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# Incidental catch of marine mammals in the southwest Indian Ocean: a preliminary review

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## ABSTRACT

Incidental catch in fishing gears is a serious threat to marine megafauna (sea turtles, sharks and marine mammals) at the global scale. In order to manage this threat, it is critical to assess its extent, both spatially and quantitatively. In the southwest Indian Ocean (from 0 to 25°S, from eastern Africa to 60°E), there is a paucity of information on marine mammal bycatch. This report reviews the marine mammal bycatch issue in this region in the following countries: Mozambique, Tanzania (including Zanzibar), Kenya, the Seychelles, the Comoros, Mayotte, Madagascar, Reunion Island and Mauritius. For each country, status of marine mammals, fishing effort, bycatch information and mitigation measures are reviewed. It appears that quantitative information (number of bycaught animals per species, impact on local populations) is limited (except for Zanzibar). However, it is clear that several fisheries incidentally catch marine mammals in the region, most notably gillnets catching dugong (*Dugong dugon*) and coastal dolphins (*Tursiops aduncus* and *Sousa chinensis*), in Zanzibar, southwest Madagascar and probably Kenya. Mitigation measures are limited, particularly efforts to reduce the use of these gears. It is now critical to quantify the extent of bycatch in gillnets and its impact on local marine mammal populations and to implement relevant and effective mitigation measures as necessary.

**Keywords:** bycatch; *Tursiops aduncus*; *Sousa chinensis*; *Megaptera novaeangliae*; southwest Indian Ocean; gillnets; longline; handline.

## INTRODUCTION

One of the most important requirements of the United Nations Convention on the Law of the Sea of 1982, which determines strategies of exploitation of marine living resources (Article 119, b), is to take into account the impact of fisheries on “species associated with, or dependent upon, harvested species with a view to maintaining or restoring populations of such associated or dependent species above levels at which their reproduction may become seriously threatened” (United Nations, 1983). The FAO Code of Conduct for Responsible Fisheries (CCRF) calls for the catch of non-targeted species to be minimized and promotes the conservation of biodiversity by minimizing fisheries impacts on non-targeted species and the ecosystem in general. Bycatch is defined by FAO as “part of a fishing unit taken incidentally, in addition to the targeted species towards which fishing effort is directed”.

Bycatch of non-targeted species in fishing gears is known to occur throughout the southwest Indian Ocean (SWIO) region (Figure 1), both in coastal and pelagic ecosystems (see for example Amir *et al.*, 2002; [Romanov](#),

2001). However, few studies have been conducted on bycatch in any of the major fisheries including long-line, purse seine, prawn trawl and gillnet fisheries, and information is mostly qualitative and not quantified. Furthermore, few mitigation measures have been implemented in the region. A dedicated study has been conducted in Zanzibar to determine the level of dolphin mortality in the gillnet fishery (Amir *et al.*, 2002). In Madagascar, interview surveys were conducted to assess the extent of cetacean bycatch in the southwest region (Razafindrakoto *et al.*, 2007). However, few additional investigations have been undertaken to assess the impact of fisheries on the survival of non-targeted species such as cetaceans and the threatened dugong (*Dugong dugon*) (Cockcroft & Krohn, 1994; Romanov, 2001; WWF EAME, 2004). The limited data available, coupled with the fact that most coastal states and territories in the WIO region are presently under-developed with poor infrastructure and limited facilities, creates a major challenge for research and management.

During the Western Indian Ocean Marine Science Association (WIOMSA) Scientific Symposium held in Mauritius in August 2005, a meeting was convened involving 16 participants working on marine mammals and sea turtles in the region. A topic of mutual concern in these taxonomic groups was the issue of fisheries bycatch and ways to mitigate this threat. In view of the limited data available on fishery-related mortality, the group resolved to establish an informal SWIO discussion group and developed a proposal to hold a regional workshop on the problem of bycatch and mitigation measures. Such an event would also be a valuable opportunity for marine mammal and turtle researchers to share ideas and to develop new partnerships and regional projects related to their field, a need clearly identified by dugong researchers in recent years (WWF EAME, 2004). The resulting regional workshop on *Incidental catches of non-targeted species in the western Indian Ocean: problems & mitigation measures*, which was held in Mayotte (France) from 13 – 15 November 2006, aimed to review the level of threat from fisheries, both coastal and pelagic, in the southwest Indian Ocean, as well as to discuss common issues and data related to bycatch within the region (Kiszka & Muir, 2007). This report presents an overview of fisheries, marine mammal bycatch and mitigation measures in the southwest Indian Ocean, based on the data gathered during the workshop and provided by participants (unpublished data) and the available literature (grey and published).

## FISHERIES AND MARINE MAMMAL BYCATCH IN THE SW INDIAN OCEAN

### Union of the Comoros

#### *Marine mammal diversity and status*

The status of marine mammals is poorly known in the Union of the Comoros. Fourteen species have been recorded around the three islands (Anjouan, Mohéli and Grande Comore), including migrating humpback whales (*Megaptera novaeangliae*) during austral winter (July-October) and the dugong (WWF EAME, 2004; Kiszka *et al.*, 2006). The commonest species around the archipelago are spinner (*Stenella longirostris*), pantropical spotted (*Stenella attenuata*) and Indo-Pacific bottlenose dolphins (*Tursiops aduncus*). Other oceanic species also occur, such as Longman's beaked whales (*Mesoplodon pacificus*) and short-finned pilot whales (*Globicephala macrorhynchus*) (Anderson *et al.*, 2006; Kiszka *et al.*, 2006). The dugong predominantly occurs south of the island of Mohéli (Marine Park; Davis & Poonian, 2007). Sperm whales (*Physeter macrocephalus*) also regularly occur, especially during late austral summer and were caught by American whalers in the vicinity of the Comoros during the 19<sup>th</sup> Century (Wray & Martin, 1983).

#### *Fisheries*

Fishing in the Comoros is entirely artisanal and catches are generally destined for local consumption. Fishing gears include beach seines, fish traps, gill nets, lines (including trolling, longlines and droplines) and purse seines; two types of boat are commonly used: *galawa* (traditional canoe) and *vedette* (motorized boat) (UNEP 2002). Lines targeting pelagic fish are by far the most common gear used in the Union of the Comoros (Poonian *et al.* in review). Shark gillnets of up to 270m long and 2m wide with a mesh size of 30cm have also been reported (*Ministère de l'Agriculture et de la Pêche*, 1995). Fishing activity in the Comoros is seasonal and seasons vary for each island: on Grande Comore, peak production occurs during Kashkazi (November-March) and on Mohéli at the beginning of Kashkazi; seasonality is more complex on Anjouan because of the island's shape: during Kusi (May – August), production peaks on the north-west coast but is poor on the east coast, but the situation is reversed during Kashkazi (Abdoulhalik 1998). The most recent surveys of artisanal fishers in the Comoros reported 3,403 *galawas* and 924 *vedettes* (Abdoulhalik 1998), and approximately 8,500 fishers (*Union des Comores*, 2005).

#### *Marine mammal bycatch*

Cetacean species reported as bycatch in the Union of the Comoros include (from most to least common): spinner dolphin, Indian Ocean bottlenose dolphin, humpback dolphin (*Sousa chinensis*) and Risso's dolphin (*Grampus*

*griseus*). Dolphins caught accidentally are generally released, since they have no value as food; however, some fishers kill them because they perceive them as a threat to fish stocks (mortality of cetaceans caught accidentally estimated at 11% on Grande Comore and 25% on Mohéli; Poonian *et al.* in review). Bycatch of dugong has been recorded in gillnets around the island of Mohéli, including inside the Marine Park and since its creation. Dugong captures were commonest in the 1970s and 80s, suggesting that the species has declined significantly in the recent years, as in other areas in eastern Africa (Davis & Poonian, 2007; WWF EAME, 2004).

#### *Mitigation measures*

A number of legal restrictions have been put in place, prohibiting destructive fishing techniques (dynamite, poison) and capture of endangered species, but the enforcement of these restrictions has proved ineffective to date (UNEP 2002). There has been an official ban on gillnets in Mohéli Marine Park since 2001 (Gabrie, 2003) and informal bans in other areas, such as the Coelacanth Park on Grande Comore, enforced by local village associations and fishing syndicates. These restrictions on gillnets have been in place for some time, in certain communities since at least 1995 (*Ministère de l'Agriculture et de la Pêche*, 1995). However, the ban on gillnet fishing in Mohéli Marine Park has been poorly received by local fishing communities; fishers were not provided with viable alternative livelihoods to compensate their loss of income from gillnetting and the ban has proved logistically difficult and costly to enforce in the absence of sustainable funding mechanisms for the Marine Park (Hauzer *et al.*, in press).

### **Mayotte (France)**

#### *Marine mammal diversity and status*

The island of Mayotte is characterized by the presence of a large closed lagoon (around 1,100 km<sup>2</sup>), and a very steep slope close to the barrier reef. More than twenty species of marine mammals have been recorded around Mayotte, including humpback whales during austral summer, the blue whale (*Balaenoptera musculus*), the dugong, at least 12 species of dolphins (including *S. chinensis*, *S. longirostris*, *S. attenuata*, *Lagenodelphis hosei*, *T. aduncus*, *T. truncatus*, *Peponocephala electra*, *Feresa attenuata*, *Pseudorca crassidens*, *G. griseus*, *Orcinus orca*, *G. macrorhynchus*), beaked whales (including *Mesoplodon densirostris*, *M. pacificus* and possibly *Mesoplodon ginkgodens*) and sperm whales (*P. macrocephalus*, *Kogia sima*, *Kogia breviceps*) (Kiszka *et al.*, 2007). The commonest species are the spinner dolphin, the pantropical spotted dolphin, the Indo-Pacific bottlenose dolphin and the melon-headed whale, which are also as resident throughout the year (Kiszka *et al.*, 2007). Short-finned pilot whales also show some evidence of residency (Kiszka, submitted).

#### *Fisheries*

The fisheries around Mayotte are artisanal and poorly developed. The most important fishery is the hand line, targeting reef fishes, especially predatory demersal species such as groupers and snappers. In 2006, 1,092 small boats (including pirogues and small barks less than 7m long) have been censused by the local fishing service (*Direction des Affaires Maritimes de Mayotte*, unpublished data). Other fishing techniques include small seines deployed on barrier and fringing reefs (less than 20 barks). Three long liners are based in Mayotte and fish in the territorial waters, targeting the swordfish (*Xiphias gladius*) and tunas, and deploying between 400 and 700 hooks each.

#### *Marine mammal bycatch*

Dugong bycatch and deliberate hunting has been recorded around Mayotte, but has declined in recent decades due to the reduction in numbers of dugong (Kiszka *et al.*, 2007a). Incidental catches in seine nets are probably very rare. During a recent interview survey (406 fishers interviewed, 2007), only 10 fishers declared that they had caught a cetacean (dolphins). They were captured both during day and night. 80% of the animals were released alive. Species involved were probably Indo-Pacific bottlenose, spinner and spotted dolphins. Four dolphins were caught by a net, three by a hand line and three by a longline (Pusineri & Quillard, submitted). The bycatch of cetaceans can be considered as marginal. Clear signs of interactions between Indo-Pacific bottlenose dolphins and short-finned pilot whales), and hand line and longline fisheries, respectively have been observed around the island of Mayotte (Kiszka, submitted). Short-finned pilot whales, melon-headed whales and spinner dolphins have been bycaught in the longline fishery, but in very limited numbers (less than 1 every 5 years). Spinner dolphin bycatch is probably linked to bait attraction (squid). Remains of gillnets have also been observed on humpback whales migrating to Mayotte on several occasions. No mortalities have been observed to date.

#### *Mitigation measures*

The use of seine nets is controlled (not allowed on seagrasses and live reefs) and the existence of several marine reserves and parks limits the extent of fisheries. Nets are not allowed in any of the two existing marine protected

areas (MPAs), and hand lining is prohibited in one of them. There are no mitigation measures in force for the longline fishery.

## Kenya

### *Marine mammal diversity and status*

There is limited information on the status of marine mammals off Kenya. The sperm whale, humpback whale, Bryde's whale (*Balaenoptera edeni*), minke whale (*B. acutorostrata*), killer whale (*Orcinus orca*), melon-headed whale, bottlenose dolphin (*Tursiops* sp.), common dolphin (*Delphinus* sp.), humpback dolphin (*Sousa chinensis*), spinner dolphin, spotted dolphin, Fraser's dolphin, Risso's dolphin and the striped dolphin (*Stenella coeruleoalba*) have been recorded (Wamukoya *et al.*, 1996). Indo-Pacific bottlenose and humpback dolphins seem to be resident in a number of coastal areas. The dugong occurred in large numbers off Kenya before the 60's and a large group of 500 were seen in the south of the country in 1967. This species declined significantly due to incidental captures in gillnets and hunting. Currently, dugongs still occur, but in small numbers, especially off the Tana delta area, in the Lamu archipelago and in Kiunga (WWF EAME, 2004).

### *Fisheries*

Kenyan fisheries employ a wide range of gears, including gillnets (2006: n=5,916), beach/prawn/reef seines (2006: n=970), prawn trawlers (2006: n=20) and others including long line kooks (2006: n=8,224), monofilament nets, baskets, hand lines, scoop nets and trolling lines. In 2006, 28 landing sites and 9,601 boats were recorded along the Kenyan coast (Kenya Marine & Fisheries Research Institute, unpublished data).

### *Marine mammal bycatch*

Little is known about marine mammal bycatch along the coast of Kenya. Incidental catches of dugongs have been recorded during interview surveys conducted in 2003 in 14 villages. Gears involved in bycatch were gillnets and trawls (WWF EAME, 2004). Cetacean bycatch is unknown, but they are suspected in many areas where gillnets are used, such as in Bofa, Tenewi Ziwayuu and Manda areas (Kenya Marine & Fisheries Research Institute, unpublished data). Species bycaught include Indo-pacific humpback and bottlenose dolphins.

### *Mitigation measures*

No mitigation measures have been implemented in Kenya to characterize and reduce marine mammal bycatch in fishing gears; however, fisher awareness-raising actions have been conducted by the Kenya Marine & Fisheries Research Institute.

## Madagascar

### *Marine mammal diversity and status*

A review of the diversity and status of marine mammals around Madagascar recorded 27 species (Rosenbaum, 2003). Large cetaceans include the humpback whale, the blue whale, the fin whale (*Balaenoptera physalus*), the southern right whale (*Eubalaena australis*), the pygmy right whale (*Caperea marginata*) and the sperm whale. During austral winters, a large number of humpback whales annually visit the known breeding grounds along the eastern coast, especially between Cap Sainte Marie south of Tolagnaro and Baie d'Antongil and in the south-western region (Rosenbaum *et al.*, 1997; Rosenbaum, 2003; Cerchio *et al.*, 2006). Bottlenose and humpback dolphins are the commonest species of the 20 odontocetes identified in the coastal waters of Madagascar and are mostly distributed along the west and north-east coasts (Cockcroft & Young 1998; Rosenbaum, 2003; Razafindrakoto *et al.*, 2004). Other species recorded include four beaked whale species, the pygmy and dwarf sperm whales as well as 10 delphinids (Rosenbaum, 2003). The dugong is known to occur in Madagascar but its status remains unclear (WWF EAME, 2004). Two species of pinniped: the crabeater seal, *Lobodon carcinophagus* and the subantarctic fur seal (*Arctocephalus tropicalis*) have been reported stranded on the shores of Madagascar (Rosenbaum, 2003; Garrigue & Ross, 1996).

### *Fisheries*

Fisheries constitute the main source of income for coastal communities and of foreign currencies for Madagascar's economy. Three types of fisheries exist in Madagascar's waters according to the power of the engines used to motorize ships or boats: commercial fishery (>50HP), artisanal fishery (<50HP) and traditional fishery (non-motorized). According to the Fisheries Department, Ministry of Agriculture, Fisheries and Livestock, 80 commercial longline and trawling fishery industries exploiting tunas, swordfish, shark, and shrimps in EEZ of Madagascar were recorded in 2006; trawling occurs within 2 miles of the littoral of Madagascar offshore. The artisanal fishery targets elasmobranchs, fishes, gastropods and crustaceans within 12 miles offshore and gillnets are the principal gear used. A total of 26 artisanal fishing companies were listed in Madagascar in 2006 (DPRH, unpublished data). Traditional fisheries target a full range of exploitable resources, elasmobranchs, cephalopods, gastropods, echinoderms, turtles, marine mammals, in shallow and pelagic waters

within Madagascar's EEZ. A total of 26,000 traditional fishers were recorded by the Fisheries Department in 2006.

#### *Marine mammal bycatch*

Marine mammal bycatch has been reported to occur in commercial, artisanal and traditional fisheries in Madagascar (DPRH unpublished data), however, accurate data are lacking. A bycatch project was initiated between 2005 and 2006 to evaluate the extent of bycatch in artisanal fisheries in the south-western region of Madagascar where bycatch of Indo-Pacific humpback, bottlenose, and Fraser's dolphins had been reported (Andrianarivelo, 2001; Razafindrakoto *et al.*, 2004). Bycatch of humpback whales, Indo-Pacific humpback dolphins, spinner dolphins and bottlenose dolphins through entanglement in nets was confirmed by this study (Razafindrakoto *et al.*, submitted).

#### *Mitigation measures*

Measures to mitigate marine mammal bycatch in any type of fishery are not yet decided in Madagascar. However, the Cetacean Conservation and Research Project of the Wildlife Conservation Society has attempted to involve local communities to implement solutions to reduce threats to marine mammals, in particular hunting and bycatch in artisanal and traditional fisheries. Different suggestions from fishers, e.g. incentive programmes for the release of animals, legislative frameworks and promotion of whale and dolphin watching were discussed during a two day workshop in 2007. A follow-up meeting was held recently to create a local association to protect whales and dolphins in the south-western region of Madagascar.

### **Mozambique**

#### *Marine mammal diversity and status*

Little has been published on the status of marine mammals along the Mozambican coast. Humpback whales are known to occur in coastal waters during austral winter (Findlay *et al.*, 1994). The commonest cetacean species in inshore waters are Indo-pacific bottlenose and humpback dolphin, especially in Maputo Bay and the Bazaruto archipelago. In Maputo, humpback dolphin abundance was estimated at 105 individuals (Guissamulo & Cockcroft, 2004). Dugongs occur in Maputo and Inhambane Bays, and the largest population, considered as the single viable population in eastern Africa, is located in the Bazaruto Bay (WWF EAME, 2004). Aerial surveys conducted between 2003 and 2005 in Bazaruto provided an estimate of 235 individuals (A. Guissamulo, personal communication).

#### *Fisheries*

60% of the Mozambican population is dependant on marine resources. A wide variety of fisheries occur including a significant prawn trawl fishery, hand lining, and gillnetting (for sharks and other large pelagic fishes).

#### *Marine mammal bycatch*

Little is known of the extent of marine mammal bycatch off Mozambique. Entanglements in gillnets appears to be a major cause of dugong mortality along the whole coast. The level of this threat has increased since the early 90s alongside an increase in gillnet use (WWF EAME, 2004). Interview surveys with fishers confirmed that humpback dolphins are also bycaught in the drift gillnet fishery (Guissamulo & Cockcroft, 1997). Gillnets seem to affect small coastal cetaceans, particularly bottlenose and humpback dolphins. A marked decline in coastal dolphin populations was observed in the early 90's (Cockcroft & Krohn, 1994). Intentional captures also contribute to the decline of humpback dolphins (Guissamulo & Cockcroft, 1997).

#### *Mitigation measures*

No mitigation measures have been undertaken in Mozambique to characterize and reduce marine mammal bycatch in fishing gears.

### **Tanzania (including Zanzibar)**

#### *Marine mammal diversity and status*

At least seven species of dolphin, three species of whales and the dugong have been reported to occur in Tanzania, including Zanzibar (Unguja Islands) where most surveys on the occurrence and distribution of cetaceans have been conducted in the coastal waters. Dolphin species include Indo-Pacific bottlenose dolphins, spinner dolphins, Risso's dolphins, Indo-Pacific humpback dolphins, Pan-tropical spotted dolphins, and common bottlenose dolphins (*T. truncatus*) (Amir *et al.*, 2002, 2005). The rough-toothed dolphin has also been reported in Tanzania and Zanzibar (*Steno bredanensis*) (Berggren *et al.*, 2001). The most common species are Indo-Pacific bottlenose, spinner and humpback dolphins (Ortland, 1997; Stensland *et al.*, 1998; Amir *et al.*, 2002, 2005). Dolphins have also been recorded in the Rufiji Delta, Saadani, around Latham Island, Tanga (northern Tanzania)

and Mtwara (south Tanzania) (Linden & Lundin, 1995), although without any reference to species. Chande *et al.*, (1994) observed three species of dolphin along the coast of Tanzania mainland, *T. truncatus*, *S. longirostris* and *S. bredanensis* during a survey conducted along Mtwara, Dar es Salaam, Bagamoyo and Tanga. Sperm whales and the humpback whales are the most commonly-recorded whales (Amir & Berggren, 2001), other species include pygmy sperm whales, long-finned pilot whale (*Globicephala melas*). The dugong has been recorded as bycatch both on the Tanzanian mainland and Zanzibar (WWF EAME, 2004).

#### *Fisheries*

The marine fisheries in Tanzania are artisanal. Fishing gears used include hand lines, gillnets, shark nets, scoop nets, long lines, troll lines, cast nets, ring nets, purse seines, movable traps, fixed fences and spears. The number of fishing vessels recorded in Zanzibar was 7096 and 7,190 in the Tanzanian mainland (MNRT, 2005; Jiddawi & Khatib, 2007). The most threatening fishing gears are drift set nets for large pelagic fish and bottom set nets for demersal species. Drift nets, targeting large pelagic fish such as kingfish, swordfish, sailfish, skipjack tuna and marlin, are approximately 500–900 m in length with variable mesh sizes from 7–20 cm, while bottom-set nets, targeting sharks and rays, vary in length up to 450 m, with mesh sizes ranging from 20–40 cm. These bottom nets are typically set very close to the shore.

#### *Marine mammal bycatch*

Dolphins and whales were recorded as bycaught in gillnets at sites around Unguja Island, in the Zanzibar Channel and along the coast of northern Tanzania. Six species of dolphins were identified from a total of 187 specimens caught in drift- and bottom set gillnets. Most of the specimens (95%) were from drift gillnets. The Indo-Pacific bottlenose dolphin was the most commonly bycaught species (47%) followed by spinner dolphin, Risso's dolphin, Indo-Pacific humpback dolphin, pan-tropical spotted dolphin and common bottlenose dolphin (Berggren *et al.*, 2007). During questionnaire surveys conducted in April 2007 and February 2008 in Mtwara, where 64 fishers were interviewed, 15 (23%) of the fishers had personally caught a dolphin in their gillnet other respondents also cited gillnets as the major threat. Indo-Pacific bottlenose, spinner, humpback and Risso's dolphins were the species involved (Amir & Jiddawi, unpublished data). Indo-Pacific bottlenose dolphins were most frequently identified (by fishers) as the species caught, although spinner dolphins were also cited as being caught, particularly in offshore gillnets.

Dugong bycatch has been recorded once in 2005 around Zanzibar and five incidences have been recorded at Mafia Island along the coast of mainland Tanzania (Amir & Muir, unpublished data). Fishers also report incidental capture of humpback whales in gillnets every year, although these are generally cut free. Dead humpback whales have been found stranded on beaches, still entangled in gillnets.

#### *Mitigation measures*

So far, there are currently no mitigations for reduction of bycatch of marine mammals in Tanzania.

## **Seychelles**

#### *Marine mammal diversity and status*

The Seychelles archipelago, including the Amirantes and Aldabra, was an important whaling ground for American whalers during the 19<sup>th</sup> Century (Wray & Martin, 1983). Leatherwood *et al.* (1984) reported the presence of sperm whales (including over the Seychelles Bank, east of Bird Island), spinner dolphins and bottlenose dolphins in Seychelles waters. Cetacean sightings and related environmental features were recorded during a NOAA survey (not targeting cetaceans) in 1995 covering a wide area of the western Indian Ocean, including the Seychelles oceanic waters (Ballance & Pitman, 1998). The commonest species observed in this area were, in order of occurrence: sperm whale, spinner dolphin, striped dolphin, bottlenose dolphin and pilot whales (certainly *G. macrorhynchus*). Other species have been observed, including rough-toothed dolphins, dwarf sperm whale, pygmy sperm whale, melon-headed whale, pygmy killer whale and beaked whales (*Mesoplodon* sp.). Longman's beaked whales have been recorded on several occasions (Anderson *et al.*, 2006). Bryde's whales have been recorded offshore, west of the Seychelles (Robineau, 1991). The presence of blue whales and fin whales around the Seychelles has been suspected by this same author. The dugong occurs in small numbers at Aldabra atoll (WWF EAME, 2004).

#### *Fisheries*

Various fishing techniques are used in the Seychelles. Among them, the drift longline (8 boats in 2006) targeting swordfish and sharks, handline (groupers/snappers), beach seine (small pelagic fishes), and traps (reef fishes). The use of gillnets (formerly targeting reef sharks) has been recently prohibited in Seychelles territorial waters.

*Marine mammal bycatch*

No marine mammal bycatch have been recorded in the Seychelles. According to the Indian Ocean Tuna Commission, this problem is not significant in tuna fisheries (IOTC, 2007).

*Mitigation measures*

As bycatch extent is limited around the Seychelles, no mitigation measures are planned.

**Reunion Island***Marine mammal diversity and status*

Ten species of cetacean have been recorded around Reunion Island; including migrating humpback whales during austral summer (Dulau-Drouot *et al.*, 2008). The commonest species are the Indo-Pacific bottlenose dolphin (evidences of residency along the west coast), the spinner dolphin, the common bottlenose dolphin and the pantropical spotted dolphin. Other species occur such as the melon-headed whale, the Fraser's dolphin and the short-finned pilot whale, but they are rarer (Dulau-Drouot *et al.*, 2008). Two other species have been recorded by the *Muséum d'Histoire Naturelle* of St Denis: the Bryde's whale, observed stranded once, and the southern right whale, that has been sighted twice (S. Ribes-Beaudemoulin & P. Durville, personal communication).

*Fisheries*

Two types of fisheries are active around Reunion: the longline (offshore and pelagic) and the hand line fishery (coastal). The longline takes place on a year-round basis, and is made up of around 30 boats. The main targeted species are swordfish and tunas. Hand lines target reef fishes, especially groupers and snappers. Around 300 boats have been registered around the island (IFREMER data). Game fishing, targeting large pelagic fishes, has a very important socio-economical value in Reunion. Its extent is unknown.

*Marine mammal bycatch*

The bycatch problem is known to be very marginal around Reunion. Bycatch has been mainly recorded in the longline, and game fishery. Risso's dolphins and short-finned pilot whales are known to have been caught in pelagic longline, but on a few occasions (J. Bourjea/IFREMER, personal communication). Spinner dolphins are occasionally entangled in game fishing lines. Capture of Indo-Pacific bottlenose dolphin in beach-seine nets is also reported, although this is a rare event. Hook injuries and dorsal fin disfigurements due to fishing lines have been recorded in spinner, Indo-Pacific bottlenose and common bottlenose dolphins. No mortalities have been documented (Dulau *et al.*, 2007).

*Mitigation measures*

As the extent of bycatch is very low around Reunion Island, no mitigation measures are planned.

**Mauritius***Marine mammal diversity and status*

Very little is known on the diversity and status of marine mammals around Mauritius. Strandings of Blainville's beaked whales have been reported by Michel & van Bree (1976). Corbett (1994), during a year-long study, observed that spinner dolphins and sperm whales were the commonest cetacean species around the island. Baleen whales have been recorded too, including the blue whale, the humpback whale and the fin whale. A diversity of odontocetes also occur: pantropical spotted dolphin, bottlenose dolphin, Risso's dolphin, striped dolphin, melon-headed whale, pygmy killer whale, and Blainville's beaked whale (Corbett, 1994). Both Indo-pacific and common bottlenose dolphin occur. Spinner dolphin is particularly common in the Bay of Tamarin, where they rest during the day (Mauritius Marine Conservation Society, personal communication). The dugong occurred around Mauritius and Rodrigues, and was considered as very abundant in this area in the 17<sup>th</sup> Century (Haskins & Davis, 2008). This species is now suspected extinct from the Mascarenes.

*Fisheries*

The following fisheries have been recorded around Mauritius: longline (5 boats) and drift longline (for tunas and swordfish, mainly on FADs, 170 boats), purse seine, handline/traps (artisanal, 3,000 boats) and beach seine (for mullets, 5 boats seasonally) (Kiszka & Muir, 2007). Latest figures are: 183 longliners, 43 purse seiners and 2 midwater trawlers; artisanal fishery (using basket traps, line, harpoon, large nets and gillnets): 2312 fishers and 1852 boats (Ministry of Agro Industry & Fisheries - Fisheries Division 2006).

*Marine mammal bycatch*

No cetacean bycatch have been recorded around Mauritius.

### *Mitigation measures*

The bycatch issue has been not studied around Mauritius, no mitigation measures are undertaken or planned. Mauritius has a huge EEZ, substantial bycatch is likely to occur and there are also unknown numbers of illegal vessels who do not report their catches.

## **DISCUSSION AND CONCLUSION**

Marine mammal bycatch has a highly variable extent within the southwest Indian Ocean region. This variability is linked to the use (or not) of gillnets, especially targeting large predatory fishes such as sharks. Around islands, such as in the Mascarene, the Comoros and Mayotte and the Seychelles, marine mammal bycatch has a very limited extent. Incidental catches in longline fisheries (targeting swordfish and tuna) is limited to oceanic species, mostly blackfish. However, these interactions need to be assessed quantitatively, as they may have consequences on local populations. Incidental catches in the purse-seine fishery seem very rare in the western Indian Ocean, as a single baleen whale species has been reported ([Romanov, 2001](#)). It may be related to the rare occurrence of associations between dolphins and tuna in this region.

Interactions, causing mortalities or injuries, with handline need to be considered, as it appears to impact regularly small coastal species of delphinids such as around Mayotte and Reunion. Gillnets are not used around these islands or simply prohibited (such as in the Seychelles). However, along continental coastlines such as in Kenya, Tanzania and Madagascar, gillnets are extensively used for sharks and other large fishes. The most affected species are Indo-pacific humpback and bottlenose dolphins, as well as the dugong, which is probably the most endangered large mammal in eastern Africa (WWF EAME, 2004). However, data on bycatch within the region remains very poor and heterogeneous, particularly in countries with important artisanal inshore fisheries (especially gillnetting). Nevertheless, from available data, coastal marine mammals are at risk along the continental coasts, including Madagascar. Now, surveys to quantify the extent of marine mammal bycatch are clearly needed, including using *Rapid Bycatch Assessment* through interview surveys (see GLOBAL project, Global Bycatch Assessment of Long-lived Species, <http://bycatch.env.duke.edu/>). Other surveys, such as observer programs and coastal marine mammal abundance estimates/demographic studies, are also clearly needed where bycatch is known to occur. These surveys will help to better understand the level of threat and to consider appropriate and effective mitigation measures, including reducing soak time, restricting use of gillnet in known cetacean/dugong habitats.

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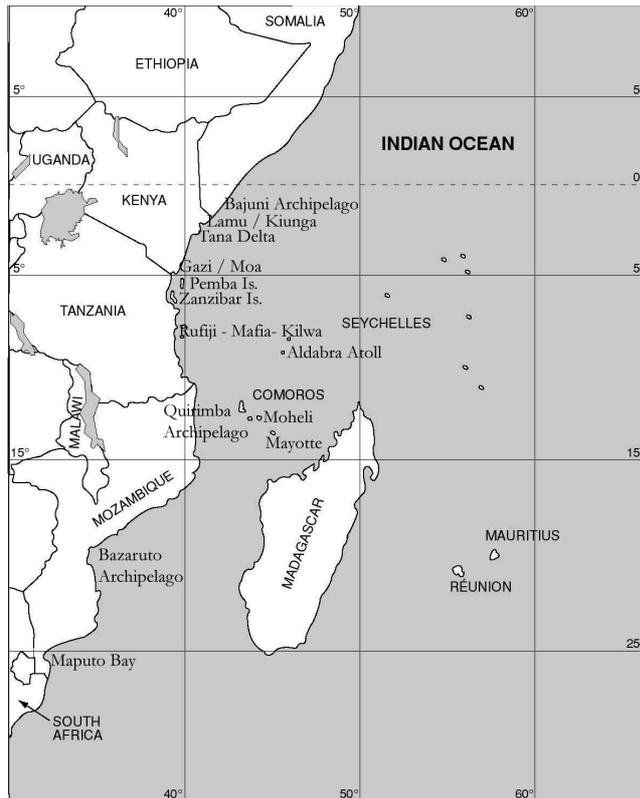
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**Figure 1:** The southwest Indian Ocean.