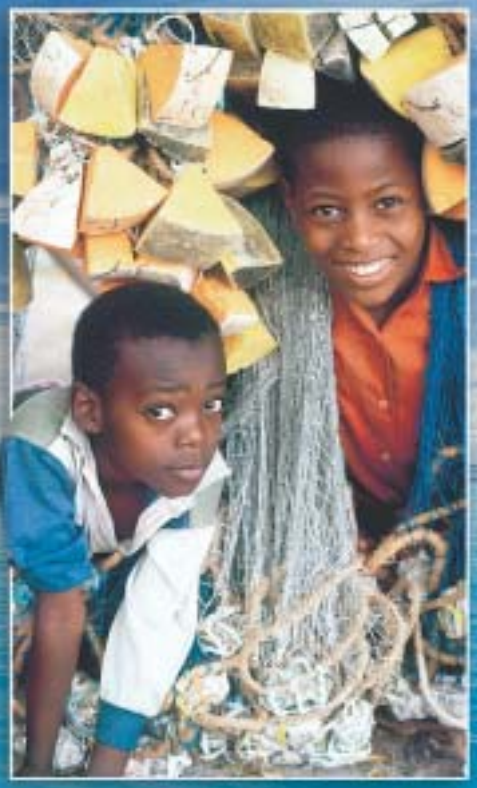


The Eastern African Marine Ecoregion

A large-scale approach to the management of biodiversity

The Eastern African Marine Ecoregion:

A large-scale approach to the management of biodiversity

The Eastern African Marine Ecoregion is an area stretching from southern Somalia to the Natal shores of South Africa. This 4,600km coastline is host to an ever-growing population of 22 million, most of whom depend on the coastal seas for their sustenance, business and leisure. This coastal region is referred to as an 'ecoregion' because of the way the marine and coastal habitats are linked, both physically and ecologically. The main habitats present in the ecoregion are mangrove forests, seagrass beds, coral reefs and open waters, home of over 11,000 species of plants and animals. Typically, these habitats form a mosaic along the coast, supporting rich and complex populations of marine species that rely on this diversity for their productivity. In the last fifty years, human activities in the coastal zone have begun to alter and destroy this biodiversity, essential to the continued existence of humans on these shores. Though many pristine areas remain, the rate of human impact is expected to increase. In the pages that follow, the physical, human and biological features of this region are described, together with WWF's Ecoregion Conservation approach aimed at focusing even greater attention on the Eastern African Marine Ecoregion. By boosting the interests and commitment of individual governments and other stakeholders, as well as supporting regional and local initiatives, it is hoped that the conservation of marine biodiversity in this ecoregion will be achieved.

What is Marine Biodiversity?

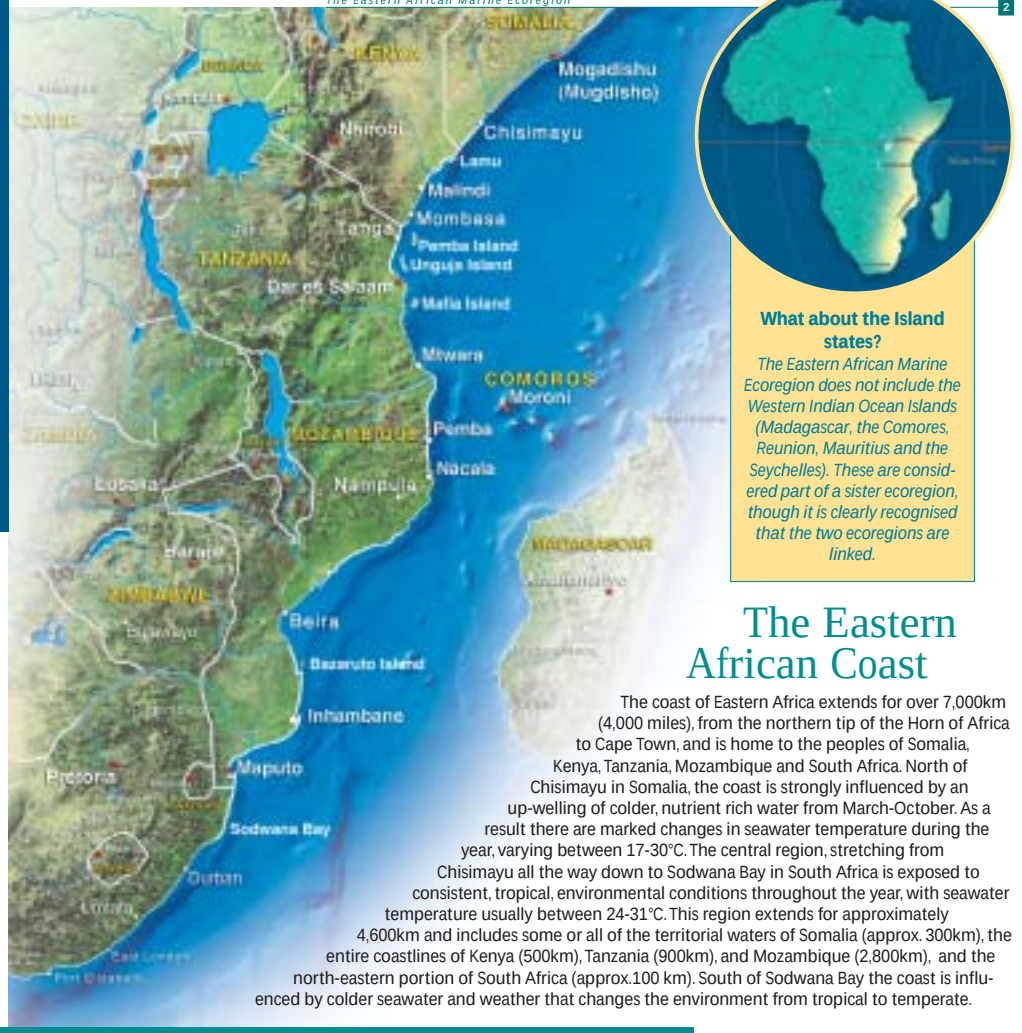
Marine biodiversity includes coastal and marine plant and animal species, their genetic variety, the habitats and ecosystems they form part of, and the ecological processes that support all of these.

The earth is home to an estimated 10 million species. The largest of these are divided by biologists into three main kingdoms: fungi, plants and animals. The Animal Kingdom is then divided into 33 distinct groups (or phyla). Humans belong to the phylum called chordates, which includes all mammals, fishes, reptiles and birds. Other common phyla of the Animal Kingdom include the arthropods (insects and crustacea: crabs, shrimps and lobsters) and molluscs (snails, squid, octopus, cockles and mussels). There are 11 phyla existing in terrestrial environments and 28 phyla living in the sea, of which 15 are exclusively marine.

Examples of exclusively marine phyla include the echinoderms (starfish and their relatives), ctenophores (comb jellies), hemichordates (acorn worms) and the echiurans (trumpet worms). The marine environment therefore includes a far greater diversity of animal groups than the terrestrial environment, which is not surprising since living organisms first appeared in the seas several hundred millions years before life on land evolved.

Whether in the sea or on land, most plant and animal species are grouped into assemblages or communities characteristic of recognisable habitats. The eastern African coast, for example, includes mangrove, seagrass and coral reef habitats. Each of these requires specific environmental conditions for its development. In the case of the mangrove habitat, shelter from wave action and soft mud or sand are the basic conditions that allow the community to flourish. The combination of habitats forms the marine ecosystem. This ecosystem, the various habitats, communities and species they comprise, constitute the marine biodiversity of the eastern African region.

Furry pin-cushion starfish, a member of the echinoderms, one of 15 exclusively marine phyla



What about the Island states?

The Eastern African Marine Ecoregion does not include the Western Indian Ocean Islands (Madagascar, the Comores, Reunion, Mauritius and the Seychelles). These are considered part of a sister ecoregion, though it is clearly recognised that the two ecoregions are linked.

The Eastern African Coast

The coast of Eastern Africa extends for over 7,000km (4,000 miles), from the northern tip of the Horn of Africa to Cape Town, and is home to the peoples of Somalia, Kenya, Tanzania, Mozambique and South Africa. North of Chisimayu in Somalia, the coast is strongly influenced by an up-welling of colder, nutrient rich water from March-October. As a result there are marked changes in seawater temperature during the year, varying between 17-30°C. The central region, stretching from Chisimayu all the way down to Sodwana Bay in South Africa is exposed to consistent, tropical, environmental conditions throughout the year, with seawater temperature usually between 24-31°C. This region extends for approximately 4,600km and includes some or all of the territorial waters of Somalia (approx. 300km), the entire coastlines of Kenya (500km), Tanzania (900km), and Mozambique (2,800km), and the north-eastern portion of South Africa (approx.100 km). South of Sodwana Bay the coast is influenced by colder seawater and weather that changes the environment from tropical to temperate.

Within the tropical portion of the eastern African coast, the shores and coastal seas harbour a characteristic set of species, habitats, dynamics, and environmental conditions. The coastal and marine plants and animals present in the region have adapted and evolved to live and breed in the consistent, reliable tropical conditions that prevail here. This coastal region, functioning largely as a unit, or ecological region, is called the **Eastern African Marine Ecoregion (EAME).**

WWF's Ecoregion Programme (Global 200)

The Global 200 identifies a series of ecoregions, representing all major habitat types in the terrestrial, freshwater and marine realms, which deserve greater emphasis because of their outstanding biological features. A total of 238 land and water based ecoregions have been identified worldwide. The Eastern African Marine Ecoregion is one of about ten marine ecoregions, for which a special focus towards the preservation of biodiversity is being developed. Other selected marine ecoregions include the Meso-American Reef (Guatelama, Honduras, Belize and Mexico), Galapagos, Gulf of California, Bering Sea and Sulu-Sulawesi Sea. Ecoregions are much larger geographical areas than the places where conservation efforts have traditionally been targeted. Furthermore, because of the complex management issues related to the political, socio-economic and biodiversity characteristics of the areas, these ecoregions require a conservation commitment over much longer periods of time – as much as 50 years.

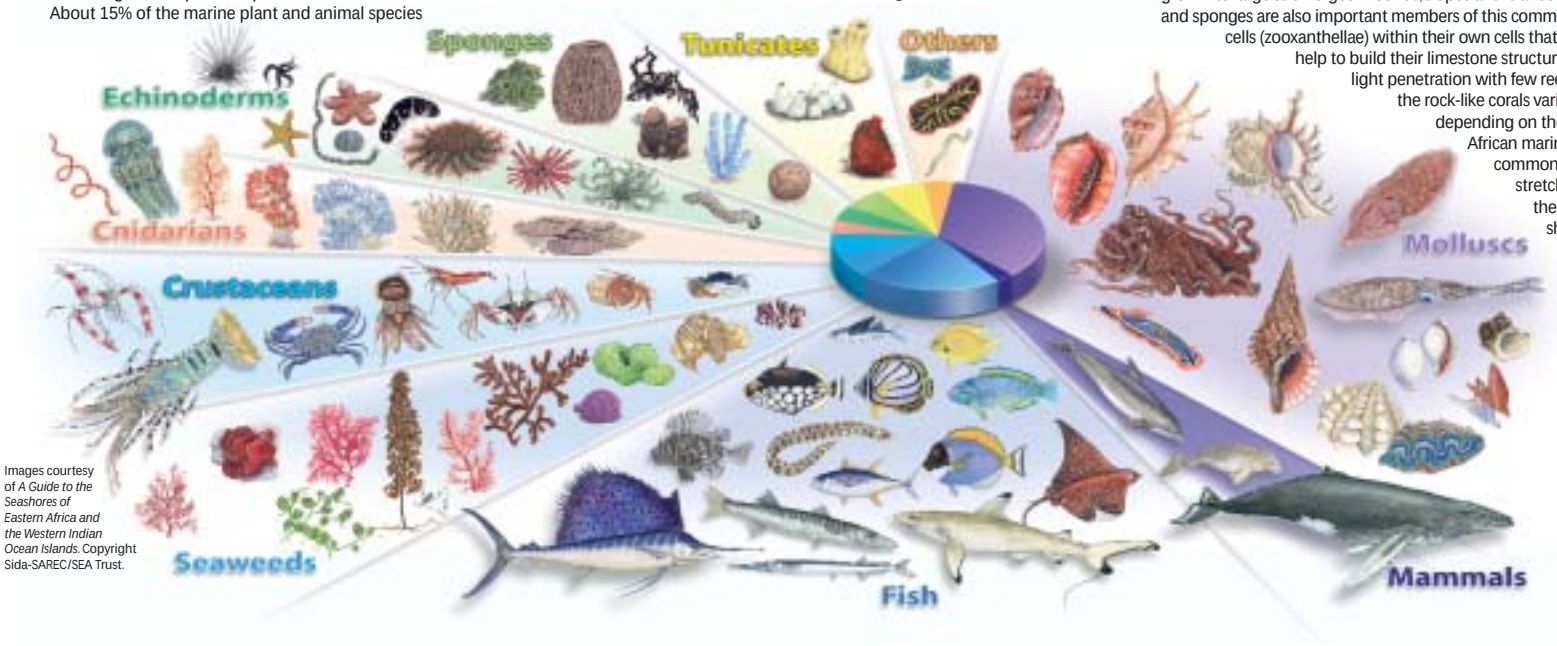
The Eastern African Marine Ecoregion and its Biodiversity

For the majority of people living along the shores of eastern Africa, life in the sea is mysterious. At high tide the reflective surface of the sea gives little indication of its secrets and no access to the extraordinary diversity of plants and animals found in its waters or on the seabed. Six hours later, as the tide has ebbed and a much greater expanse of the shore is exposed, a mix of sand, mud or rock may stretch away from the beach for 500m or more. This intertidal zone is accessible on foot, and a short stroll will reveal myriad forms of shells, crabs, seagrasses, seaweeds (algae), starfishes and other creatures. In rock pools small fish, shrimps, coral colonies, sponges and sea-squirts can be seen, while at the back of sheltered bays and inlets, where wave action is reduced, mangrove stands and forests are found.

For a fuller understanding of the marine biodiversity of these warm, tropical waters however, it is necessary to take a mask and snorkel and drift or swim in the shallow waters over the coral reefs and seagrasses where a spectacle of biodiversity can be seen. The inshore waters of the eastern African marine ecoregion support around 1,000 different seaweeds, several hundred sponge species, over 200 coral species, more than 3,000 species of molluscs (oysters, cockles, mussels and clams), over 300 species of crabs, at least 50 species of starfishes, over 100 species of sea-cucumbers and more than 1,500 species of fish. As studies continue, the number of species recorded for these waters continues to rise, but already we know that the eastern African marine ecoregion supports an incredibly rich species composition, easily exceeding 11,000 species of plants and animals.
About 15% of the marine plant and animal species occurring in the region are pan-tropical, that is they can be found in all warm seas. Between 60-70% are found only across the Indo-Pacific, a vast area of similar tropical conditions that stretches from eastern Africa to the eastern Pacific Ocean islands of Hawaii and Polynesia. Whilst 10-15% of the eastern African marine life is found nowhere else on earth. These species (including several species of corals, starfish, molluscs and fish) are said to be endemic to the region.

All of the larger animals and plants of the ecoregion that we have described so far can be seen with the naked eye, but there is also an abundance of minute life forms. These microscopic creatures include much of the plankton, bacteria and fungi. Though vital to all other life, these tiny creatures are much less well known, but could well number tens of thousands of species, and thus the larger creatures represent only a small percentage of the total marine biodiversity of the region. As research continues we will learn more. Even for the larger animals there is still insufficient information on species distributions and abundance. For example, the well-known, deep water, ancient fish, the Coelacanth, first discovered in 1938 by fishermen off South Africa, was thought to be endemic to the SW Indian Ocean until the discovery in 1998 of a close relative of this fish off Sulawesi (Indonesia), 10,000km from its previously known population.

Approximate proportions of the main plant and animal groups of larger marine organisms in the eastern African marine ecoregion.



Images courtesy of *A Guide to the Seashores of Eastern Africa and the Western Indian Ocean Islands*. Copyright Sida-SAREC/SEA Trust.

On the seashores, and in the shallow coastal waters, the habitats that contain the bulk of the larger plants and animals are easy to identify. These are the sand beaches and dunes, mangrove forests, river deltas, seagrass beds, rocky shores, mud flats, coastal lagoons, coral reefs and open waters. Each habitat has its characteristic compliment of species, though many species require more than one habitat. Fish and shrimps for example will move from one habitat to another for food, breeding or for refuge.

The **beaches and coastal mud flats** of the region provide feeding and breeding areas for about 35 species of resident and migratory seabirds. Between October and March each year, hundreds of thousands of shorebirds fly from their breeding grounds in northern Europe to feed on the mud flats of the large mangrove estuaries of Lamu in Kenya, the Rufiji River in Tanzania and the Zambezi Delta in Mozambique. Other resident seabirds, nesting on small, isolated islands will scout the seas for hundreds of kilometres in search of sardines and anchovies to feed their young. Further down the shore, **seagrasses** form extensive beds on mud and sand, to depths of 15m or more, though they are restricted in their depth range by the presence of light. These are the only true flowering plants to have colonised the sea and 12 species are found in the region. Seagrass beds are home to thousands of small species of animals and plants including seaweeds, sponges, worms, crabs, shrimps, marine snails, starfish, sea-cucumbers and fish. Some of these depend on the seagrass beds for shelter, food or as nursery grounds. Much larger creatures like the Dugong (or sea cow, distant relative of the elephant) and marine turtles also feed on seagrasses.

Seagrass bed

Mangrove forests occupy the largest area of all these coastal habitats, typically around river estuaries. Ten species of salt-resistant trees, some reaching 20m in height, plus numerous shrubs and palms, form the mangrove forests of eastern Africa, all specially adapted to survive in sea water and root in mud or sand. Mangroves are one of the most productive habitats on earth. When exposed at low tide the forests teem with crabs, worms and snails, many of which are food to birds. At high tide mangrove forests attract hundreds of species of fish, crabs and shrimps which swim among the submerged branches and depend on the forests as feeding areas and nursery grounds for their young. The best developed forests occur around river mouths where they are important in trapping river sediments that would otherwise be washed out to sea. Kenya has a total area of mangrove of about 53,000ha (530km^2) and Tanzania, with a total of 133,000ha (1,330km^2) also contains the largest continuous mangrove forest of 53,000ha in the Rufiji River delta. Mozambique has by far the largest mangrove area in the region with 500,000ha (5,000km^2) scattered along its 2,800km coastline, and the South African coastline supports a smaller extent of mangrove, the southermost forests of the continent.

Masked boobies on Latham Island

Coral reefs are an extremely species-rich habitat, rivalled only by tropical forests in terms of their diversity and productivity. They are a community based on rock-forming coral animals and algae that exist and grow into large submerged mounds, slopes and islands. Non-reef building corals and seaweeds, soft corals and sponges are also important members of this community. The coral animals harbour microscopic algal cells (zooxanthellae) within their own cells that allow them to use sunlight to make food and so help to build their limestone structure. The depth of coral reefs is therefore limited by light penetration with few reefs extending deeper than 40 metres. Growth of the rock-like corals varies between a few millimetres to 10cm per year, depending on the species and water conditions. In the eastern African marine ecoregion fringing coral reefs are the most common type of reef, in many places forming continual stretches of 100km or more, and constituting most of the estimated total of 1,500km of reefs along these shores.

Mangroves at low tide

Rock-forming corals and reef fish

1 Dugong

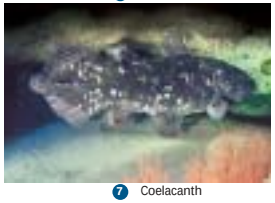
2 Bottlenose dolphin

3 Slinger

4 Humpback whales

5 Raggedtooth shark

6 Shortnose blacktail shark



7 Coelacanth

The **open waters** of the region are important for large pelagic fish including various species of tuna and billfish, such as the black marlin whose distribution is restricted to eastern Africa and Australia. The region also provides crucial nursery or feeding habitats for 34 species of marine mammals, including the endangered Humpback whales that migrate from Antarctica each year into the warm waters off eastern Africa to give birth. The depths of the seas are little known, as specialist equipment is needed to explore and study this dark and hazardous world. Certainly animals unknown to science are yet to be discovered. The Coelacanth for example, is now known to live at depths of 50-400m in southern Mozambique and northern South Africa. Deep-water sharks, lantern fish and giant squid may also be found at these depths.

The geographical extent of the coastal habitats of eastern Africa is something that is often difficult to grasp. Most people live in the big cities and towns along the coast with very little access, or interest, in other parts of the coastline. As a result, very few people have a broader view of the extent of mangroves, coastal lagoons or coral reefs. Since coral reefs live below the surface of the sea, even fewer people, perhaps only spear-fishermen or SCUBA divers, have any idea of the incredible diversity and variety of animals and plants that live together to form the coral reef habitat.

From the shoreline, the line of breaking surf is usually the only indicator of the presence of coral reefs. Migrant fishermen and airline pilots probably have the best over-view of the geographical extent of the coastal habitats in the region. The view from an aircraft window for example, will reveal that coral reefs form only a narrow strip, usually fringing the land or islands, and mostly not much wider than 1000m.

Typically the coast of the eastern African ecoregion is comprised of a mixed array of the coastal habitats described above. These various habitats are often closely connected physically and are linked both through the coastal waters and by the species they comprise.

Aerial view of mangrove creek discharging into the Indian Ocean

Connectivity within the Ecoregion

The monsoon winds of eastern Africa, with their characteristic seasonal reversal from the north-east (NE) to the south-east (SE), are a major influence on the climate and seas, affecting weather patterns, rainfall and human activities. Another feature of the eastern African ecoregion is the tides. The coast from Chisimayu to Sodwana Bay, experiences a maximum tidal range of 3-4 metres, with a tidal regime roughly the same throughout the region, that is, time of low tide in Mombasa is almost the same as that in Maputo. This almost uniform vertical movement of the coastal waters throughout the region increases the strength of tidal currents and the resulting mixing of inshore waters. Superimposed on the movement created by tidal currents, is the much larger scale movement of oceanic and long-shore currents that exist along these shores. Ocean currents are driven by the rotation of the earth and the prevailing winds. The main current that influences the region is the South Equatorial Current that travels west across the Indian Ocean reaching the African coastline at approximately the border between Tanzania and Mozambique. There it splits into the north-flowing East Africa Coastal Current (EACC), and generally south-flowing Mozambique Current. The EACC travels steadily north at speeds of 2-5 knots (3-9km per hour) depending on the season. During the SE monsoon, the EACC is accelerated and continues north leaving the coast at Somalia. During the NE monsoon season the current speed is reduced and the meeting with the southward-flowing Somali current off Kenya results in the east-flowing Equatorial Counter Current. The Mozambique current extends southwards in a twisting and curling manner along the Mozambique coast varying in extent from year to year. Towards the southern end of Mozambique, the Agulhas Current swings round from southern Madagascar and continues southwards along the KwaZulu-Natal coast of South Africa, eventually mixing with the cold waters off the southern tip of Africa.

Although the strength and extent of influence of the region's ocean currents varies from year to year, dictated by global environmental conditions that in turn affect the strength of the monsoon winds, the overall effect is a fairly consistent movement of offshore waters along the coastline. Combined with the daily ebb and flood of the tide, the resulting currents mix and distribute the inshore waters, its sediments, nutrients, plankton and other floating marine life.

The minute floating plants and animals, the latter usually feeding on the former, and on each other, comprise the plankton community. This community, of which the familiar jellyfish is a member, includes the eggs and larval stages of much larger marine animals such as fish, lobsters, crabs, shrimps, oysters, coral, sponges, as well as the spores of seaweeds. When a mature, female lobster (for example) casts adrift her half a million eggs, she is unlikely to ever see her young. The hatched larvae will join the plankton community, many will be eaten, and others will be washed out into the deep ocean never to find a suitable home. But a few, several weeks later, will finally metamorphose into miniature lobsters. The juveniles may be hundreds of kilometers away from the home reef of their parents. Seeds of coconut trees, mangrove trees, seagrasses and many other coastal plants also rely on the currents as their means of dispersal. Other specialist swimmers use the currents to navigate and carry them throughout the region to reach feeding or breeding areas. Loggerhead turtles nesting in KwaZulu Natal in northern South Africa have been found in Zanzibar, and vast schools of tuna migrate each year through the eastern African waters to feed and breed.

The above descriptions of coastal and offshore currents, tidal influences, the transport of nutrients and plankton and the movement of large marine animals, reflect the important connectivity within the ecoregion. This cohesion, provided by the coastal waters that bathe these shores, is vital to sustaining the biodiversity and productivity of the region.

The jellyfish, a well-known member of the plankton community

Fishing boats in Maputo harbour

Uses of and Threats to Biodiversity

People have been present along the shores of the eastern African marine ecoregion for over 25,000 years. The first inhabitants may have never actually ventured into the sea, but simply collected shells and fish from the shore at low tide, or cut mangrove poles for building. With the advent of sea trade, mainly by merchants visiting from Arabia about 2,000 years ago, coastal settlements began to develop and expand. These were centred on sites with safe anchorage for ships, such as Mombasa, Zanzibar, Kilwa, and Ilha de Mozambique. Some of the trade items included turtles, sea shells and mangrove poles, as well as ivory, minerals and slaves.

Estimates of the coastal populations for the Eastern African ecoregion (2000).

Country	Total population (millions)	Estimated Coastal population (millions)	% of total population
Somalia	9.9	3.8	38
Kenya	30.0	2.7	9
Tanzania	33.5	8.4	25
Mozambique	19.6	6.6	34
South Africa	40.4	na*	na*

na* = not available.

The coastal people of the eastern African marine ecoregion presently number around 22 million, comprising between 9-38% of the population of the countries along this stretch of coast (see table above). These coastal people are the main dependants of the region, though others such as foreign businesses (e.g. hotels, fishing companies) are also important especially for creating job opportunities. All depend on the coastal environment for their livelihoods. Most of the coastal population live in the cities and towns in the region, notably Chisimayu, Mombasa, Tanga, Bagamoyo, Zanzibar, Dar es Salaam, Mtwara, Nacala, Beira and Maputo. The ports of these cities connect the region with traders from Europe, the Middle East, Asia and beyond, handling cargoes of oil, timber, minerals and fish.

Today the growth of the coastal population is faster than any inland area, largely because the coastal cities and towns attract rural migrants. The average population growth rate for the region is about 3% per year, whilst the growth rate of coastal populations, is estimated at 5-6% per year. This rapid increase in the number of coastal dwellers in the region has a major influence on marine biodiversity, on the resources of the coastal seas and on the quality of the coastal environment.

The marine biodiversity of eastern Africa, with its many species of plants and animals, constitutes a vital resource for the well being of coastal and inland inhabitants. In most rural areas along the 5,000km coastline, people are involved in a diverse range of activities that exploit this biodiversity. Over the last fifty years increasing demands for these marine resources have resulted in significant ecological changes in many parts of the ecoregion.

Coastal fishermen of Tanzania

Humpback whale and calf, seasonal visitors to the region

Marine mammals, for example, were hunted to the edge of extinction in the Indian Ocean before anyone realised that they were declining to such low numbers that their very existence was threatened. The more recent intensive collection of certain animals (e.g. sea-cucumbers) has caused local extinction along some areas of the coast. Sharks and rays are extremely slow breeders, producing only a few juveniles each year. They too are being fished beyond their natural recovery rates, with the result that these days in the shallow waters of most of the region, sharks are very rarely observed. A few larger species, known to have been abundant one hundred years ago, are currently so rare that there is a very real possibility that they may completely vanish from the region. Trends indicate that in the next 50 years Dugongs and marine turtles may no longer be part of the marine diversity of eastern Africa. Dugongs used to be common around estuarine areas where they fed on seagrasses. Nowadays, perhaps only a few hundred are believed to exist in the entire region. In many areas marine turtles continue to be caught and killed for meat. Five of the world's seven marine turtle species (Green, Hawksbill, Olive Ridley, Loggerhead and Leatherback), all of which are recognised as being in danger of extinction, nest on the beaches of the region. In many places their eggs are taken from their nesting sites which are also vulnerable to destruction from the construction of beach hotels, sand-mining and beach erosion.

Leatherback turtle hatchling

Fisheries are a vital employment activity to hundreds of thousands of families on the coast. At least as many again are involved in the post-harvest activities of marketing and processing. The products of the industry (fish, molluscs, shrimps and crabs) provide the main protein component of the diet of the majority of the coastal people and many more people inland (where dried or salted products are sold). In Tanzania, for example, the estimated average consumption of seafood per person (9.4 kg/year) is greater than the combined consumption of meat and poultry. For the entire region at least 500 species of fish constitute the bulk of catches, yielding an estimated 200,000 tonnes each year. Most of the catch is from fishers equipped with simple, artisanal gears such as hook and line, hand spears, woven fish traps and various types of nets. Total catches from Mozambique are about 115,000 tonnes, with between 90-95% being caught by about 80,000 artisanal fishers. Other more industrialised fishing methods also exist, including motorised vessels equipped with trawl nets hauled by power winches. In Mozambique alone the industrial and semi-industrial fishing fleet exceeds 150 vessels, earning the economy over US$ 100 million per year, mostly through the export of shrimps. These trawlers are also active in Tanzania and Kenya, though not to the same scale as in Mozambique which has far greater areas around river mouths suitable for shrimps.

Pole and line fishing off Mozambique

Shrimp trawler off Mozambique

Over the last few decades destructive fishing methods, such as the use of dynamite and small-meshed nets, have destroyed seagrass beds and coral reefs. These practices still continue in many places despite being illegal in all countries. Preliminary research along the coast of Kenya and Tanzania indicates that human activities such as these have reduced fish catches from coral reefs by 30-40%. Large proportions of the by-catch (e.g. non-commercial or unwanted species) of shrimp trawlers are juvenile fish. The loss of these immature individuals threatens future fishery resources. Offshore fishing grounds, some of the only areas on earth from where fish catches are increasing, are also open to plundering, often by industrial foreign fleets.

Salt pans in Tanzania

Mangrove wood is extremely hard and insect-resistant. The harvesting of mangroves for timber and fuel, like basic fishing techniques, has been practised for thousands of years, with poles continuing to be exported from the region. Reckless cutting of mangroves has cleared large areas of previously productive forest. Mangrove forests are also the first to be cleared for the construction of salt pans from where most of the region's much-needed sea salt is produced. Additional pressure from tourism developers, coastal construction, farmers and the ever-growing need for fuel wood, further encourages large swathes of primary mangrove forest to be cut indiscriminately with little or none re-planted.

Seaweed farming in Zanzibar

Seaweeds have recently become an important economic resource in Tanzania where they are farmed for export and processing into food additives. The seaweed is grown on lines attached to wooden stakes across the seabed of shallow lagoons. Other methods of farming marine organisms, known as **mariculture**, include the culture of shrimps and fish in coastal ponds, usually in mangrove areas. There are not many mariculture farms in the region at present. However, investors and developers have started to persuade governments of the region of the financial benefits of such practices, which, if not sensibly developed, can adversely affect not only the forests, but also the many fisheries and people who depend on the productivity of the habitat.

Pollution of coastal waters and fish kills

Recently **medical research** into fighting the various forms of cancer and other diseases which affect humans has begun focusing on the sea for possible cures derived from animals such as sponges, soft corals and tunicates. This kind of research, known as **bio-prospecting**, has started to explore the rich coral reefs of eastern Africa where these animals are found in abundance.

Sponges and soft corals

Clear cutting of mangrove forest

Durban Bay

The rapid growth of the **coastal urban centres** in Kenya, Tanzania, Mozambique and South Africa, and the fast development of the coastal tourism sector, produce vast quantities of **pollution** from untreated domestic sewage, posing a threat to the nearshore habitats such as coral reefs. Pollution from industrial waste is generally not a problem since the level of this development is localised at present, though measures need to be in place to prevent potential harm. Pollution from shipping and oil terminals is also minimal at present, despite a large proportion of oil exports from the Gulf region passing through the coastal seas of eastern Africa. Serious oil spills have already occurred around Mombasa and Maputo, damaging nearby mangrove forests and beaches. The threat of further spills is likely to increase as economies develop and industries expand - demanding greater supplies of oil.

Coastal tourism contributes significantly to local economies of the region, particularly Kenya, where it accounts for a large and increasing proportion of foreign currency earnings. In Tanzania and Mozambique the potential for growth of this sector is huge. Tourism relies heavily on the coastal zone, not just for beach sites for development, but for food and as a leisure area for tourists. Though an important source of income, coastal tourism often raises a number of environmental concerns. The activities of tourists can affect the marine ecosystem directly, through boat and anchor damage to coral reefs, and indirectly by increasing demands for cleared land for development, collection of shells for souvenirs, seafood, and mangrove poles and coral lime for construction. The **extraction of living corals**, baked in kilns to produce lime, has also contributed to coastal habitat degradation especially in Tanzania.

Live coral extracted for lime production

The many large rivers along the coast of the ecoregion carry vital nutrients and sediments that are important to plankton, mangroves and seagrass beds. These rivers connect the shoreline with the interior of the continent of Africa; thus activities hundreds of kilometres upstream can influence the coastal zone. During periods of severe floods the tremendous loads of **sediment** washed out to sea can overwhelm nearby coral reefs that require clean waters for their existence.

Changes to the coastlines caused by human activity have exacerbated the **effects of climate change**. Sea level is rising at about 1 millimetre per year, which, under normal circumstances, habitats can adapt to, but the loss of inshore coral reefs and coastal mangrove forests adds to the potential damage caused by sea level rise and coastal erosion. The result can be catastrophic. Already the loss of coastal land due to erosion is an ever-growing concern to developers and farmers.

DIRECT CAUSES OF COASTAL DEGRADATION

No further studies are needed to confirm what government departments are now quite sure of - the destruction of the coastal resources of the region is continuing to worsen. The direct causes are inter-linked and include:

- Population growth
- Increased pressure on resources
- Increased use of destructive methods
- Pollution
- Coastal erosion
- Coastal tourism and industrial development
- Climate change *(resulting in seawater warming, more frequent El Nino events, severe flooding)*

Fallen coconut trees - a clear sign of beach erosion

The Importance of Biodiversity Conservation

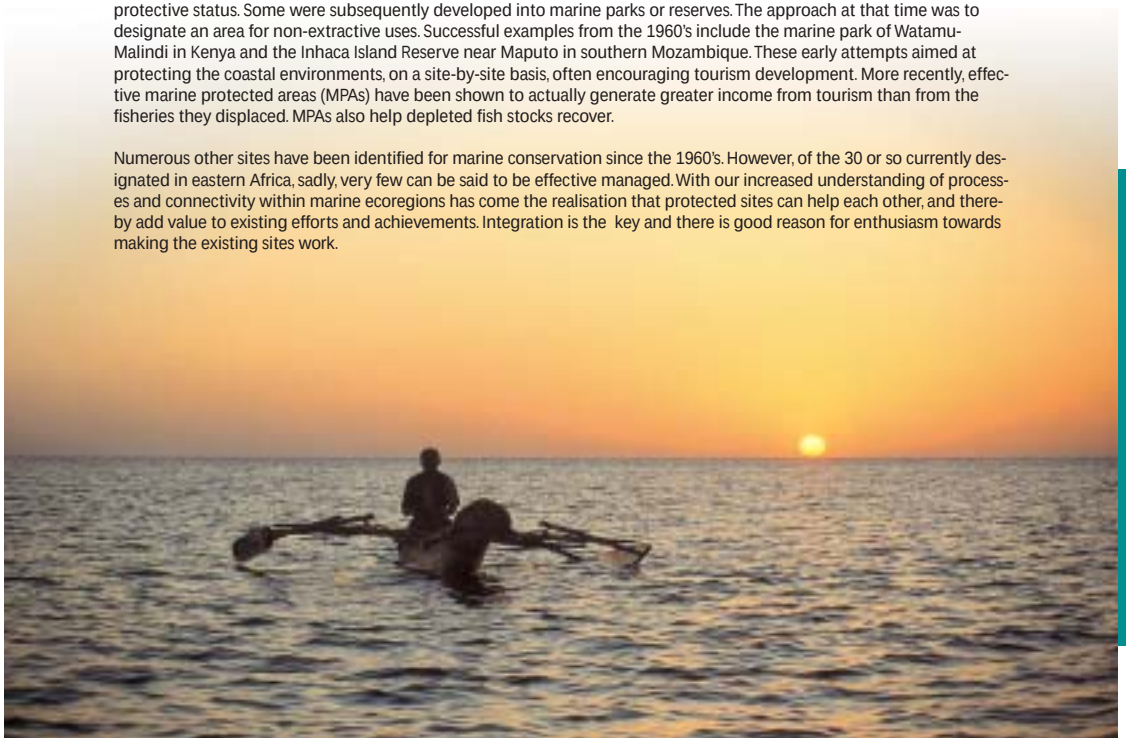
With the continuing growth of coastal human populations, the importance of conserving the integrity, productivity and value of the marine biodiversity on which we all depend is paramount. Marine resources are important globally as well as to local people, so we must all share the responsibility of conserving them. At present we are destroying our marine biodiversity. It is critical that biodiversity be maintained and that the degradation, which began several decades ago, is halted. Failure to achieve this will result in ever diminishing returns from the sea.

The four most important reasons for maintaining marine biodiversity are:

- A diverse and healthy marine ecoregion is more productive and therefore provides more fish, mangrove wood, etc. for the users. Each species has a specialised way of using different resources and adapting to changes (e.g. in water salinity or temperature), thus by having more species the productivity of the habitats and ecosystem is maximised.
- A diverse and healthy marine ecoregion, through having more species, is also more stable. This helps protect against environmental changes (e.g. sea level rise, flooding, hurricane and cyclone damage) and improves recovery.
- A diverse and healthy marine ecoregion allows species that depend on different habitats at certain stages of their life cycle (e.g. larval period, growth period, reproduction and nesting) to continue to exist. Keeping only one habitat may not be sufficient to retain all species, but keeping all habitats in a healthy condition again maximises productivity.
- The quality of life for coastal people, and visitors, relies in part on the marine biodiversity for aesthetic reasons.

Despite the threats to the marine biodiversity of the eastern African marine ecoregion and the recognition that it is being degraded, there are still many biodiversity-rich areas, some of them in almost pristine condition. However, achieving effective marine conservation is not a simple task. Over 40 years ago many coastal sites were identified as deserving of protective status. Some were subsequently developed into marine parks or reserves. The approach at that time was to designate an area for non-extractive uses. Successful examples from the 1960's include the marine park of Watamu-Malindi in Kenya and the Inhaca Island Reserve near Maputo in southern Mozambique. These early attempts aimed at protecting the coastal environments, on a site-by-site basis, often encouraging tourism development. More recently, effective marine protected areas (MPAs) have been shown to actually generate greater income from tourism than from the fisheries they displaced. MPAs also help depleted fish stocks recover.

Numerous other sites have been identified for marine conservation since the 1960's. However, of the 30 or so currently designated in eastern Africa, sadly, very few can be said to be effective managed. With our increased understanding of processes and connectivity within marine ecoregions has come the realisation that protected sites can help each other, and thereby add value to existing efforts and achievements. Integration is the key and there is good reason for enthusiasm towards making the existing sites work.



Common dolphins, one of 34 species of marine mammal common to the region

One of the key components of effectively managed MPAs is the creation of a baseline against which we can measure the changing condition of habitats. If the mangrove forests of today had all been harvested at some time in the last forty years, no one would know what their full diversity comprised. Mangrove forests would be seen as muddy expanses with a few stumps of trees and some scattered seedlings supporting a handful of small fish during high tide, i.e. far removed from the towering 20m tall trees and tangles of roots of a truly pristine and well-developed forest, and the mass of fish and other marine life they support.

In many tropical countries poverty is the main driving force behind the degradation of marine and terrestrial resources, although even wealthy countries experience such problems due to over-consumption of resources, ignorance and greed. In the eastern African ecoregion the majority of coastal inhabitants are poor. Driven by the need for income, younger fishermen especially have taken to the use of destructive gears, and discarded the traditional wisdom of their fathers for careful use of the sea and its riches. Many now fish with little or no regard for the future. Given the opportunity, many of the younger generation that use the sea would prefer to undertake a benign marine or land-based activity, but opportunities are few. Unfortunately, without combating poverty and providing alternative income-generating activities, little can be achieved towards long-term conservation.

Marine Protected Areas (MPAs)

Marine protected areas are generally designed to accommodate a multitude of marine resource users. The active participation of all the main users is seen as an integral part of the process of deciding what types of management systems are appropriate. By definition, however, the designation of an MPA will restrict some activities, thereby requiring some form of enforcement. A legal framework for the management of the MPA is vital.

Current practices recognise that to balance the needs of all users with conservation objectives, a **zoning** scheme is necessary, whereby clearly defined activities (e.g. fishing, tourism, mariculture, mangrove harvest, and research) are permitted in specific (and possibly overlapping) areas or zones. **Core zones** totally protected from all extractive or damaging activities may also be considered, and are known to help considerably with:

- preserving the genetic and ecological basis of the region as a whole;
- providing safe refuges for breeding stocks of fish as well as boosting replenishment, recovery and productivity of neighbouring areas;
- providing a baseline for comparison with other areas, or the future, and;
- attracting environmentally-aware tourists and thus generating alternative incomes and further boosting awareness.

Ecoregion Conservation: Theory and Practice

Big-eyes, common members of the reef fish community

The scale and approach of conservation efforts around the world has recently been re-examined. WWF and other major institutions concerned with the use of natural resources (World Conservation Union (IUCN), World Resources Institute (WRI), The Nature Conservancy (TNC), Conservation International (CI) and UNEP) concluded that conservation in the 21st Century needs to:

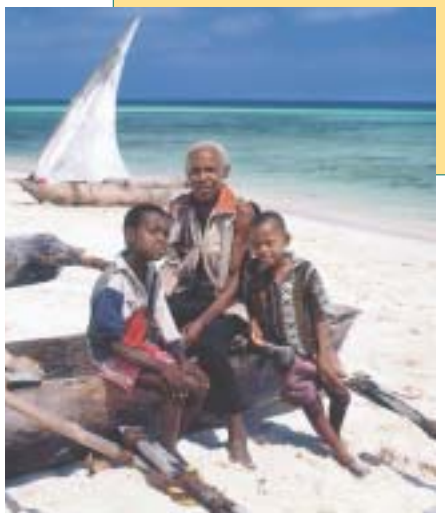
- be driven by a common vision and raise a collective voice for conservation;
- use networks of protected areas within managed coastlines as the core component of conservation planning;
- be planned and implemented over time scales compatible with ecological processes (30-50 years);
- combine rigorous science, traditional knowledge and practical politics, and;
- be integrated in the broader social, economic, and policy factors critical to sustainability.

Together these institutions recognised that the traditional focus on species, protected areas, environmental policy and public information, though reasonably successful in the past, will not be enough to meet the challenges of the future. Instead, working with stakeholders at much larger geographical scales, and better integration into development planning is seen as the appropriate approach. The Ecoregion approach supports conservation of biological diversity and ecological processes at broader scales and the links between different species habitats within the bigger picture of national development.

ECOREGION CONSERVATION

The Ecoregion Conservation approach is an important tool for bringing stakeholders together to set ambitious conservation goals, to lay out a strategy to reach those goals and to facilitate implementation. This approach aims at focusing even greater attention on regions and boosting the interest and commitment of individual national governments. The potential benefits of the ecoregion approach are that it:

- builds collaboration for conservation;
- creates energy for stakeholder participation;.
- generates donor and government support;
- provides options for conservation effort, and;
- integrates conservation in the broader vision of coastal development.



The old and new generation of fishermen

Ecoregion Conservation should not be seen as a separate initiative to replicate what other regional or local initiatives are trying to achieve, but rather to support them to accomplish the conservation of biodiversity. Marine Ecoregion Conservation attempts to harmonise local and international efforts to secure healthy marine and coastal environments in order to provide sustainable benefits for present and future generations. To be successful over the long term, Ecoregion Conservation must be multidisciplinary - involving, encouraging and depending upon the participation of all sectors who affect biodiversity or who are affected by it. These stakeholders range from local communities of coastal inhabitants, to national governments, international conservation organisations, and businesses, such as foreign investors and owners of industrial fishing fleets. To achieve this there needs to be a strong emphasis on creating and sustaining partnerships.

Establishing Priorities for Biodiversity Conservation

It has been recognised that, at least in the short-term, it is not possible to sustainably manage the entire length of the eastern African marine ecoregion. Efforts still need to be focused on specific areas within the region, but these need to be selected to include the full range of habitats with a view to maintaining ecological function and diversity. However, the risk exists that even when individual sites are successfully managed and conserved, in 20 or 30 years time we may end up with a few, isolated areas of high biodiversity surrounded by degraded habitats. For the long-term benefit of the people of eastern Africa and the sustained conservation of the marine life upon which they depend, a network of effective, strategically-placed marine protected areas is needed. A reduction of the general threats imposed by human activities is, as always, of greatest importance. This ultimately calls for management of marine protected areas within the context of an integrated coastal managment strategy.

To establish priorities for biodiversity conservation in the eastern African marine ecoregion, a series of meetings, culminating in Mombasa in April 2001, were convened to: (a) collect and analyse baseline data on the biological, socio-economic, policy, legal and institutional characteristics of the ecoregion; (b) build on approaches consistent with national priorities, and; (c) identify key sites of biodiversity that should be prioritised for their conservation value. Participants at these meetings included natural and social scientists, as well as other interested parties from all the countries in the ecoregion, except Somalia.

The participants at the Mombasa meeting developed a common **vision statement** to describe what we should be striving for over the long term and agreed that 50 years from now the Eastern African Marine Ecoregion should be...

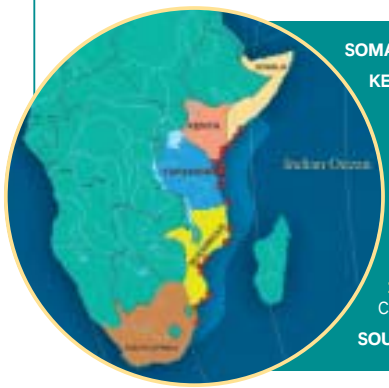
“A healthy marine and coastal environment that provides sustainable benefits for present and future generations of both local and international communities, who also understand and actively care for its biodiversity and ecological integrity.”

Identification of key sites of biodiversity for conservation

All participants contributed information and expertise to help map priority areas for species and community groups. The criteria used to select these sites included their contribution to global or ecoregion biodiversity and to national economies.

A total of 21 sites (•) within the ecoregion were identified, with 8 considered to be of *Global (G)* importance, and a further 13 sites identified as important on *EcoRegion (ER)* or *Sub-Region (SR)* levels.

From north to south, these sites are:



SOMALIA: **1.** Shebela Delta *(SR)* **2.** Bajuni *(SR)*

KENYA: **3.** Lamu Archipelago *(G)* **4.** Tana River Delta *(ER)* **5.** Mida Creek-Malindi *(G)*

KENYA-TANZANIA: **6.** Msambweni-Tanga *(ER)*

TANZANIA: **7.** Pemba Is. *(ER)* **8.** Unguja Is. *(ER)* **9.** Bagamoyo *(SR)* **10.** Latham Is. *(ER)* **11.** Rufiji-Mafia Complex *(G)*

TANZANIA-MOZAMBIQUE: **12.** Mtwara-Quirimbas *(G)*

MOZAMBIQUE: **13.** Nacala-Mossuril *(ER)* **14.** Ilhas Primeiras e Segundas *(ER)* **15.** Zambezi Delta system *(G)* **16.** Sofala Bay *(SR)* **17.** Bazaruto Archipelago *(G)* **18.** Inhambane Bay *(SR)* **19.** Inharrime Complex (SR) **20.** Maputo Bay-Machangulo Complex *(G)*

SOUTH AFRICA: **21.** Greater St. Lucia Wetlands *(G)*

Eastern African Marine Ecoregion Priority Areas

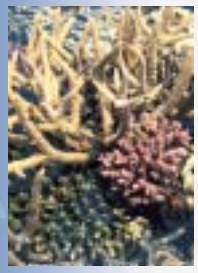
The 8 sites of global importance were selected because of the following main features:

3 *Lamu Archipelago*

- Extensive mangrove formations in delta, creeks and basins (345 km²) with 160 km² in pristine condition.
- Breeding populations of Olive Ridley, Hawksbill and Green turtles and Dugong.
- Most northerly coral reefs in the ecoregion.
- Colony of 10,000 Roseate Terns and breeding site for Ospreys and Pelicans.

5 *Mida Creek-Malindi*

- High coral diversity (>60 genera)
- Important bird feeding area (including Flamingos).
- Muddy high nutrient bay with sudden drop-off providing a nursery for sharks and globally important feeding area for sailfish, marlin and swordfish.



11 *Rufiji-Mafia Complex* (Rufiji River Delta, Mafia Island and Songo Songo Archipelago)

- Extensive and varied coral reef habitats with high coral cover and diversity (>45 genera).
- Rufiji River delta with extensive riverine and deltaic mangroves (53 km²).
- Very important breeding area for shrimp and fish and nesting and feeding site for shorebirds.
- Abundance of top predators including crocodiles.
- Important feeding area for Dugong and turtles.
- Resident populations of Hippopotamus.

12 *Mtwara-Quirimbas Complex* (Mnazi Bay, Ruvuma Delta and Quirimbas reefs to Pemba)

- Located where the South Equatorial Current meets the African coast.
- Extensive complex of reefs with high coral diversity (>48 genera).
- Important turtle feeding and nursery site and feeding area for Crab Plovers and migratory birds.
- Unique Ruvuma dunes system with likelihood of rare or endemic flora.
- Important nursery area for Humpback whales.

15 *Zambezi Delta system*

- Part of the largest mangrove complex in the western Indian Ocean (2,800 km²) with a large pristine proportion.
- Terrestrial complex includes floodplains, grassland and palm savanna.
- Important area for globally threatened wetland birds e.g. Wattled Cranes, Pelicans, African Skimmer.
- Concentrations of Risso's Dolphin, Humpback Dolphins and whales including breeding Humpback Whales

17 *Bazaruto Archipelago*

- Complex of coral communities with 6 endemic gastropod mollusc species.
- Parabolic sand dunes.
- Populations of six bird species regularly exceeds 1% of the global population.
- Largest Dugong population in the ecoregion, plus 5 dolphin, 3 whale, 4 turtle and 4 shark species.
- Unique sand blown island (barrier to cyclones and barrier Lakes).

20 *Maputo Bay-Machangulo Complex* (including Inhaca Island)

- Important feeding area for turtle, dugong and migratory birds e.g. Whimbrel and Flamingos.
- Extensive marshes and flooded grasslands with endemic fish and plant species.
- Important for Dugong, whales, white and whale sharks.
- Turtles (Loggerhead and Leatherback) nesting area.
- Northern limit of migration for Southern Right Whale.
- Endemic fishes and unique tube-worm reefs.
- Deep rocky formations dominated by gorgonians.

21 *Greater St. Lucia Wetlands*

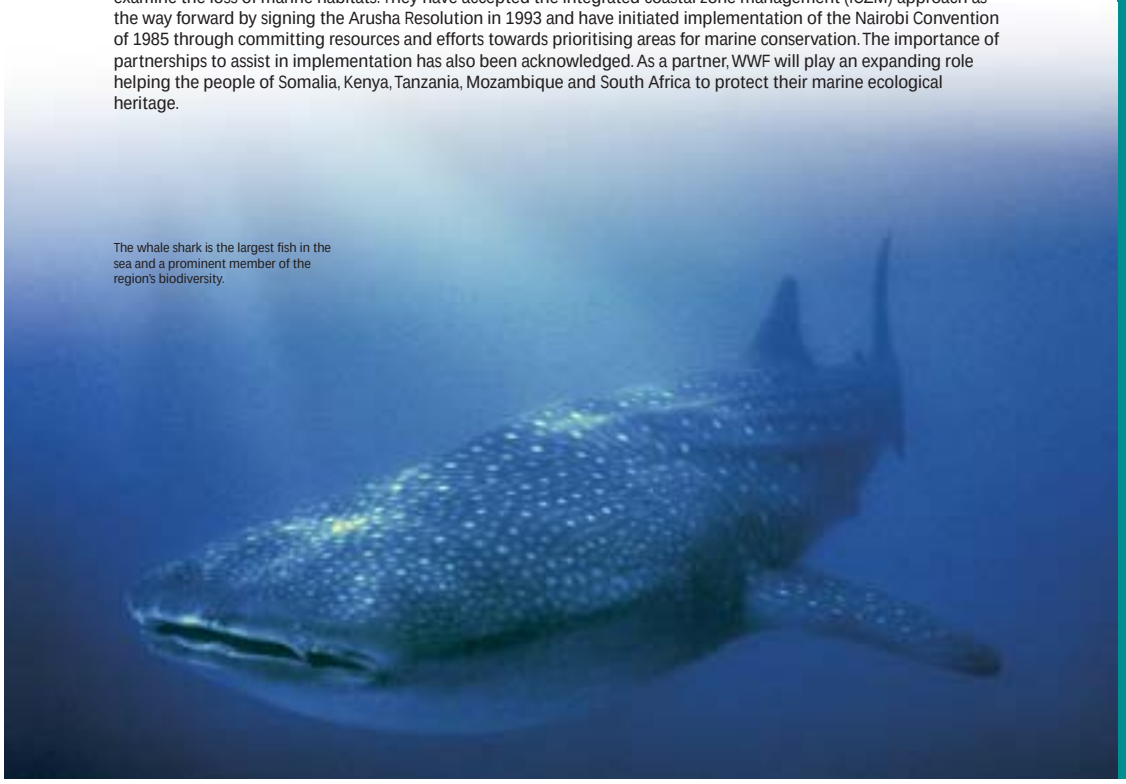
- Longest estuary in Africa.
- Southernmost coral communities in the western Indian Ocean, extending for 80km.
- Narrow coastal shelf with deep canyons, with a resident population of Coelacanth.
- High endemism of soft corals.
- Important for Dugong, seasonal aggregation of whale sharks and raggedtooth sharks.
- Loggerhead and Leatherback turtle nesting area.
- Nesting seabirds, including the White-backed Pelican and Caspian Tern.

From Vision to Conservation - the way forward?

To proceed from the vision to the reality of a healthy and productive ecoregion, the participants at the Mombasa workshop concluded that it was important to extend partnerships to involve other professionals. It was also noted that there was a need to fill gaps in current marine and coastal conservation efforts and that a preliminary assessment of current conservation initiatives should be undertaken, to learn from previous experiences. There was general acceptance of the need to boost our knowledge of species, habitats, the way that these resources are used, as well as to promote greater public awareness of the value and role of the biodiversity of the coast. Support for research and conservation, and a change of focus from conserving endangered species to conserving whole areas of biodiversity was recommended, as was the need to examine over-exploitation of some fisheries and pollution from land based activities. WWF, under its Ecoregion Conservation Programme, can contribute to resolving some of these issues.

It was recognised that the practical implementation of this vision will involve a balance between conservation and consumption, between human needs and those of other species in the ecoregion, and between the needs of present and future generations. If we concentrate our efforts on the 21 sites, much of the coastal and marine biodiversity of the eastern African marine ecoregion, and its integrity, will be sustained. This approach also anticipates that while conservation efforts are focused on specific areas, the wider public (i.e. educators, civil society, industry, governments, etc.) will increase their understanding and appreciation of marine biodiversity and its importance. Only through their participation, can alternatives be found to practices that are steadily eroding the integrity and value of our coastal assets.

Understanding marine biodiversity as a valuable asset has evolved gradually over the past thirty years. Recognising the importance of a regional approach to sustaining marine biodiversity is a concept that has developed even more recently. At a regional level, there has already been some cooperation to examine the loss of marine and coastal biodiversity. Beginning in 1985, the governments of the western Indian Ocean countries have regularly met and agreed on plans to examine the loss of marine habitats. They have accepted the integrated coastal zone management (ICZM) approach as the way forward by signing the Arusha Resolution in 1993 and have initiated implementation of the Nairobi Convention of 1985 through committing resources and efforts towards prioritising areas for marine conservation. The importance of partnerships to assist in implementation has also been acknowledged. As a partner, WWF will play an expanding role helping the people of Somalia, Kenya, Tanzania, Mozambique and South Africa to protect their marine ecological heritage.



The whale shark is the largest fish in the sea and a prominent member of the region's biodiversity.

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FURTHER READING

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For more information on the Global 200 visit the following websites: www.panda.org and www.worldwildlife.org.

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