacanth is a deep water fish species living at depths of between 100 and 200 m. This fish species is recognised as a species of evolutionary value because it forms part of the link between marine and terrestrial fauna. Believed to have been extinct prior to its re-discovery in the 1960's on the

(1) IUCN, 2007

Coast of South Africa, living populations are now known from the Comores, Tanzania, Mozambique and South Africa.

The survey area is part of the migration route for tuna (*Euthynnus affinis*) and several pelagic bill fish species that occur in the area, including the sailfish (*Istiophorus platyperis*), marlin (*Makaira indica*), swordfish (*Xiphias gladius*), dolphin fishes (*Coryphaena hippurus*) and wahoo (*Acanthoybium solandri*) (1).

Whale sharks and manta rays are migrating species feeding on plankton in the surface waters. These species move between algal blooms and are therefore capable of crossing deep water habitats seeking places of high plankton abundance.

Marine turtles are protected by national and international regulations because of their exposure to multiple threats. Their local conservation is also important. Marine turtles are capable of crossing large and deep oceans and can potentially use the survey area as a migration route.

The region is part of the calving ground of baleen whales, a feeding area for spinner and spotted dolphins (which feed on mesopelagic fish and squid species), and sperm whales, beaked whales and pilot whales that feed on deep sea squid.

The dugong is probably the most endangered marine mammal species in the Western Indian Ocean and therefore there is concern for ensuring its conservation.

(1) Richmond, 1998

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