10
Threatened Marine Species

Matthew D. Richmond

Opposite page: Sperm whales in the WIO. © Hughes Vitry.

INTRODUCTION

This chapter describes the marine species whose continued presence in the western Indian Ocean (WIO) is considered threatened. Decades ago it would have been inconceivable for most people to consider marine creatures becoming scarce or even going extinct. The vastness of the oceans compared to the seemingly tiny footprint of human activities should surely preclude species disappearing. Unfortunately, things have changed dramatically. Humans all but exterminated the last blue whales over one hundred years ago. In recent history, numerous terrestrial mammals, birds, snakes and frogs can no longer survive in the wild in large enough populations to ensure their continued existence on Earth (eg Myers and others, 2000, Brooks and others, 2006).

Threatened species are those considered Critically Endangered, Endangered or Vulnerable (Figure 10.1). In these categories, the best available evidence indicates that a taxon is facing a high to extremely high risk of extinction in the wild. Criteria that result in taxa being categorised as threatened relate to the reduction in size of their populations, their geographic range, existing population sizes, and the probability of their extinction in the wild over a given time period (see IUCN Red List).

The total number of species in the WIO region is not precisely known, but the estimated range is between 11 000 and 20 000 or more (eg Griffiths 2005), with estimates varying depending on the water depth and organism size, mindful that invertebrate fauna in most deep sea environments are the least known. Determining which of these species are threatened was achieved by scrutinizing

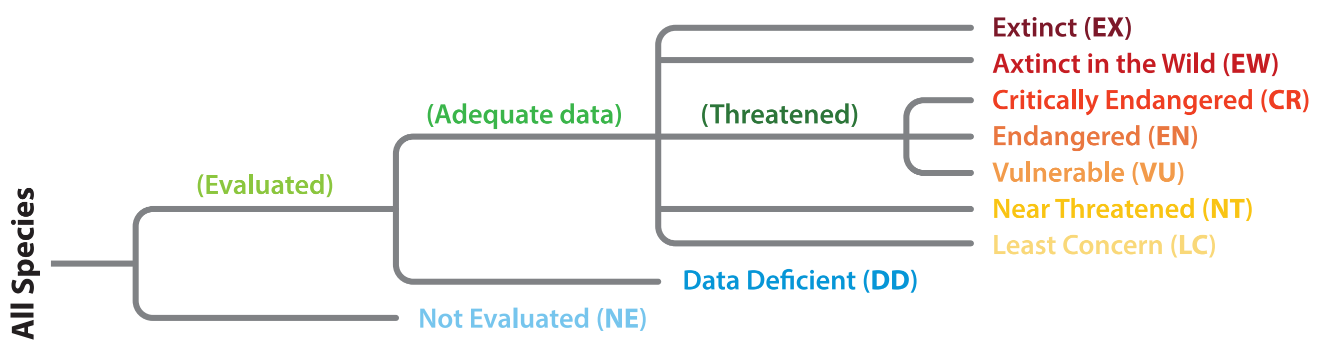

Figure 10.1. The IUCN Red List categories, used to identify the species in the WIO that are threatened.

the latest edition (2014.2) of the *IUCN Red List of Threatened Species* (or simply the Red List) and facilitating the process using the filter available on the MarineBio Conservation Society website. A review revealed that, globally, there around 800 marine species (and/or sub-populations) on the Red List that are categorised as threatened. Since we know considerably more about the diversity of life on land than in the sea (eg Pimm and others, 1995), and even less about threats to marine life (especially in the deep sea), this figure is considered conservative. It should also be noted that, while the trend in general is unfortunately for species to move up the threat ladder, for example, from Near Threatened to Extinct in the Wild, there are exceptions whereby species that were Vulnerable have dropped to one of Least Concern because numbers or populations have increased and threats have reduced.

VULNERABLE OR THREATENED MARINE SPECIES IN THE WESTERN INDIAN OCEAN

The marine portion of the Red List was checked for those species occurring in the WIO region at least for part of their lives. There are 161 species (including two subpopulations) listed as threatened (Table 10.1). The great majority of these, 126 species, are listed as Vulnerable (VU), with 27 considered Endangered (EN) and eight species listed as Critically Endangered (CE; a ray, three sharks, two fish and two marine turtle species). Near Threatened, Least Concern and those listed as Data Deficient (see Figure 10.1) are excluded here, though these include many species that are now far less common in the WIO than they once were, and that may end up higher up the list in future. The full list of threatened marine species in the WIO is presented in Appendix 10.1.

As stated on the IUCN Red List website, the "Categories and Criteria are intended to be an easily and widely understood system for classifying species at high risk of global extinction. The general aim of the system is to provide an explicit, objective framework for the classification of the broadest range of species according to their extinction risk. However, while the Red List may focus attention on those taxa at the highest risk, it is not the sole means of setting priorities for conservation measures for their protection."

In the descriptions that follow, species are mainly listed in the three highest categories of the Red List, with the top two categories, EN and CE, the most critical (see Table 10.2). Where relevant, additional species are noted in the ensuing sections based on other international criteria. Many are listed by the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES); the Convention on the Conservation of Migratory Species of Wild Animals (also known as CMS or Bonn Convention), an inter-governmental treaty concluded under the aegis of the United Nations Environment Programme, concerned with the conservation of wildlife and habitats on a global scale; the UN 1982 Convention on the Law of the Sea (UNCLOS), with respect to Articles 64 and 65 on highly migratory species and marine mammals, respectively (as listed in its Annex I); and, the Convention on Biological Diversity (CBD

Table 10.1. Vulnerable and endangered taxonomic groups.

Major taxa	Vulnerable (VU)	Endangered (EN)	Critically Endangered (CE)	Totals
Seagrasses	1	0	0	1
Corals	76	8	0	84
Gastropods	2	0	0	2
Holothurians	6	4	0	10
Rays	7	4	3	14
Sharks	22	4	1	27
Fish	9	2	2	13
Marine Turtles	1	2	2	5
Marine Mammals	2	3	0	5
Totals	126	27	8	161

2000), also known as the Nairobi Convention.

The main threats currently applicable to each species or group of species are categorised under seven themes (eg overharvest, habitat destruction, limited reproductive output/slow recovery, limited geographical distribution/endemicity, restricted depth range, susceptibility to climate change and disease and increased predation due to habitat degradation (eg crown-of-thorn starfish on coral). These are included in the full list of the threatened WIO marine species (Appendix 10.1).

SEAGRASSES

Of the twelve species of seagrass widely found in the WIO region (Bandeira 2011) only *Zostera capensis* is listed as Vulnerable. It occurs exclusively in the WIO with a small portion in the southeast Atlantic, on sand in shallow waters. Extending from the southern Angola coast, through parts of South Africa (especially northern KwaZulu-Natal) and north to Kenya, it occupies less than 2 000 km² and is absent from the smaller islands states (Short and others,

Table 10.2. Endangered (EN) and critically endangered (CE) WIO species and their CITES listing.

Major taxa	Scientific name	Status	Common English name	CITES Appendix
Corals	*Acropora roseni*	EN	Scleractinian hard coral	II
	Acropora rudis	EN	Scleractinian hard coral	II
	Anacropora spinosa	EN	Scleractinian hard coral	II
	Ctenella chagius	EN	Scleractinian hard coral	II
	Parasimplastrea sheppardi	EN	Scleractinian hard coral	II
	Pocillopora fungiformis	EN	Scleractinian hard coral	II
	Stylophora madagascarensis	EN	Scleractinian hard coral	II
	Millepora tuberosa	EN	Hydrozoan fire coral	II
Holothurians	*Holothuria lessoni*	EN	Golden sandfish	-
	Holothuria nobilis	EN	Black teatfish	-
	Holothuria scabra	EN	Golden sandfish	-
	Thelenota ananas	EN	Prickly redfish	-
Rays	*Aetobatus flagellum*	EN	Longheaded eagle ray	-
	Aetomylaeus vespertilio	EN	Reticulate eagle ray	-
	Electrolux addisoni	CE	Ornate electric sleeper ray	-
	Anoxypristis cuspidata	EN	Narrow sawfish	I
	Pristis clavata	EN	Dwarf sawfish	I
	Pristis pristis	CE	Largetooth sawfish	I
	Pristis zijsron	CE	Green/Narrowsnout sawfish	I
Sharks	*Haploblepharus kistnasamyi*	CE	Natal shyshark	-
	Holohalaelurus favus	EN	Honeycomb Izak, Natal Izak	-
	Holohalaelurus punctatus	EN	African Spotted catshark	-
	Sphyrna lewini	EN	Scalloped hammerhead	-
	Sphyrna mokarran	EN	Great hammerhead	-
Fish	*Latimeria chalumnae*	CE	Coelacanth	I
	Argyrosomus hololepidotus	EN	Madagascar Kob	-
	Cheilinus undulatus	EN	Humphead wrasse	II
	Thunnus maccoyii	CE	Southern Bluefin tuna	-
Turtles	*Caretta caretta*	EN	Loggerhead Ttrtle	I
	Chelonia mydas	EN	Green turtle	I
	Dermochelys coriacea	CE	Leatherback turtle (sub-pop)	I
	Eretmochelys imbricata	CE	Hawksbill turtle	I
Mammals	*Balaenoptera borealis*	EN	Sei whale	I
	Balaenoptera musculus	EN	Blue whale	I
	Balaenoptera physalus	EN	Fin whale	I

2010). Recently, a new seagrass species, *Thalassodendron leptocaule*, was described from southern Mozambique (see Duarte and others, 2012). The species is similar to the widespread *T. thalassodendron*, though differing slightly in habitat preference and, as far as is known, recorded only in eight scattered localities between Richards Bay in South Africa and Inhambane in Mozambique. Given its relatively small distribution in a region where human anthropogenic activities are well documented and climate change is of concern (see Bandeira and Paula 2014), this species is a potential candidate for threatened status in future evaluations.

The main *driving force* affecting the continued existence of *Z. capensis* is human population growth that leads to increased coastal development, destructive fishing pressure, coastal pollution and sedimentation, and climate change, resulting in a rise in sea temperatures that may affect the whole environment and particularly the seagrass ecosystem. Here, seagrasses are considered "ecosystem engineers" in the benthic environment (see Jackson 2001). These factors are considered *pressures indicators* that damage habitats, at times exacerbated by flooding which may be related to climate change or river catchment degradation. Such pressures are particularly prevalent in Mozambique where this species occupies possibly the greatest area, since it is recognised that the distribution of this species in temperate regions (notably South Africa) is limited by available habitat (Short and others, 2010).

HARD CORALS

Globally, most hard coral species (Scleractinia) are considered Vulnerable, primarily due to overall habitat degradation which is used as a proxy for population decline. Within the WIO region, of the approximate 200 recorded species (Schleyer 2011), eight species are Endangered (Table 10.2). The *driving forces* behind their threatened status are several, and include population growth that leads to increased coastal development, the changes listed for seagrasses (above) as well as the trade in corals (dead and live for the aquarium industry), and climate change. Increased seawater temperatures lead to coral bleaching, a *pressure indicator* that has been devastating and is well-documented, especially for coral reef communities in the Seychelles during the 1996-97 El Niño event. Coral disease and predation by crown-of-thorns starfish (COTS) are additional pressures that are on the increase, while species restricted in depth or geographic range, such as *Ctenella chagius*, *Parasimplastrea sheppardi*, *Pocillopora fungiformis* and *Stylophora madagascarensis*, are particularly vulnerable, as are those with limited reproductive/dispersal abilities, particularly brooders (Wilkinson 2004). The full details on threatened WIO corals are provided in Appendix 10.1 Table 10. A1.

Black corals (Antipatharia) occur in deep water, where they are slow-growing. Global populations were heavily overharvested by the jewellery trade in many parts of the world, though not necessarily in the WIO region, a reason for their inclusion in CITES Appendix II in 1981. Blue corals (*Heliopora coerulea*), listed as Vulnerable, are also CITES Appendix II-listed. Species included in Appendix II are not necessarily threatened with extinction, but trade in them is regulated to avoid usage incompatible with their survival.

GASTROPOD MOLLUSCS

The WIO region is home to over 3 200 shelled marine molluscs, including 2 500 gastropods plus 700 species of bivalve, oysters, clams and mussels (Richmond and Rabesandratana 2011). Two species of cone shells, *Conus jeanmartini* and *C. julii*, are considered Vulnerable (see Appendix 10.1 Table 10.A2), both occurring exclusively around the Mascarene Islands of Mauritius and Réunion (Raybaudi-Massilia 2013). Their status is defined under Red List criterion B, based on the observed decline in mature individuals inferred from their reduced appearance in the shell trade – both species are valued by collectors (Rice 2007). While the observed reduction may also be a consequence of increased protection, the precautionary approach was used in the Red List for these very rare species, until proven otherwise. The main *driving forces* are likely to be demand by the shell collecting trade, especially given the rarity of these species. Meanwhile, the *pressure indicator* appears to be demand for income/food and resultant deep-water prawn trawling, with cone shells landed as a by-catch.

There are seven species of giant clams (*Tridacna*), of which two are present in the WIO region (*T. squamosa* and *T. maxima*). These are not threatened, and listed as "Lower Risk/conservation dependent", yet there is concern for the sustainability of the intensive fishery in some parts of the tropics, and universal degradation of coral reef habitat in which they live (see above). The largest species (*T. gigas*) occurs only in parts of the western Pacific Ocean, where it and two other small-territory species are very threatened and duly listed as Vulnerable. These bivalves were included in CITES II in 1985 due to concern regarding the sustainable harvest of all giant clams.

SEA CUCUMBERS

Of the 140 species of sea cucumber (holothurians) recorded in the WIO region (Rowe and Richmond 2011), ten are considered threatened and four Endangered (Table 10.2, Appendix 10.1 Table 10.A2). The overall *driving force* affecting many of the larger sea cucumbers is human population growth and income needs, leading to increased fishing pressure by WIO fishermen, primarily for consumers in Asia where beche-de-mer is considered a delicacy (Marshall and others, 1999). Consequently, over-fishing is the main pressures indicator. Species most affected are those with the highest value, namely *Holothuria lessoni* (and the related species *H. scabra*), *H. nobilis* (endemic to the Indian Ocean) and one species of the Stichopodidae family, *Thelenota ananas* (see Box 10.1). These four species are listed as Endangered due to declines in their abundance of ~50-90 per cent over more than half of their range (see Appendix 10.1 Table 10.A2).

RAYS

There are over 30 species of rays in ten families reported in the WIO region (Esseen and Richmond 2011), of which the continued existence of three true rays and four sawfishes is threatened (Appendix 10.1 Table 10.A3). Two of the sawfish (*Pristis pristis* and *P. zijsron*) and the ornate electric sleeper ray (*Electrolux addisoni*) are listed higher up the threat ladder as Critically Endangered. The ray was only discovered in 2007, known from a very small territory and, like most rays and sharks, is of slow reproductive capacity. Further, its habitat is reportedly disturbed by recreational diving and commercial fishing. There is also increasing development along the coastline where it occurs, increasing future risk from pollution, and further habitat degradation (Compagno 2009).

Though only two of the four species of sawfishes are Critically Endangered, all sawtooth species are listed in CITES Appendix I which effectively bans commercial international trade in sawfish or their parts. Most have narrow depth ranges, low fecundity, have been heavily fished, are caught in by-catch and their shallow reef habitat is being degraded by anthropogenic and climate changes (eg coral bleaching). The need for seafood, and for income from the sale of seafood to expanding coastal populations, constitute major *driving forces* that cause rays to be targeted, with sawfish caught as a by-catch. *Pressure indicators* affecting WIO populations of rays are fishing effort (eg numbers of fishers and gear types).

SHARKS

Twenty-seven species of shark, over 50 per cent of an estimated 50 species in at least 13 different families reported in the WIO region (Esseen and Richmond 2011) are considered threatened (Appendix 10.1 Table 10.A3). Of these twenty-seven, the Natal shyshark (*Haploblepharus kistnasamyi*) is the only species considered Critically Endangered. This rank was allocated primarily because of its localized occurrence and presumably small population, but also in view of threats from coastal development, particularly in the vicinity of Durban where industrial and tourism development have expanded rapidly, and heavy commercial fishing pressure for prawns (Human 2008).

Four sharks are listed as Endangered: the honeycomb Izka and African spotted catshark (*Holohalaelurus favus* and *H. punctatus*), and the scalloped and great hammerhead (*Sphyrna lewini* and *S. mokarran).* Hammerhead shark fins are some of the most highly valued, leading to increased targeting of these species in some areas (Clarke and others, 2006).

The remaining 22 species of shark are listed as Vulnerable and include the great white, oceanic whitetip, two species of mako, guitar shark, whale shark and others (see Appendix 10.1 Table 10.A4). The whale shark and two species of mako sharks (*Isurus oxyrinhchus* and *I. paucus*) are also included in CITES Appendix II, in which the trade in shark products is not banned, if sustainability of the harvest can be demonstrated, accompanied by appropriate CITES documentation. Individual whale sharks are occasionally caught, accidentally as by-catch in gill-nets and other nets, though there is no (visible) trade in the species and their fins are not in high demand. The whale shark is also listed in Appendix II of CMS and together with hammerhead sharks and other oceanic species in Annex I of the Highly Migratory Species list of UNCLOS (1982). Whale sharks are regularly observed off southern Mozambique, Seychelles and other locations, and it has recently been demonstrated that a population is resident all year in the waters around Mafia Island, Tanzania (Cagua and others, 2015).

In 2013, CITES signatory countries agreed to increase the protection of five commercially exploited species of sharks and manta rays, elevating them to CITES Appendix II. Effective from September 2014, the international trade of four species of WIO sharks was banned (oceanic white-tip shark, scalloped, smooth, and great hammerhead and manta rays). At the 17th Session of the Indian Ocean Tuna Commission (IOTC) meeting (December 2014), members agreed to the release of oceanic white-tip sharks if caught in fishing gear and to ban retention on board, shipping, landing or storing of this species by any vessels under IOTC jurisdiction. Combined with the recent CITES protection, the oceanic white-tip is now protected around the world. The IOTC also adopted a proposal to ban the setting of purse-seine fishing nets around whale sharks, which can result in their death.

The IOTC 17th Session concluded that at least the oceanic white-tip and scalloped hammerhead sharks in the WIO are likely to be vulnerable to overfishing; there is a paucity of information available on them, both are commonly taken by a range of fisheries and their life history characteristics make them vulnerable – they are relatively long-lived, and have relativity few offspring. Their stock status is considered uncertain as they lack quantitative stock assessments and basic fishery indicators are limited for these species in the Indian Ocean. The outlook is that maintained or increased fishing effort on them may result in declines in their biomass and productivity.

As with rays, the need for seafood and income (from sale of shark fins) for expanding coastal populations are major *driving forces* affecting the capture of WIO sharks. The increasing demand for shark fins in Asia, where local stocks have dwindled and increased affluence is driving the demand, add to the *driving forces*. Such forces result in increasing pressure, involving greater fishing intensity and the use of destructive gear as well as specific gear that targets sharks, notably deep-set gill-nets.

BONY FISH

Thirteen species of bony fish, of an estimated 1 900 species reported in the WIO region (Esseen and Richmond 2011), are considered threatened (Appendix 10.1 Table 10.A4). Among these, two are listed as Critically Endangered, the coelacanth (*Latimera chalumnae*), included in CITES Appendix I, and the southern bluefin tuna (*Thunnus maccoyii*). While the southern bluefin tuna is managed by the Commission for the Conservation of Southern Bluefin Tuna (CCSBT) the coelacanth is subject to individual country efforts to protect its populations (see Chapter 9).

Listed as Endangered are two species, the humphead wrasse (*Cheilinus undulatus*) and Madagascar kob (*Argyrosomus hololepidotus*). The geographic and depth ranges of these and the above two species are very different. Coelacanth and Madagascar kob have limited geographic ranges and narrow water depth ranges; humphead wrasse are widely distributed throughout the Indo-Pacific region, yet in small numbers; and southern bluefin tuna are widely distributed and occur from the surface to 500 meters depth.

The remaining nine fish species, listed as Vulnerable, include bigeye tuna, three groupers (black-saddle, giant and lunartail), the green humphead parrot, two seahorse (*Hippocampus*) species and the Indo-Pacific bonefish, all seven typically associated with inshore coral reef/seagrass habitats, plus the blue marlin (an oceanic species). Seahorses of the genus *Hippocampus* are listed under CITES Appendix II and considered highly threatened in some localities in the WIO region due to overfishing fuelled by demand from Asia for dried seahorses (Mcphearson and Vincent 2004; Vincent and others, 2011). Blue and black marlin, swordfish, sailfish, dolphinfish, southern bluefin and bigeye plus nine other tuna species are included in the highly migratory species list in Annex I of the 1982 UNCLOS.

Bigeye tuna are important in commercial fisheries in both the Pacific and Indian Oceans. There is a single stock in the Indian Ocean, considered in relatively good condition and effectively managed. However, because Western and Central Pacific stocks, that represent >20 per cent of the global population, are being overfished, the species is listed as Vulnerable (Collette and others, 2011). Added to this is a possible further decline due to heavy fishing pressure on the much smaller skipjack tuna on which it feeds (Collette and others, 2011). In the WIO, where purse seine and longline fisheries target this species, reduced fishing pressure has recently come about largely due to the security risk of fishing in pirate waters in the NW of the region. Reduced fishing in that region on juvenile bigeye and other species has, unfortunately, been offset by the longline fleet (mainly Taiwanese and Japanese vessels) moving to the south and east, and consequently increasing the pressure on albacore tuna (IOTC-SC17 2014).

According to recent IOTC assessments, the stock status of black marlin in the Indian Ocean is that it is not overfished but subject to overfishing; the status for blue marlin was changed from that reported in 2013 and it is now determined to be overfished but not subject to overfishing; striped marlin are considered overfished and subject to overfishing (IOTC-SC17 2014).

Driving forces affecting endangered reef and bottom-associated fish species are the same as for rays and sharks: the need for seafood by WIO consumers and income from seafood to supply expanding local coastal populations. *Driving forces* affecting threatened tuna and some billfish species have roots further afield, with foreign fishing fleets targeting these high-value commercial species for export to Europe, USA and Asiatic markets. *Pressure indicators* include overfishing and the use of destructive fishing methods (eg explosives in Tanzania) and widespread habitat degradation (especially of coral reefs) from destructive fishing practices and sedimentation. *Pressure indicators* that are linked to regional fisheries management organisations such as the IOTC include catch per unit effort (CPUE) by different fishing gear. While the coelacanth has benefitted from protection under CITES I, and is the focus of the gazettement of a new marine protected area (MPA) in Tanzania, it is still accidentally caught in deep waters by bottom-set shark nets and longlines.

MARINE TURTLES

There are five species of marine turtle in the WIO region, nesting and foraging in specific areas. All are threatened, with two that are Critically Endangered: the hawksbill turtle (*Eretmochelys imbricata*) and a south-west Indian Ocean leatherback subpopulation (*Dermochelys coriacea*). The two Endangered species are the green turtle (*Chelonia mydas*) and loggerhead turtle (*Caretta caretta*). The fifth species, the olive ridley (*Lepidochelys olivacea*) is listed as Vulnerable. All are in the CITES Appendix I and Appendices I and II of CMS, and included in the CMS under the Memorandum of Understanding for the conservation and management of marine turtles and their habitats (see Appendix 10.1 Table 10.A5). Signatories to the latter include states in the Indian Ocean and South East Asia (known as IOSEA), as well as in other regions, within whose waters these species migrate, forage or nest.

The **hawksbill** turtle is an example of a species climbing the extinction ladder, being listed as Endangered by the IUCN up until 1996, and being moved to Critically Endangered from 1996 onwards due to dramatic worldwide population declines caused by international trade in their raw shell (Mortimer and Donnelly 2008; Mortimer and Collie 1998). After the trading ban resulting from CITES Appendix I listing, international trade in this commodity was significantly reduced but by-catch and habitat destruction remain threats in some countries (Meylan and Donnelly 1999). In the WIO, numerous islands and atolls provide extensive nesting and foraging habitat for hawksbills, but the main nesting sites are in the Seychelles (Mortimer and Collie 1998) with significant increases in nesting activity on Cousin Island (Allen and others, 2010). Nesting has also been recorded on small islands off the NW of Madagascar (Bourjea and others, 2006), on Juan de Nova island (Lauret-Stepler and others, 2010), and occasionally in the Misali Island MPA, off Pemba Island, Tanzania (Pharoah and others, 2003). Nesting also takes place beyond the region in Oman, India and Western Australia.

Leatherbacks in the WIO are a subpopulation that nests principally along South Africa's KwaZulu-Natal coast, but this extends into southern Mozambique and around the Cape of Good Hope into the Atlantic Ocean. Nesting populations in South Africa have been monitored consistently for 50 years, and account for >90 per cent of the total abundance of the subpopulation, which surprisingly includes only a small number of mature individuals (estimated 148 adult males and females) with evidence of a low but continuing decline (Nel and others, 2013). These are the main arguments for its Critically Endangered listing.

This abundance trend for leatherbacks contrasts with the increasing trend and greater abundance of **loggerheads** that nest along the same coastline, but drivers of these divergent patterns are unclear at present (Nel and others, 2013). The SW Indian Ocean population is one of six in the IOSEA region, nesting coinciding with beaches used by leatherbacks, principally in the southern Mozambique-northern KwaZulu-Natal area (Hamann and others, 2013). There is also nesting in the southern and south-western parts of Madagascar (Baldwin and others, 2003). Recent research has revealed that immature loggerheads are found in high density in the SWIO pelagic area, most of them probably originating from the stock from Oman (see Dalleau and others, 2014). This species is highly sensitive to the longline fishery, the most important fishery in the southwest Indian Ocean (Lewison and others, 2004).

Green turtles in equatorial and tropical WIO areas are the most frequently encountered turtle, with annual estimates for the number of nesting females ("nesters") ranging from about 14 000 to 25 000. These figures are split between many locations: around 3 000 occur around the Comoros island of Moheli (Innocenzi and others, 2010); between 2 000 and 10 000 amongst the French islands in the Mozambique Channel (Le Gall 1988, Lauret-Stepler and others, 2010); some 3 500 at Mayotte (Bourjea and others, 2007); around 2 000 reported amongst the main Seychelles islands (including its granitic islands, and the Amirante and Farquhar islands) (see Mortimer 1984; Mortimer and others, 2011a), plus 3 000 to 5 000 on Aldabra (Mortimer and others, 2011b); and between 750 and 1 000 use Tromelin (Le Gall 1988). In addition, several hundred nesters use beaches in Kenya (eg Okemwa and others, 2004), Tanzania (eg West 2011) and Madagascar (eg Bourjea and others, 2006). Foraging grounds can be extensive and trans-boundary (eg West 2014).

The **olive ridley's** global status is ranked as Vulnerable, yet in the WIO it is reported to have nested in Kenya, Tanzania and Mozambique in the past, though no records of recent nests are known and this species is feared to be close to extinction in the WIO. Fortunately, management of the vast rookeries on the coast of India are effectively maintaining healthy populations of this species. The highest numbers by far nest in the Indian Ocean at Gahirmatha, located in the Bhitarkanika Wildlife Sanctuary, which supports perhaps the largest nesting population, averaging 398 000 females in any given year (Shanker 2003). They are also found nesting on the Andaman and Nicobar Islands and to a lesser extent in the Lakshadweep Islands. This population continues to be threatened by nearshore trawl fisheries and interactions of individuals in their pelagic (drift) phase with the purse seine tuna (see Bourjea and others, 2014) and longline fisheries.

Driving forces affecting WIO marine turtle populations include coastal development and population growth, artisanal fisheries which comprise large numbers of boats using a large range of fishing gear in turtle foraging grounds, and the direct poaching of eggs and adults for meat at nesting sites, especially in Tanzania and Mozambique. *Pressure indicators* include habitat degradation of vital nesting beaches as well as foraging grounds, in places due to increased sedimentation. These can be measured in terms of the number of turtles captured in nets, the destruction of foraging habitats (coral reefs and seagrass beds), the effects of climate change, the alteration of nesting habitat (by human activity and coastal development), and the number of interactions with non-net fisheries.

MAMMALS

Of the 34 species of marine mammals that inhabit the WIO (Guissamulo 2011), five species are considered threatened (Appendix Table 10.A5). Of these, two are listed as Vulnerable, the dugong (*Dugong dugon*) and the sperm whale (*Physeter macrocephalus*), and three are listed as Endangered – the sei (*Balaenoptera borealis*), fin (*B. physalus*) and blue whales (*B. musculus*). Most whales have been protected from commercial harvest in certain regions by the International Whaling Commission (IWC) since the 1970s (some 40-50 years), and through a general moratorium on commercial whaling in 1985, but some regional subpopulations are still threatened by other human and climate-change related factors.

The five threatened whales and the dugong in the WIO region are listed in CITES Appendix I, and some are included in Appendix I and II of the CMS (see Appendix 10.1 Table 10.A5). The dugong is one of the most endangered mammals in Africa (WWF 2004; Muir and Kiszka 2011), though the Red List considers the global population of the **dugong**, spanning 48 countries from Mozambique to Australia as Vulnerable. It is recognized that the WIO population has been significantly depleted over recent decades such that it is considered extinct in Mauritius (Rodrigues) and near-extinct in many other countries, namely Kenya and Tanzania, while it is barely surviving in Mozambique. The *driving forces* behind these declines are human population growth and coastal development, leading to *pressure indicators* such as the degradation of its main habitat, seagrass beds, and its capture for meat and oil (with some incidentally harvested as by-catch in the gill-net fishery, some targeted).

Sperm whales are now only harvested in small-scale fisheries in Japan and Indonesia (Taylor and others, 2008). However, their recovery rate is very low, possibly in the order of one per cent per year (Whitehead 2002). Individuals are seen sporadically in waters off the Seychelles and Mauritius (Box 10.2) and floating dead whales are regularly encountered in the waters of Kenya and Tanzania, for no obvious reason. The most probable threats in the WIO constitute collision with ships and entanglement and drowning in fishing nets. Being predominantly an offshore species, its habitat and food source (deep-water squid) are largely unaffected by anthropogenic factors. *Driving forces* affecting sperm whales are related to human population growth and increased demand for fish, with resulting *pressure indicators* that are unique and comprise increased shipping as well as offshore fishing.

In the Indian Ocean, **blue whales** are most abundant in the southern Indian Ocean, on the Madagascar plateau, and off South Australia and Western Australia. They are found year round in the northern and equatorial Indian Ocean, especially around Sri Lanka and the Maldives, and at least seasonally near the Seychelles. Protected worldwide since 1966, they are rarely caught by whaling ships but continue to be subject to ship strikes and entanglement in small numbers (NMFS 1998).

A cosmopolitan species, the **sei whale** favours deep, colder waters, so few are seen in the tropics. Numbers off South Africa suggest a decline lasting into the 1970s and a global decline over the last three generations, hence its Endangered listing. Sei whales are still hunted in Iceland. Its overall decline is attributed to southern hemisphere losses (declining by >70 per cent over the last three generations); while north Atlantic subpopulations may have increased recently, north Pacific trends are unknown. In general, the global status of **fin** whales is poorly understood (Reilly and others, 2013).

Driving forces affecting baleen whales are related to human population growth and increased demand for fish, with resulting *pressure indicators* that include their incidental capture in gill-nets, collisions with shipping, offshore fishing and chemical pollution. Growing development in the region and its need for energy are also *drivers* that lead to increased seismic surveys for oil and gas in the marine environment, yet another *pressure indicator* (see Chapter 26 this volume).

Whales and dolphins within seven families, including the species dealt with above, are included in Annex I of the Highly Migratory Species list of UNCLOS (1982). The Indo-Pacific humpback dolphin (*Sousa chinensis*) and Orca (*Orcinus orca*) are also found in the WIO, yet neither are listed as threatened in the IUCN Red List, nor by CITES, but are included in Appendix II of the CMS. The humpback dolphin is presently under study as to whether it comprises two or three distinct species. If separated from *S. chinensis*, *S. plumbea* would become the WIO form, in which case it would qualify as Vulnerable or higher (see Reeves and others, 2008). Following the precautionary principle, WIO humpback dolphins should be regarded as such.

A recent SWIOPF (2012) analysis concluded that marine mammal mortality through fisheries interactions in the SW Indian Ocean is generally low, and certainly lower than in many other regions of the world. However, the effects of climate change involving a reduction in the extent of sea ice in the Antarctic is expected, possibly with its complete disappearance in summer, as mean Antarctic temperatures are rising faster than the global average (Turner and others, 2006). The implications of this for baleen whales that feed in these waters during the southern summer, and over-winter and give birth in the warm WIO waters, are unclear.

CURRENT TRENDS AMONG POPULATIONS OF THREATENED MARINE SPECIES

The overall trend is one of a continuing decline in populations of most of the 161 marine species (including two subpopulations) identified as threatened in waters of the WIO region. There are encouraging signs of recovery in certain species (for example some of the whales) or specific groups in specific locations (eg most marine turtles in Seychelles and green turtles throughout much of the WIO), and populations of other species have stabilized. However, many of the marine creatures that live in or are dependent on inshore marine habitats, in this case mainly seagrass beds and coral reefs, are threatened because their habitat is being degraded or destroyed by humans. These two habitats have been reduced in geographic extent, especially over the last twenty years, and their biological integrity is being compromised by unsustainable coastal resource use and the consequence of coastal and industrial development (see Chapters 5-6).

Habitat destruction is a major problem in the marine and coastal environment in many parts of the world, the WIO region being no exception. Marine and coastal habitats are degraded by a multitude of factors, often due to seemingly universal *driving forces* involving population growth and coastal development. Destructive fishing practices, particularly bottom trawling (eg Mozambique, Madagascar, South Africa) and dynamiting coral reefs (exclusively in Tanzania) destroys entire ecosystems. Over-fishing weakens the sustainability of resources and may damage habitats and change ecosystem equilibrium. Environmental degradation (often measured in terms of seawater quality or changes in seabed life) is common close to large WIO coastal conurbations.

Coastal development is taking place at unprecedented rates around many large coastal cities in the WIO and its effects include destruction of marshes and floodplains that are in-filled for real estate development (eg Dar es Salaam), agricultural runoff that results in nutrient pollution from fertilizers and/or agro-chemicals (eg Mauritius), domestic sewage and solid waste pollution of coastal waters (eg Mombasa) leading to harmful algae blooms that block sunlight and deplete the water of oxygen. Sediment and silt originating from river catchment degradation, poor agricultural practices and changes in coastal land use discharge into coastal waters where their build-up on coral reefs can block the sunlight necessary for coral growth (eg NW Madagascar). Marine and beach pollution are associated with development and increased human settlement on the coast. Contaminants, often including toxic substances such as industrial chemicals, pesticides and oil waste, enter the marine environment from large coastal urban and industrial centres (eg Durban). Mining activities introduce metals such as mercury and other chemicals into rivers that discharge into the sea (eg Ruvuma, bordering Mozambique and Tanzania).

The above are only examples of the many environmental threats that appear to be increasing in the WIO, and that directly and indirectly impact on the biodiversity and productivity of coastal waters and their threatened species. These represent *pressure indicators*, some specific to the threatened species in general, others to threatened species in particular localities. Measurement of change in terms of quantity and/or quality (eg stocks of a specific fish population, chemical concentration of a particular pollutant, or prices of rare shells) would represent *state indicators*. These could then be used to monitor and describe changes over time, eg a reduction in area of seagrass cover could represents an *impact indicator* (Table 10.3).

One relevant factor is that, compared to other oceanic regions, the WIO is fringed mainly by developing countries, where marine life constitutes a vital source of subsistence (mainly as food). The challenge is to conserve threatened species while guaranteeing human survival. This is an important issue that must be addressed in the region: marine biodiversity is not only "food" or "money for food", but it can also be a source of revenue through its protection for ecotourism. A few successful community-driven marine resource management ventures are emerging (eg Itsamia, Comoros) but many more are needed to stem the rise in *driving forces*.

CAPACITY AND NEED TO PROTECT THREATENED SPECIES IN THE WIO REGION

Local capacity to implement measures to safeguard threatened marine environments (in some cases the environment in general) are severely lacking in some countries in the WIO. The best equipped in terms of personnel capacity, legislative framework, equipment and enforcement are Sey-

Table 10.3. State and impact indicators for threatened WIO marine species.

Major taxa (and number of species)	State indicators	Impact indicators
Seagrass (1)	Area covered (km^2); shoot density.	Loss in area coverage and density.
Hard corals (84)	Coral reef condition: includes water condition, species diversity, hard coral cover (%).	Reduction in percentage of live cover, diversity indices, water condition.
Gastropod molluscs (2)	Standing stock, indices being by-catch and shell availability/price in the shell trade.	Fewer individuals caught per unit fishing effort, higher price and lower volumes traded.
Holothurians (10)	Standing stock derived from field surveys; fisher/fishery surveys; export volumes, prices; species composition and specimen size.	Lower standing stock and export volumes, increase in less valuable species, smaller sizes and higher prices.
Rays (14)	Standing stock derived from field surveys, fisher/fishery surveys.	Reduced standing stock, landings, smaller sizes, higher prices.
Sharks (27)	Standing stock derived from field surveys, fisher/fishery surveys; dried fin export volumes.	Reduced standing stock, landed and fin export volumes, higher prices.
Fish (13)	Standing stock derived from field surveys, fisher/fishery surveys (eg sea fisheries observer programme).	Reduced standing stock, higher prices, lower volumes landed.
Turtles (5)	Standing stock derived from field (beach nesting activity) surveys, fisher/fishery surveys (eg sea turtle observer programme); surveys of foraging grounds.	Reduction in standing stock and length, condition of nest sites, degraded foraging grounds.
Mammals (5)	Standing stock derived from field surveys (whale watching), fisher/fishery surveys.	Reduction in standing stock.

chelles, Mauritius, Réunion (France) and South Africa. Less well equipped are Tanzania and Mozambique. Kenya and Madagascar lie somewhere in between.

Driving forces that are largely responsible for threatened marine species in the WIO region include fast-growing populations, combined with low levels of education and environmental awareness among coastal people; a low level of confidence in management authorities; high levels of poverty accompanied by a general lack tradition of marine resource stewardship or concern for environmental degradation; a lack of capacity or willingness to implement management measures; widespread corruption in government institutions that fail to prevent environmental degradation; and over-harvesting of resources that results from the need for food and income. These factors significantly affect the abilities of countries like Tanzania and Mozambique to implement effective marine conservation measures and progress in this regard is very slow, in some cases non-existent.

Authorities in many WIO countries are unable to manage stocks of marine life, enforce management regimes or fisheries regulations. Tanzania is held in high esteem when conservation of terrestrial species and ecosystems is concerned, despite recent increases in elephant poaching, yet management of the marine environment continues to present challenges for the responsible authorities. In Kenya, Tanzania, Comoros, Madagascar and Mozambique, marine protected areas (MPAs) do exist, and some achieve at least some of their conservation goals but, overall, marine resources and biodiversity are constantly under pressure from resource users and, in many cases, are at best stable or continue to degrade, albeit slower than if there was no legal protection.

Other than the coelacanth, most threatened marine species in the WIO region are implicated in fisheries that are expanding in intensity, extent and efficiency, and are resulting in increased collateral, non-target damage. Fisheries management is a challenge in most parts of the world, made more difficult in multi-species, coral reef-based fisheries, exploited by fishers with low incomes and few alternatives. In countries like Comoros, Madagascar, Tanzania, Kenya and Mozambique, where 21 of the 35 endangered species shown in Table 10.2 are CITES-listed (Appendices I or II), management and conservation of these species becomes more difficult as population pressures increase. CITES status has, for many (but not all) species, helped reduce trade in most parts of the world and ensure the continued survival of these species in the wild. Most of the successes are terrestrial, though hawksbill turtles remain a hopeful marine success. In many WIO countries, enforcement of CITES procedures and paperwork to acceptable levels is at present unrealistic for the volumes traded. The local capacity, as described above, is simply not there. In these countries, the threats and pressure indicators are likely to worsen.

CONCLUSIONS AND RECOMMENDATIONS

The management of threatened species faces many challenges in the WIO, yet it must be done. Responses to the threats facing the 161 species already considered threatened need to be developed with urgency and their implementation coordinated throughout the national territories of WIO countries. The main challenges will be to meet the increasing demand for biological resources caused by population growth and increased consumption, in the short-term, while always considering the long-term consequences and trends. Failure to achieve these objectives will witness a continued decline in the situation that that will certainly be reflected in a longer list of threatened species by 2050, with a greater number higher up the threat ladder, and a greater portion of degraded coastal habitats.

Developing *response indicators* to prevent, compensate, mitigate or adapt to changes recorded by *impact indicators* (as well as responding to *state* and *pressure* indicators) is often complex and demanding. The surest means to address the primary *driving forces*, viz growth in human population-related pressures, will be to educate populations and provide the means to reduce population growth. While recognizing that this is a slow and longer-term goal, it is a challenge that has been avoided for too long and the time to act is now. Effective action will require considerable effort, dedication and patience. Nine broad recommendations are outlined below to address most of the pressures indicators, some of which can be developed into legislation or other instruments that represent responses.

RECOMMENDATIONS

Raised awareness

This is needed at all levels of society, from marine resource harvesters (fishers, seaweed farmers, mangrove cutters, dive-boat operators, international coastal hotel managers), through local and regional governance structures, to senior management and institutions. The focus needs to be on providing information on threatened species, biodiversity and the need for sustainable marine resource management, based on sound science (including reliable data). Implementation needs to be integrated across all sectors and stakeholders, following the ecosystem approach and involving local communities. Training and capacity building are also needed, particularly to increase the number and quality of students to generate national experts on threatened species and create a dynamic within each country to follow up on their status.

Increased funding for marine resource management

The costs of protecting marine areas, species or communities can far exceed the income they generate and, consequently, they are often ignored and not financed sustainably, especially in the short-term. Increased support for MPAs is needed, where necessary using novel technologies. Research findings warrant responses, especially where threatened marine species are involved.

WIO Threatened Species Task Force

Small units of specialist are needed to visit WIO countries, under the umbrella of a regional mandate, to identify "national" Red Lists on marine species with certainty and strengthen actions for their protection. This could involve a review of the data capture and management instruments related to the threatened species, introduce the DPSIR approach and generally assist overcome impediments to their protection and improve its effectiveness. For species where such a regional task force exists, links to global organizations that deal with that species need to be strengthened.

National integration and cross-sectoral cooperation

Coordination within governments, and between governments and stakeholders needs to be strengthened on all marine issues, aiming for fully integrated coastal zone management (ICZM) with thourough environmental and social impact assessments (ESIAs).

Strengthened regional integration and coherence

Adherence to the conditions of the Nairobi Convention needs improvement and all IMO conventions and other instruments (eg CBD, IOSEA, CITES, etc.) need to be ratified. Participation in the Regional Fisheries Management Organization (RFMO) and the Southern Indian Ocean Deep-sea Fishers' Association (SIODFA) is warranted, where relevant, for the enhanced protection of marine life and to foster regional cooperation, promote trade rules and practices that promote the sustainable use of biodiversity and threatened species. Illegal, unreported and unregulated fisheries (IUU) in the WIO region needs to be addressed and requires regional collaboration.

Alternative livelihoods

Alternative income generating activities for fishers and coastal communities need to be developed and promoted. Regional successes and the latest technology need to be shared; ecotourism is an example which delivers results.

Alternative food sources/equivalents

Alternative food sources need development for coastal populations, as well as value-adding for existing harvests. Regional successes and the latest technology again need to be shared. This must be done without adding pressure to other species (including commercial species) for which stocks are not in good shape, hence avoiding transfer of effort from one threatened species to another.

Monitoring the harvest of threatened species

Adequate monitoring of marine resource use is needed, especially of threatened species, using improve methods where necessary, once again sharing regional successes and the latest technology.

Targeted research

Research on threatened species needs promotion and support to identify research priorities, investigate their distribution, ecology, dispersal and connectivity, migration, population structure and breeding. Also important are fisheries by-catch and habitat biodiversity. Finally, there remains the need to develop environmental indicators and mitigation measures, and to improve harvesting techniques and alternatives (eg mariculture, or enhancements like "casitas" for lobsters, artificial reefs, or re-stocking).

BOX 10.1. SEA CUCUMBERS IN THE WIO

Close-up of a red prickly sandfish, *Thelenota ananas*, showing the distinctive soft, irregular papillae which give it a shaggy appearance. © Michael H. Schleyer.

Sea cucumbers (or holothurians) are elongate, soft-bodied echinoderms without projecting arms. They have a mouth at the anterior end, surrounded by a ring of 10–30 food-capturing tentacles, and an anus at the posterior. Tube-feet, which are used mainly for locomotion, occur in various arrangements. The skeleton comprises microscopic ossicles of different shapes and sizes embedded in the dermis (skin) of the body wall. Sea cucumbers feed by using their tentacles to collect sediment into their mouths or by suspension feeding from the water. The tentacle shape reflects the type of feeding strategy and aid species identification. There are some 1 400 species worldwide, of which about 140 species occur in shallow waters of the WIO (Rowe and Richmond 2011).

Most holothurians are of little interest to humans, but demand for bêche-de-mer or dried sea cucumber in SE Asia and China has led to massive overfishing of the twenty or so species in demand. As a result, ten species from the WIO are now on the IUCN Red List, with one of the most endangered being the Red prickly sandfish (*Thelenota ananas*), partly due to its low fecundity. Of the family Stichopodidae, *T. ananas* reaches 70 cm in length, and is unmistakable due to it long, firm, loaf-shaped body covered in distinctive soft, irregular papillae giving a shaggy appearance. It is dark reddish-brown and lives among shallow reefs from the WIO and Red Sea to the western Pacific Ocean.

Over the last ten years, increased scarcity of sought-after bêche-de-mer species has encouraged research that has led to successful breeding of some to a size where they can be introduced to the natural environment (ranching or re-stocking). There are now ongoing projects to artificially breed and culture sea cucumbers (eg *Holuthuria scabra*) at various locations in the tropics, including the WIO, some in cooperation with private companies. Though mortality of cultured juveniles is high, once they reach 20 g and are placed in the wild, the survival rate is very good. Studies reveal that it can take six months for juveniles to reach 250 g, the desired weight for the export market. Farming or ranching sea cucumbers is expected to be profitable and environmentally friendly, providing a livelihood for coastal communities in the WIO and many tropical areas.

Useful reference: Toral-Granda, V., Lovatelli, A. and Vasconcellos, M. (eds.) (2008). Sea Cucumbers. A global review of fisheries and trade. FAO Fisheries and Aquaculture Technical Paper No. 516. Rome, FAO, 317 pp

BOX 10.2. SPERM WHALES IN THE WIO

A sperm whale mother and calf off Mauritius in the WIO. © Hughes Vitry.

Sperm whales (*Physeter macrocephalus*) are the most iconic of whales, made famous in popular culture by Hermann Melville's 1851 novel 'Moby Dick'. They are found in the tropical zones of all major oceans, including the WIO. Although males undertake seasonal migrations to higher latitudes, female-led groups are likely to be resident in the tropics throughout the year. Sperm whales are characterised by significant sexual dimorphism. While males can attain 18 m in length and 30-50 t in weight, females are typically only 10-12 m and 10-12 t in weight. Sperm whales feed on giant squid at depths of up to 2 000 m and can live for 60-70 years (Berggren 2009).

Filling much of the characteristically large head of sperm whales (the species' latin name of *macrocephalus* translates as *large-head*) is the spermaceti organ, producing a waxy liquid called spermaceti. This organ may play a role in both buoyancy and echolocation; Sperm whales may also use bursts of high-energy sound to stun their prey, and spermaceti may play a role in focusing these soundwaves. However, spermaceti has properties that made it unrivalled as an industrial lubricant, for use as candle-wax and for use in cosmetics and medicines. It was even used in space technology. Although whaling declined in the first half of the 20th century, there was an upsurge after WWII. Records suggest that between 1950 and 1976, Japan and the Soviet Union alone killed more than 220 000 sperm whales (WDCS 2010). The hunting of Sperm whales was made illegal in 1985.

Current estimates for global Sperm whale populations are in the order of 300 000 individuals, compared to the estimated pre-whaling era population of c.1million. There is no separate estimate for population sizes in the WIO (Berggren 2009).

Useful reference:

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APPENDIX 10.1

Table 10.A1. Full list of threatened WIO coral species.

Notes on threat codes: a) overall species habitat degradation, used as a proxy for population decline; **b)** susceptible to coral bleaching and disease; **c)** narrow depth range; **d)** Crown-of-thorns (COT) predation; **e)** harvested (for aquaria; **f)** restricted geographic range; **g)** limited reproduction/dispersal (brooders). **Source:** Wilkinson (2004). **Abbreviations:** Indo-West Pacific region - IWP; Indo-Pacific region - I-P; PNG – Papua New Guinea; Pacific Ocean - PO; Western Indian Ocean – WIO.

Species	Red List Category & Criteria:	Distribution	Threat
Acanthastrea brevis	VU A4ce ver 3.1	IWP	a,b
Acanthastrea hemprichii	VU A4c ver 3.1	IWP	a,b
Acanthastrea ishigakiensis	VU A4c ver 3.1	IWP	a,b,c
Acropora aculeus	VU A4ce ver 3.1	IWP	a,b,d,e
Acropora acuminata	VU A4ce ver 3.1	IWP	a,b
Acropora anthocercis	VU A4ce ver 3.1	IWP	a,b,d
Acropora echinata	VU A4cde ver 3.1	IWP	a,b,d,e
Acropora hemprichii	VU A4ce ver 3.1	IWP	a,b,d
Acropora horrida	VU A4cde ver 3.1	IWP	a,b,d
Acropora listeri	VU A4ce ver 3.1	IWP	a,b,d
Acropora lovelli	VU A4ce ver 3.1	IWP	a,b,d
Acropora palmerae	VU A4ce ver 3.1	IWP	a,b,d
Acropora pharaonis	VU A4ce ver 3.1	IWP	a,b,d
Acropora polystoma	VU A4ce ver 3.1	IWP	a,b,d
Acropora retusa	VU A4ce ver 3.1	IWP	a,b,d
Acropora roseni	EN A4ce ver 3.1	IWP	a,b,d
Acropora rudis	EN A4ce ver 3.1	IWP	a,b,d
Acropora solitaryensis	VU A4ce ver 3.1	IWP	a,b,d
Acropora spicifera	VU A4ce ver 3.1	IWP	a,b,d
Acropora vaughani	VU A4ce ver 3.1	IWP	a,b,d,e
Acropora verweyi	VU A4ce ver 3.1	IWP	a,b,d
Acropora willisae	VU A4ce ver 3.1	IWP	a,b,d,e
Alveopora allingi	VU A4cd ver 3.1	IWP	a,b,d
Alveopora daedalea	VU A4c ver 3.1	IWP	a,b,d
Alveopora fenestrata	VU A4c ver 3.1	IWP	a,b,d,e
Alveopora verrilliana	VU A4cd ver 3.1	Red Sea to IP (incl. Mauritius)	a,b,d,e
Anacropora reticulata	VU A4ce ver 3.1	Central IP (incl. Mauritius)	a,b,d
Anacropora spinosa	EN A4ce ver 3.1	Central IP (incl. Mauritius)	a,b,d
Anomastraea irregularis	VU A4ce ver 3.1	IWP	a,b,d
Catalaphyllia jardinei	VU A4cd ver 3.1	IWP	a,e
Caulastrea connata	VU A4c ver 3.1	IWP	a,b,c
Ctenella chagius	EN A4c ver 3.1E	BIOT + Mauritius, Réunion	a,b,f
Echinopora robusta	VU A4c ver 3.1	Sri Lanka + WIO	a,b,f
Euphyllia cristata	VU A4cd ver 3.1	IWP	a,e
Favites spinosa	VU A4c ver 3.1	Red Sea to PNG (incl. WIO)	a,b,c
Fungia curvata	VU A4c ver 3.1	E + WPO, Red Sea (incl. WIO)	a,b
Fungia seychellensis	VU A4c ver 3.1	IWP	a,f
Galaxea astreata	VU A4cd ver 3.1	IWP	a,b,e
Goniastrea deformis	VU A4c ver 3.1	IWP	a,e
Goniopora albiconus	VU A4c ver 3.1	IWP	a
Goniopora planulata	VU A4c ver 3.1	IWP	a,b

Species	Red List Category & Criteria:	Distribution	Threat
Heliopora coerulea	VU A4cde ver 3.1	IWP	a,b,c,e
Horastrea indica	VU A4c ver 3.1	WIO	a
Isopora brueggemanni	VU A4ce ver 3.1	Red Sea - central PO (incl. WIO)	a,g
Isopora cuneata	VU A4ce ver 3.1	WIO to central PO	a,b,d
Isopora crateriformis	VU A4ce ver 3.1	IWP	a,b,g
Leptastrea aequalis	VU A4c ver 3.1	Madagascar - WPO	a,b,c
Leptoria irregularis	VU A4c ver 3.1	WIO - WPO	a,b,c
Leptoseris incrustans	VU A4ce ver 3.1	IWP	a,b,d
Leptoseris yabei	VU A4ce ver 3.1	IWP (Madagascar)	a,b
Millepora tuberosa	EN A4c ver 3.1	WPO + Mauritius	a,b,e (curio trade)
Montastrea serageldini	VU A4c ver 3.1	IWP	a
Montipora australiensis	VU A4ce ver 3.1	IWP	a,b,d
Montipora calcarea	VU A4ce ver 3.1	WIO - WPO	a,b,d
Montipora caliculata	VU A4ce ver 3.1	WIO	a,b,d
Montipora corbettensis	VU A4c ver 3.1	WIO - WPO	a,b,d
Montipora friabilis	VU A4ce ver 3.1	WIO - WPO	a,b,d
Montipora lobulata	VU A4c ver 3.1	IWP	a,b,d
Montipora meandrina	VU A4c ver 3.1	Red Sea, Madagascar, WPO	a,b,d
Montipora orientalis	VU A4c ver 3.1	WIO to WPO	a,b,d
Montipora stilosa	VU A4c ver 3.1	IWP	a,b,d
Pachyseris rugosa	VU A4cd ver 3.1	IWP	a,b,e
Parasimplastrea sheppardi	EN A4c ver 3.1	IWP	a,b,f
Pavona bipartita	VU A4c ver 3.1	IWP	a,b
Pavona cactus	VU A4cd ver 3.1	IWP	a,b,e
Pavona decussata	VU A4c ver 3.1	IWP	a,b
Pavona venosa	VU A4c ver 3.1	IWP	a,b
Pectinia africanus	VU A4c ver 3.1	WIO	a,b,e,f
Pectinia lactuca	VU A4cd ver 3.1	IWP	a,b,e
Physogyra lichtensteini	VU A4cd ver 3.1	IWP	a,e
Pocillopora ankeli	VU A4c ver 3.1	IWP (Madagascar)	a,b,c
Pocillopora fungiformis	EN A4c ver 3.1	WIO (Madagascar)	a,b,f
Pocillopora indiania	VU A4c ver 3.1	WIO	a,b,f
Porites nigrescens	VU A4cde ver 3.1	IWP	a,b,e
Porites sillimaniana	VU A4cde ver 3.1	WIO - WPO	a,b,e
Poritipora paliformis	VU A4c ver 3.1	WIO - Sri Lanka	a
Psammocora stellata	VU A4ce ver 3.1	IWP (incl. Seychelles)	a,b,d
Seriatopora aculeata	VU A4c ver 3.1	Madagascar, WPO - central PO	a,b
Stylophora madagascarensis	EN A4c ver 3.1	Madagascar	a,b,f
Symphyllia hassi	VU A4c ver 3.1	IWP	a,b,c
Turbinaria mesenterina	VU A4cd ver 3.1	IWP	a,e
Turbinaria peltata	VU A4cd ver 3.1	IWP	a,e
Turbinaria reniformis	VU A4c ver 3.1	IWP	a,b,c
Turbinaria stellulata	VU A4c ver 3.1	IWP	a,b,c

Table 10.A2. Full list of threatened WIO seagrass, mollusc and sea cucumber species.

Notes on threat codes: a) overall species habitat degradation, used as a proxy for population decline; **e)** harvested (by collectors of *Conus* shells, assumed black market; holothurian, for food); **f)** restricted geographic range; **g)** limited reproduction/dispersal (low fecundity + late sexual maturation). **Sources** for *Zostera* (Short and others, 2010); and *Conus* (Raybaudi-Massilia 2013). **Abbreviations:** Indo-West Pacific region - IWP; Indo-Pacific region - IP; Pacific Ocean - PO; Western Indian Ocean – WIO.

Species	Red List Category & Criteria:	Distribution	Threat
PLANTAE TRACHEOPHYTA			
Zostera capensis	VU B2ab(ii,iii) ver 3.1	WIO (not small islands) < 2,000 km^2	a (esp. Mozambique)
MOLLUSCA GASTROPODA			
Conus jeanmartini	VU D2 ver 3.1	Réunion (deepwater)	e (shrimp trawling),f
C. julii	VU B1ab(v)+2ab(v) ver 3.1	Mascarenes	e,f + possibly extreme weather events.
ECHINODERMATA HOLOTHUROIDEA			
Actinopyga echinites	VU A2bd ver 3.1	WIO – central PO	e (declined > 60-90% in > 50% of range)
A. mauritiana	VU A2bd ver 3.1	WIO – central PO	e (declined > 60-90% in > 50% of range)
A. miliaris	VU A2bd ver 3.1	WIO – central PO	e (declined > 60-90% in > 50% of range)
Holothuria arenacava	VU D2 ver 3.1	Kenya	f, e (assumed)
H. fuscogilva	VU A2bd ver 3.1	WIO – central PO	e (declined > 60-80% in > 30% of range)
H. lesson	E A2bd ver 3.1	IWP	e (highest value; declined 50% in > 50% of range)
H. nobilis	E A2bd ver 3.1	Indian Ocean	e (high value; declined 60-70% in > 80% of range)
H. scabra	E A2bd ver 3.1	IWP	e (high value; declined > 90% in > 50% of range)
Stichopus herrmanni	VU A2bd ver 3.1	IWP	e (declined > 60-90% in > 50% of range)
Thelenota ananas	E A2bd ver 3.1	IWP	e (high value; declined 80-90% in > 50% of range), g

Table 10.A3. Full list of threatened WIO ray and shark species.

Notes on threat codes: a) overall species habitat degradation, used as a proxy for population decline; **c)** narrow depth range; e) overharvested (for food); **f)** restricted geographic range; **g)** low fecundity; **h)** rare; **i)** by-catch. **Abbreviations:** Indo-West Pacific region - IWP; Indo-Pacific region - IP; Pacific Ocean - PO; Western Indian Ocean – WIO.

Species	Red List Category & Criteria:	Distribution	Threats
RAYS			
Aetobatus flagellum	EN A2d+3d+4d ver 3.1	IWP	g,e,h
Aetomylaeus vespertilio	EN A2bd+3d+4d ver 3.1	WIO – PO	g,e,h
Dipturus crosnieri	VU A3d ver 3.1	Madagascar	a,c,f,g,h,i
Electrolux addison	CE B2ab(ii) ver 3.1	S Africa	a,c,f,g
Heteronarce garmani	VU A2d+4d ver 3.1	Moz., S Africa	a,e,h,i
Himantura uarnak	VU A2bd+3bd+4bd ver 3.1	IWP	a,e,g
Manta alfredi [2]	VU A2abd+3bd+4abd ver 3.1	circumtropical	e,g
Manta birostris [2,a,b]	VU A2abd+3bd+4abd ver 3.1	circumtropical	e,i
Rhinoptera javanica	VU A2d+3cd+4cd ver 3.1	IWP	a,g,i
Taeniurops meyeni	VU A2ad+3d+4ad ver 3.1	IWP	a,e,g
Anoxypristis cuspidate [1]	EN A2cd ver 3.1	WIO - WPO	e,g
Pristis clavata [1]	EN A2cd ver 3.1	WIO - WPO	a,c,e,g,i
Pristis pristis [1]	CE A2cd ver 3.1	IWP-Atlantic	a,c,e,g,i
Pristis zijsron [1]	CE A2cd ver 3.1	IWP	a,c,e,g,i
SHARKS			
Alopias pelagicus	VU A2d+4d ver 3.1	WIO – PO	e,g,i
Alopias superciliosus	VU A2bd ver 3.1	circumglobal	e,g
Alopias vulpinus	VU A2bd+3bd+4bd ver 3.1	circumglobal	e,g,i
Carcharhinus longimanus [2]	VU A2ad+3d+4ad ver 3.1	circumtropical	e,g,i
Carcharhinus obscurus	VU A2bd ver 3.1	cosmopolitan	e,g
Carcharhinus plumbeus	VU A2bd+4bd ver 3.1	circumglobal	e,g
Carcharias taurus	VU A2ab+3d ver 3.1	Subtrop/temp	a,e,g
Carcharodon carcharias [2,a,b]	VU A2cd+3cd ver 3.1	cosmopolitan	e,g,i
Centrophorus granulosus	VU A2abd+3d+4d ver 3.1	circumglobal	e,g,h
Galeorhinus galeus	VU A2bd+3d+4bd ver 3.1	widespread (Moz., S Africa)	e,g
Haploblepharus kistnasamyi	CE B1ab(iii) ver 3.1	S Africa	a,c,e,f,g,h
Hemipristis elongate	VU A2bd+3bd+4bd ver 3.1	IWP	e,g
Holohalaelurus favus	EN A2abcd+3bcd+4abcd ver 3.1	Moz., S Africa	e,f
Holohalaelurus punctatus	EN A2abcd+3bcd+4abcd ver 3.1	Moz., S Africa	c,g,h,i
Isurus oxyrinchus	VU A2bd+4d ver 3.1	IWP	e,h,i
Isurus paucus	VU A2bd+3d+4bd ver 3.1	cosmopolitan	e,h,i
Nebrius ferrugineus	VU A2abcd+3cd+4abcd ver 3.1	IWP	a,c,e,g
Negaprion acutidens	VU A2abcd+3bcd+4abcd ver 3.1	IO-WPO	a,c,e,g
Odontaspis ferox	VU A2bd+4bd ver 3.1	widespread	g,h
Pseudoginglymostoma brevicaudatum	VU A3cd+4cd ver 3.1	WIO	a,e,f,h,i,
Rhina ancylostoma	VU A2bd+3bd+4bd ver 3.1	IWP	a,e,i
Rhincodon typus [2,b]	VU A2bd+3d ver 3.1	cosmopolitan	e
Rhynchobatus djiddensis	VU A2d+3d+4d ver 3.1	Red Sea – WIO	e,g,i
Sphyrna lewini [2]	EN (WIO) A2bd+4bd ver 3.1	circumglobal	e,i
Sphyrna mokarran [2]	EN A2bd+4bd ver 3.1	circumglobal	e,g
Sphyrna zygaena [2]	VU A2bd+3bd+4bd ver 3.1	circumglobal	e,i
Stegostoma fasciatum	VU A2abcd+3cd+4abcd ver 3.1	IP	a,c,e,i
CITES listing: 1. Appendix I; 2. Appendix II; 3. Appendix III; a. Appendix I CMS; b. Appendix II CMS.			

Table 10.A4. Full list of threatened WIO bony fish species.

Notes on threat codes: a) overall species habitat degradation, used as a proxy for population decline; **c)** narrow depth range; **e)** overharvested (for food); **f)** restricted geographic range; **g)** low fecundity; **h)** rare; **i)** by-catch. **Abbreviations:** Indo-West Pacific region - IWP; Indo-Pacific region - IP; Western Indian Ocean – WIO.

Species	Red List Category & Criteria:	Distribution	Threats
SARCOPTERYGII			
Latimeria chalumnae [1]	CE A2bcd ver 2.3	WIO	c,e,f,g,h,i
ACTINOPTERYGII			
Argyrosomus hololepidotus	EN B1ab(ii,iii,v)+2ab(ii,iii,v) ver 3.1	Madagascar	e,f,h,i
Bolbometopon muricatum	VU A2d ver 3.1	IWP	a,e
Albula glossodonta	VU A2bcd ver 3.1	IP	a,e
Cheilinus undulatus [2]	EN A2bd+3bd ver 3.1	IP	a,e
Epinephelus albomarginatus	VU A2d ver 3.1	WIO - India	e,f
Epinephelus lanceolatus	VU A2d ver 3.1	IP	a,e
Hippocampus histrix [2]	VU A2cd+4cd ver 3.1	IP	a,e,h,i
Hippocampus kelloggi [2]	VU A2d+4d ver 3.1	IP	a,e,h,i
Makaira nigricans [a]	VU A2bd ver 3.1	cosmopolitan	e,h,i
Plectropomus laevis	VU A2d+4d ver 3.1	IP	e,i
Thunnus maccoyii [a]	CE A2bd ver 3.1	cosmopolitan	e,i
Thunnus obesus [a]	VU A2bd ver 3.1	circumtropical	e (central PO)
1. CITES Appendix I; 2. CITES Appendix II; a. UNCLOS Annex 1.			

Table 10.A5. Full list of threatened WIO marine turtles and mammals.

Notes on threat codes: a) overall species habitat degradation, used as a proxy for population decline; **c)** narrow depth range; **e)** over-harvested (for food); **f)** restricted geographic range; **g)** low fecundity; **h)** rare; **i)** by-catch. **Abbreviations:** Indo-West Pacific region - I-WP.

Species	Red List Category & Criteria:	Distribution	Threats
REPTILIA			
Caretta caretta [1,a,b]	EN A1abd ver 2.3	circumglobal	a,e,i
Chelonia mydas [1,a,b]	EN A2bd ver 3.1	circumglobal	a,e,i
Dermochelys coriacea [1,a,b]	CE C2a(ii) ver 3.1	circumglobal	a,e,i
Eretmochelys imbricata [1,a,b]	CE A2bd ver 3.1	circumglobal	a,e,i
Lepidochelys olivacea [1,a,b]	VU A2bd ver 3.1	circumtropical	a,e,i
MAMMALIA			
Balaenoptera borealis [1,a,b,c]	EN A1ad ver 3.1	cosmopolitan	e,i
Balaenoptera musculus [a,c]	EN A1abd ver 3.1	cosmopolitan	e,i
Balaenoptera physalus [1,a,b,c]	EN A1d ver 3.1	cosmopolitan	e,i
Physeter macrocephalus [1,a,b,c]	VU A1d ver 3.1	cosmopolitan	e,i
Dugong dugon [1,b]	VU A2bcd ver 3.1	I-WP	e,i
1. CITES Appendix I; a. Appendix I CMS; b. Appendix II CMS; c. UNCLOS Annex 1.			


PGBMC
MICOA
PLANTIO DE MANGAL
PROIBIDO PASSAGEM
CUVIALIWA KWA APA
WACATAZA KUPITA.