



Regional Assessment

Western Indian Ocean



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REGIONAL OVERVIEW

Research on bycatch of long-lived, air-breathing vertebrates is at a relatively nascent stage in the Western Indian Ocean. There are reports of bycatches of dugongs, sea turtles, and dolphins (humpback and bottlenose), primarily in gillnet and trawl fisheries. In the southern-most latitudes of this region, seabird bycatch has also been documented in longline gear. Recently, local scientists have initiated efforts to assess bycatch of sea turtles and marine mammals in the region. In particular, members of the Western Indian Ocean Marine Science Association (WIOMSA) have initiated collaborative projects to investigate bycatch of marine mammals and sea turtles. In 2006, WIOMSA sponsored the Western Indian Ocean Regional Workshop on Incidental Catch of Non-targeted Marine Species: Problems and Mitigation Measures. At that workshop, researchers concluded that one of the most significant threats to marine mammals and sea turtles in this region is by-catch in artisanal gillnets and that quantitative assessments of these catches were needed (Kiszka and Muir 2007). In addition, the Indian Ocean – Southeast Asian Marine Turtle Memorandum of Understanding (IOSEA) hosted the Year of the Turtle in 2006 to increase visibility of turtle conservation in the region.

STUDY AREA

The Western Indian Ocean region includes the western part of the Indian Ocean and the Red Sea, Persian Gulf and Arabian Sea (FAO fishing area 51). Twenty-four countries border this region: Bahrain, Comoros, Djibouti, Eritrea, Egypt, India (west coast), Iran, Iraq, Kenya, Kuwait, Madagascar, Maldives, Mauritius, Mozambique, Oman, Pakistan, Qatar, Saudi Arabia, Somalia, South Africa (east coast), Sudan, Tanzania, United Arab Emirates, and Yemen. In addition, several French overseas territories are located in this region: Reunion Island, Mayotte, Tromelin, Europa, Bassas da India, and Juan de Nova.

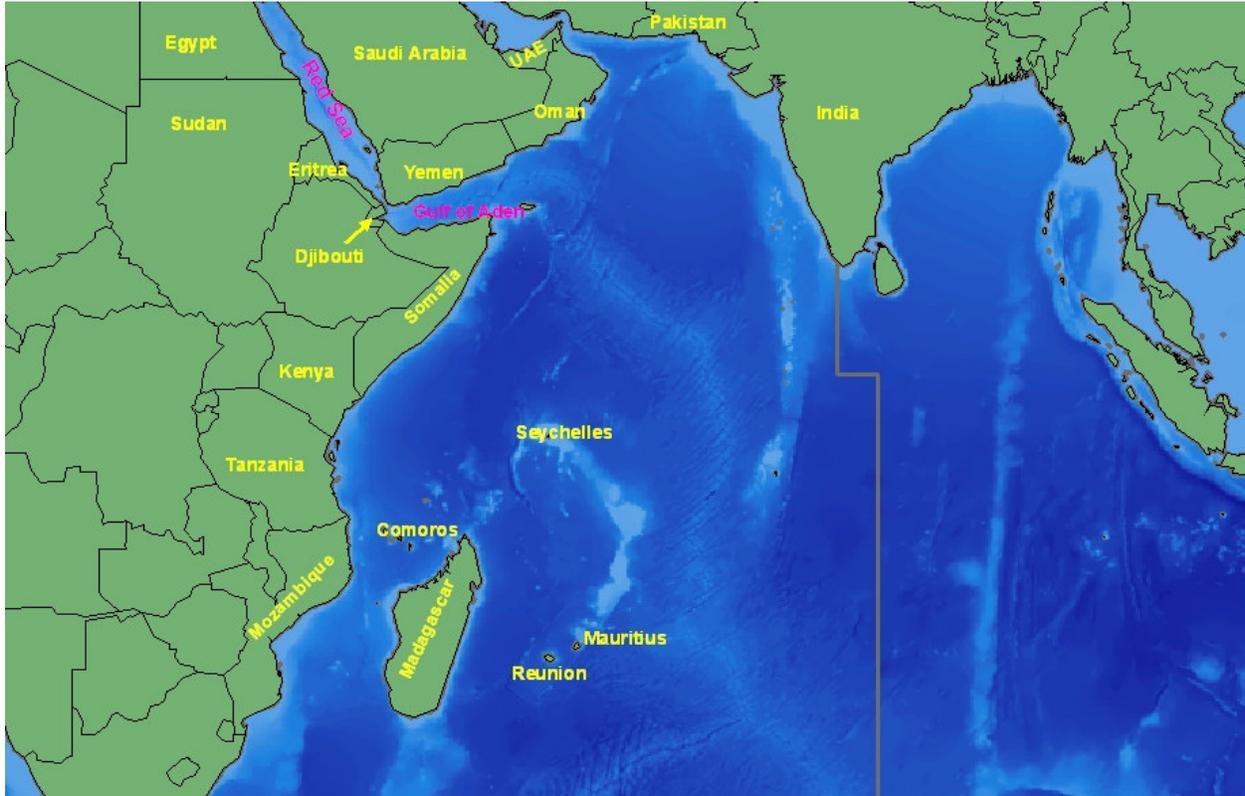


Figure 1. Map of Western Indian Ocean Region. The bold line is the demarcation of the eastern boundary of the region.

HABITAT

The Western Indian Ocean region encompasses a range of oceanographic features that influence fisheries and likely drive patterns of marine mammal, sea turtle and seabird distribution, although far less is known about the latter. The currents off the eastern coast of Africa are driven by monsoon, and thus there is distinct seasonality in the oceanography of this region. In general, there is a clockwise current through the Western Indian Ocean; the Southern Equatorial Current flows westward until it reaches the Tanzanian coast and then turns northward into the East-Africa Coastal Current and southward into the Mozambique Current. It continues northward to Somalia as the Somali Current; however, during the northern monsoon season (November – April), the northern part of the current is reversed and forms the Somali Counter Current (McClanahan 1988). These currents, along with strong offshore winds, lead to upwelling off the Somali coast during the northern monsoon season. Thus, the Somalia coast has greater surface productivity, whereas the southern portions of the region have greater benthic productivity (McClanahan 1988). The northward flow of the Somali current during the northern monsoon season is stopped by the outflow of the Gulf of Aden. The Arabian Sea and Gulf of Oman have year-round upwelling that supports high productivity.

The southern portion of the region is dominated by the Agulhas Current, which runs south and is a combination of the Mozambique Current (between Madagascar and the east coast of Africa) and the Madagascar Current (along the east coast of Madagascar). The Agulhas Current appears to be less productive than the Somali current (WCMC 1996). In addition, this area has several islands and archipelagos (e.g., Comoros, Seychelles, Madagascar) that have more oceanic characteristics (FAO 1997).

SEABIRDS, MARINE MAMMALS, AND SEA TURTLES

A complete list of seabirds, marine mammals, and sea turtles found in the Western Indian Ocean region can be found in Table 1. The marine mammals present include the dugong and several species of cetaceans; there are no pinnipeds in this region. The IUCN Red List classification may not be appropriate as a guide to conservation status here, because we have virtually no information on the status of many populations in the region. For example, dugongs (*Dugong dugon*) are critically endangered in many areas of the Western Indian Ocean (WWF EAME 2004), but are listed as vulnerable on the IUCN Red List.

Table 1. Seabird (B), marine mammal (M), and sea turtle (T) species that occur in the Western Indian Ocean region, including species and common names, as well as IUCN Red List status (CR=critically endangered, EN=endangered, VU=vulnerable, NT=near threatened, LC=least concern, DD=data deficient)..

Taxa	Species	Common Name	IUCN status
m	<i>Balaenoptera borealis</i>	sei whale	EN
m	<i>Balaenoptera edeni</i>	Bryde's whale	DD
m	<i>Balaenoptera musculus</i>	Blue whale	EN
m	<i>Balaenoptera physalus</i>	Fin whale	EN
m	<i>Berardius arnuxii</i>	Arnoux's beaked whale	LR
m	<i>Carporea marginata</i>	pygmy right whale	LR
m	<i>Delphinus capensis</i>	long-beaked common dolphin	LR
m	<i>Delphinus delphis</i>	short-beaked common dolphin	LR
m	<i>Dugong dugon</i>	Dugong	VU ^a
m	<i>Eubalaena australis</i>	southern right whale	LR
m	<i>Feresa attenuata</i>	pygmy killer whale	DD
m	<i>Globicephala macrorhynchus</i>	short-finned pilot whale	LR
m	<i>Globicephala melas</i>	long-finned pilot whale	LR
m	<i>Grampus griseus</i>	Risso's dolphin	DD
m	<i>Hyperoodon planifrons</i>	southern bottlenose whale	LR
m	<i>Indopacetus pacificus</i>	longman's beaked whale	DD
m	<i>Kogia breviceps</i>	pygmy sperm whale	LR
m	<i>Kogia sima</i>	dwarf sperm whale	LR
m	<i>Lagenodelphis hosei</i>	Fraser's dolphin	DD
m	<i>Lissodelphis peronii</i>	southern right whale dolphin	DD
m	<i>Megaptera novaengliae</i>	humpback whale	VU
m	<i>Mesoplodon densirostris</i>	Blainville's beaked whale	DD
m	<i>Mesoplodon grayi</i>	Gray's beaked whale	DD
m	<i>Mesoplodon layardii</i>	Layard's beaked whale	DD
m	<i>Neophocoena phocaenoides</i>	finless porpoise	DD
m	<i>Orcinus orca</i>	killer whale	LR

Taxa	Species	Common Name	IUCN status
m	<i>Peponocephala electra</i>	melon-headed whale	LR
m	<i>Physeter macrocephalus</i>	sperm whale	VU
m	<i>Pseudorca crassidens</i>	false killer whale	LR
m	<i>Sousa chinensis</i>	indo-pacific humpbacked dolphin	DD
m	<i>Stenella attenuata</i>	panropical spotted dolphin	LR
m	<i>Stenella coeruleoalba</i>	striped dolphin	LR
m	<i>Stenella longirostris</i>	spinner dolphin	LR
m	<i>Steno bredanensis</i>	rough-toothed dolphin	DD
m	<i>Tursiops aduncus</i>	Indo-pacific bottlenose dolphin	DD
m	<i>Tursiops truncatus</i>	bottlenose dolphin	DD
m	<i>Ziphius cavirostris</i>	Cuvier's beaked whale	DD
s	<i>Anous stolidus</i>	Brown Noddy	LC
s	<i>Bulweria fallax</i>	Jouanin's petrel	NT
s	<i>Diomedea amsterdamensis</i>	Amsterdam albatross	CR
s	<i>Diomedea dabenea</i>	Tristan albatross	EN
s	<i>Diomedea exulans</i>	wandering albatross	VU
s	<i>Larus hemprichii</i>	Sooty gull	LC
s	<i>Larus leucophthalmus</i>	White-eyed gull	NT
s	<i>Macronectes giganteus</i>	southern giant petrel	VU
s	<i>Morus capensis</i>	Cape gannet	VU
s	<i>Phaeton aetherus indicus</i>	Red-billed Tropicbird	LC
s	<i>Phalacrocorax nigrogularis</i>	socotra cormorant	VU
s	<i>Phoboetria fusca</i>	sooty albatross	EN
s	<i>Phoboetria palpebrata</i>	light-mantled albatross	NT
s	<i>Procellaria aequinoctialis</i>	white-chinned petrel	VU
s	<i>Pseudobulweria aterrima</i>	mascarene black petrel	CR
s	<i>Pterodroma barau</i>	Barau's petrel	EN
s	<i>Puffinus persicus</i>	Persian shearwater	
s	<i>Spheniscus demersus</i>	african penguin	VU
s	<i>Sterna albifrons albifrons</i>	Little Tern	LC
s	<i>Sterna anaethetus</i>	Bridled Tern	LC
s	<i>Sterna bengalensis</i>	Lesser-crested Tern	LC
s	<i>Sterna bergii velox</i>	Swift tern	LC
s	<i>Sterna caspia</i>	Caspian tern	LC
s	<i>Sterna fuscata</i>	Sooty tern	LC
s	<i>Sterna repressa</i>	White-cheeked tern	LC
s	<i>Sterna saundersi</i>	Saunders's Little Tern	LC
s	<i>Sula dactylatra</i>	Masked booby	LC
s	<i>Sula leucogaster plotus</i>	Brown booby	LC
s	<i>Thalassarche carteri</i>	Indian yellow-nosed albatross	EN
s	<i>Thalassarche chrysostoma</i>	grey-headed albatross	VU
s	<i>Thalassarche melanophrys</i>	black-browed albatross	EN
s	<i>Thalassarche salvini</i>	Salvin's albatross	VU
t	<i>Caretta caretta</i>	Loggerhead turtle	EN
t	<i>Chelonia mydas</i>	Green turtle	EN
t	<i>Dermochelys coriacea</i>	leatherback turtle	CR
t	<i>Ertemochelys imbricata</i>	hawksbill turtle	CR
t	<i>Lepidochelys olivacea</i>	Olive ridley turtle	EN

^a In this region, this classification does not apply, because dugongs are known to be highly endangered or even extinct in some areas (WWF EAME 2004).

The most comprehensive information available at the regional scale exists for dugongs. An assessment of dugongs was conducted in the southern portion of the Western Indian Ocean region in 2004 (WWF-EAME 2004). Dugongs exist as tiny (often less than 10 animals), relict populations in Kenya, Madagascar, Tanzania, Seychelles, and the Comoros Archipelago (Comoros and Mayotte). In addition, a population estimated at approximately 100 exists in the Bazaruto Archipelago of Mozambique (WWF-EAME 2004). Kiszka and Muir (2007) speculated that there also may be a population in the waters of northwest Madagascar, but this area has not yet been surveyed.

At the national level, there are a few reports on the status of other marine mammals and sea turtles (Amir *et al.* 2002; Muir 2005; Kiszka *et al.* 2006).

Two species of seabirds are endemic to the Western Indian Ocean (excluding the Persian Gulf, Red Sea, and Gulf of Aden): Mascarene black petrels (*Pseudobulweria aterrima*) and Barau's petrel (*Pterodroma barau*). The Mascarene black petrel is only known from a few specimens found in the 1970s and some possibly seen at sea in the 1980s and is listed as critically endangered on the IUCN Red List. Barau's petrel nests almost exclusively on Reunion Island, but is a highly pelagic species and is listed as endangered on the IUCN Red List. Neither species is known to be captured in fishing operations (IUCN 2007). Jaquemet *et al.* (2004) reported the distribution of the more abundant seabirds around Reunion Island (i.e., Brown noddy, Audubon's shearwater, Lesser noddy, White-tailed tropicbird, Wedge-tailed shearwater, sooty tern, and Barau's petrel) and noted that their distribution was associated with bathymetry and distance to shore. Four species and three subspecies of seabirds are endemic to the Red Sea and Gulf of Aden: Jouanin's petrel (*Bulweria fallax*), Socotra cormorant (*Phalacrocorax nigrogularis*), sooty gull (*Larus hemprichii*), white-eyed gull (*Larus leucoptalmus*), Red-billed Tropicbird subspecies (*Phaeton aethereus indicus*), Masked booby subspecies (*Sula dactylatra melanops*), and swift tern subspecies (*Sterna bergii velox*, PERSGA/GEF 2003). A recent report on seabirds in the Red Sea and Gulf of Aden reported that most studies on seabirds are 1 to 2 decades old and need to be updated; however, this report does review all estimates of breeding pairs in the region (PERSGA/GEF 2003).

FISHERIES

Characterizing fisheries in this region is difficult, because the majority of vessels are artisanal and employ small boats or pirogues; some gear is also deployed directly from shore. Fishermen use several different gear types (e.g., spearguns, handlines, gillnets, trawls, seine nets, etc.) and do not always focus on a particular "target" species.

There is one regional fishery management organization in this region – the Indian Ocean Tuna Commission (IOTC). The fisheries managed by the IOTC include pelagic longlines, purse seines, and artisanal gillnets. The IOTC has an observer program, but reports of bycatch were initiated only recently and to date are limited to fishes and sharks. The IOTC recently encouraged member states to report bycatch of seabirds, sea turtles, and other species (IOTC 2006). In 2007, the IOTC sponsored a workshop on depredation of tuna catches in the pelagic longline fishery.

Most fishing on mainland Africa takes place in the southern monsoon season (i.e., December to May), because the sea conditions are often too rough in the northern monsoon season. However, fishing on the oceanic islands (Mayotte, Mauritius, Seychelles) is year-round (Kiszka and Muir 2007).

Total marine fish landings in the WIO region were 371,000 tons in 2005, which accounts for less than 1% of the world's fish landings (data obtained from <http://www.fao.org/fi/website/FIRetrieveAction.do?dom=topic&fid=16140>). However, many landings may be unreported in subsistence fisheries (WCMC 1996). Figure 2 reports marine fisheries production and number of people fishing in several countries in the Western Indian Ocean region.

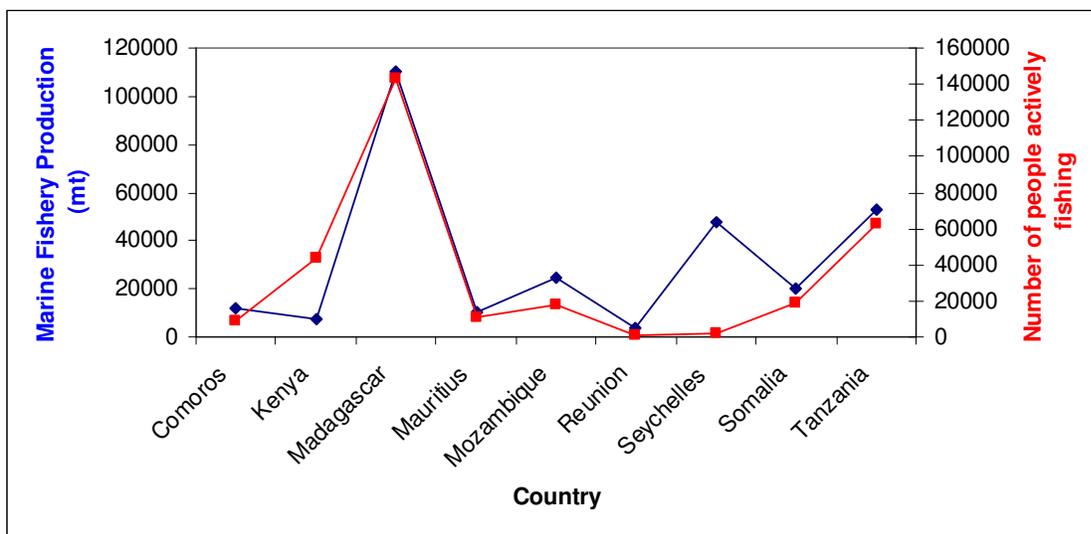


Figure 2. Marine fisheries production and number of people fishing in the southern Western Indian Ocean. Data from Walmsley *et al.* 2006. Marine fishery production is for 2001; number of people actively fishing years: Comoros and Kenya 1994; Mozambique, Reunion, Somalia, and South Africa 1990; others 1996.

Artisanal Fisheries

See above for difficulties in characterizing artisanal fisheries.

Prawn Trawl

Kiszka and Muir (2007) reported that Kenya, Madagascar, Mozambique, and Tanzania have prawn trawl fisheries. However, these are relatively small fleets (e.g., 10 and 26 vessels in Kenya and Madagascar, respectively).

Industrial Longline

Longlines are used in the Indian Ocean mainly to catch swordfish (*Xiphias gladius*) and tuna. These are mostly industrial vessels regulated by the IOTC. The overlap of albatrosses and petrels with the longline fishery are cause for concern. However, this overlap mostly takes place south of the Western Indian Ocean (see the Southern Oceans regional summary for more information; Tuck *et al.* 2003).

BYCATCH OF SEABIRDS, MARINE MAMMALS, AND SEA TURTLES

Without basic population information (abundance, population structure, rate of increase), and in the absence of bycatch rates, the impact of fisheries bycatch on these species is difficult to determine. It is important to note that for most of the countries in this region, “bycatch” does not exist; fishermen utilize whatever they catch and, in some cases, these species are targeted as catch. Available rates, estimates, and counts of bycatch for this region are presented in Table 2.

Table 2. Bycatch rates and estimates of bycatch for marine mammals, seabirds, and sea turtles reported in the WIO.

Country	Taxa	Fishery	Estimate/Rate	Reference
Eritrea	Sea turtles	Shrimp/fish trawls	3342/11 years ^a	Teclेमariam <i>et al.</i> 2007
Kenya	Sea turtles	Prawn trawl	3/trawl day	Mueni & Mwangi (2002) ^b
Kenya	Sea turtles	Prawn trawl	500-1000/yr ^c	Wamukoya & Mbendo (1995) ^b
Kenya	Sea turtles	various	1422 (1998-2004) ^d	Zanre (2005)
Madagascar	Sea turtles	Prawn trawl	2 in 2005 ^c	Bourjea <i>et al.</i> (2007)
Madagascar	dolphins	Gillnets longlines	4/zone/yr ^f 1/zone/yr	Razafindrakoto <i>et al.</i> (2007)
Madagascar	Sea turtles	Gillnets	508-541/month ^g	Walker & Roberts (2005)
Madagascar	dolphins	gillnet	6500 ^h	Andrianarivelo (2001)
Mozambique	Green sea turtles	Gillnets and beach seines	30-35/month	see Bourjea <i>et al.</i> (2007)
Mozambique (Sofala Bank)	Sea turtles	Industrial Shrimp trawl Semi-industrial shrimp trawl	1305-3672/yr 627-1764/yr	Gove <i>et al.</i> (2001)
Mozambique (Bazaruto Bay)	C. caretta C. mydas	Beach-seine	.0267/seine .168/seine	Guissamulo & Chacate (2007)
Seychelles	Sea turtles	longline	.004 turtles/1000 hooks (30 longliners)	Miossec & Bourjea (2003) ⁱ
Spain (SW Indian Ocean)	Sea turtles	longline	25/531,916 hooks	Azir <i>et al.</i> (2006)
Spain (SW IO)	Marine mammals (unidentified)	longline	3/531,916 hooks	Azir <i>et al.</i> (2006)
Spain (SW IO)	Seabirds (unidentified)	longline	3/531,916 hooks	Azir <i>et al.</i> (2006)
Tanzania (Zanzibar)	dolphins	gillnet	93/year ^j	Amir <i>et al.</i> (2002)
Tanzania (Zanzibar)	dolphins	gillnet	143/3 years ^k	Amir <i>et al.</i> (2005a)
Zanzibar (Tanzania)	Sea turtles (green and hawksbill)	gillnet	6-10/month	Bourjea <i>et al.</i> (2007)

^a 690 were reported dead; 2462 released alive

^b cited in Okemwa *et al.* (2004)

^c When TEDs not in use; TEDs are now mandatory under Kenyan law (Bourjea *et al.* 2007)

^d Turtles were released alive through Watamu’s bycatch release program. Not all fishermen participated in the program; therefore, this is merely a count of those that participated, not a bycatch estimate.

^c 2004: 120 turtles; but, TED use now mandatory, resulting in only 2 sea turtles caught in 2005

^f Razafindrakoto *et al.* (2007) broke the study area (southwest Madagascar) into 3 zones.

^g from 7 villages in southwest Madagascar

^h 6500 dolphins caught between 1984 and 1999 in 3 villages; but most of these were caught in a drive fishery targeted at dolphins.

ⁱ cited in Bourjea *et al.* (2007)

^j 93 dolphins (*Tursiops aduncus*, *Stenella longirostris*, and *Sousa chinensis*) were estimated caught in 1999

^k 143 dolphins (Indo-pacific bottlenose dolphin, spinner dolphin, Risso's dolphin, Indo-pacific humpback dolphin, Pan-tropical spotted dolphin, and bottlenose dolphin) were collected; this number is not an estimate, rather a count of collected specimens. Dolphins were collected from driftnet and bottom set gillnet fishermen.

Little information is available on bycatch in the Red Sea and Gulf of Aden (countries: Djibouti, Egypt, Jordan, Saudi Arabia, Somalia, Sudan, Yemen). However, Pilcher and Alsuhaibany (2000) reported “large amounts of by-catch, including turtles, dolphins and finfish are killed.” In addition, Moqbil (2007) reported that shore sardine nets, trawlers, and other fishing gears are a threat to sea turtles in Yemen. He reported, “As a result of these fishing activities, we observed some turtles tied with ropes, some bleeding, with cut appendages, smashed heads, etc.” Aspinall and Baldwin (1999) speculated that the finless porpoise (*Neophocaena phocaenoides*) was rare in the Arabian Gulf due in part to bycatch in fisheries (gillnets, beach seines, and commercial trawls; Jefferson and Curry 1994 and Baldwin *et al.* 1999 cited in Collins *et al.* 2005), based on evidence from beach strandings and one caught in a gillnet in March 1998. In addition, Collins *et al.* (2005) speculated that finless porpoises were likely subject to bycatch in wide-mesh set gillnets set to capture dugongs in the Arabian Gulf. Marsh *et al.* (2001) reported bycatch of dugongs in gillnet fisheries in the Arabian Gulf; however, no bycatch estimates or rates are available, and the only evidence of bycatch came from stranded individuals exhibiting line marks. PERSGA/GEF (2003) did not cite fisheries bycatch as a source of mortality for seabirds, but suggested it may be a concern.

All sea turtle species, dugongs, and several cetacean species, especially Indo-Pacific humpback and bottlenose dolphins, are taken as bycatch in artisanal fisheries (deBoer *et al.* 2002; see Table 2 for full citation list) in the Western Indian Ocean region. In Tanzania, sea turtles are caught in gillnets and prawn trawls. Recent estimates in one state of Tanzania indicate as many as 1,000-2,000 sea turtles are taken as bycatch in the artisanal gillnet fishery. In another state, researchers estimated 2-5 turtles are caught per day in gillnets (Muir 2005). However, to date no rigorous estimates of total bycatch of sea turtles in prawn trawls exists in Tanzania. Project GloBAL's rapid assessment in this area should provide the first quantitative estimates.

Artisanal Fisheries

Artisanal fisheries in this region encompass a diverse range of gear types, including gillnets, trawls, beach seines, hook-and-line, and spear-guns. Similar to findings in other regions, artisanal vessels are believed to lead to high levels of bycatch; in addition, Kiszka and Muir (2007) highlighted the need to investigate bycatch in artisanal gillnets in this region.

As part of an ongoing assessment in the Comoros, Poonian *et al.* (RBA report) found that hook and line fisheries were the dominant fishing method and were responsible for most of the bycatch of both sea turtles and marine mammals in this country. Around Mayotte, hook and line fisheries are known to catch hawksbill turtles. High rates of dorsal fin disfigurements in Indo-

Pacific bottlenose dolphins have been observed in Mayotte, and hand lines are the suspected cause (J. Kiszka, pers. comm.).

Sea turtle bycatch in a subsistence gillnet fishery in Madagascar was estimated as 300 turtles per month (mostly green) in one village alone (Walker and Roberts 2005). Also in Madagascar, Andrianarivelo (2001) conducted surveys and direct observations and estimated that 6,500 dolphins (*Stenella longirostris*, *Sousa chinensis*, and *Tursiops truncatus*) were killed in three villages over 15 years. However, most of these were taken in a drive fishery that was targeting dolphins.

Sea turtles and marine mammals are also caught in medium to large mesh gillnets (> 5 inch mesh; *jarifa/jarife*), usually set for sharks, in all places where this fishery has been examined (Tanzania RBA, Walker and Roberts 2005). Substantial data gaps remain, but the observations of bycatch reported here are likely to be typical of the region as a whole and it is likely that these gear types are responsible for similar levels of bycatch in other countries. Clearly, however, more quantitative information is needed on bycatch and effort for all artisanal fisheries in this region.

Prawn Trawl

Kiszka and Muir (2007) reported that there was a bycatch of sea turtles (Green and hawksbill) in the prawn trawl fisheries of Kenya, Madagascar, Mozambique, and Tanzania; the only known recorded bycatch rates and estimates for these fisheries are listed in Table 2. A rapid bycatch assessment and observer program is currently being conducted in Tanzania to assess bycatch in the prawn trawl fishery (C. Muir and B. Ngatunga, pers. comm.).

Industrial Tuna Longline

There are some reports of seabird bycatch in tuna longline fisheries in the southern Indian Ocean; however, it is likely these fall outside the WIO (see Southern Oceans regional summary; Tuck *et al.* 2003). One recent report tested circle hooks to reduce sea turtle bycatch in longlines, but no reports are available prior to this mitigation study (Azir *et al.* 2006). Azir *et al.* (2006) also reported 3 unidentified marine mammals and 3 unidentified seabirds caught during the experiment, but those animals were released alive; few other reports exist. Bycatch of Risso's dolphins (*Grampus griseus*) and short-finned pilot whales (*Globicephala macrorhynchus*) has been reported off Reunion Island (J. Bourjea, pers. comm.).

BYCATCH MITIGATION

As little is known regarding bycatch in this region, there has been limited action to mitigate bycatch.

Ariz *et al.* (2006) tested circle hooks on two Spanish longline vessels in the southwest Indian Ocean. However, due to a small sample size, they were unable to make any definitive conclusions regarding bycatch mitigation in longlines.

Turtle excluder devices (TEDs) on shrimp/prawn trawl nets are required in Madagascar, Mozambique (Kiszka and Muir 2007), and Kenya (Bourjea *et al.* 2007), but there are no data on compliance or effectiveness.

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