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Cetacean bycatch in Indian Ocean tuna fisheries: recent updates and perspectives from the 13th Meeting of the Working Party on Ecosystems and Bycatch of the Indian Ocean Tuna Commission

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Abstract
Bycatch is the most significant threat to cetaceans around the world. However, the magnitude of bycatch is still poorly known, particularly in certain ocean basins such as the Indian Ocean. Tuna fisheries, both industrial and small-scale, are of major socioeconomic importance throughout the Indian Ocean. Published information suggests that cetacean bycatch rates in this region are relatively low in pelagic longlines and in purse-seines. However, the increasing use of drift gillnets, particularly in the northern Indian Ocean, is of concern. Preliminary estimates have suggested that as many as 60,000 cetaceans are caught annually in gillnets in the Indian Ocean. Further investigations are required to refine these estimates. The Indian Ocean Tuna Commission (IOTC) is responsible for the management of tuna and tuna-like species. The IOTC's Working Party on Ecosystems and Bycatch (WPEB) reviews and analyzes information on non-target species. At its annual meeting in September 2017 the WBEP formally acknowledged the importance of cetacean bycatch and adopted a work plan that included this subject as a research priority. While a severe shortage of data remains, the stage is set for collaboration with the IOTC on data collection and ultimately for mitigating bycatch in the region.

Cetacean bycatch in Indian Ocean tuna fisheries: an overview

The magnitude of cetacean bycatch in the Indian Ocean region is poorly known, and limited research has been conducted so far in small-scale coastal (but see Kiszka *et al*. 2009, Temple *et al*. 2018) and industrial open-ocean fisheries (e.g. Anderson 2014, Escalle *et al.* 2015). Some bycatch is known to occur in most fisheries, and it could be the leading cause of the decline of some populations of coastal cetaceans (e.g. Kiszka 2015, Cerchio *et al.* 2015). Tuna fisheries, both industrial and small-scale, are of major socioeconomic importance throughout the Indian Ocean. Industrial tuna fisheries are dominated by purse-seines and pelagic longlines, whereas artisanal tuna fisheries involve the use of handlines, poles-and-lines, and gillnets. Over the last two decades, there has been an increasing number of studies suggesting that cetacean bycatch rates are low in industrial tuna fisheries in the Indian Ocean (Romanov 2002, Wang and Liu 2010, Sabarros *et al.* 2013, Escalle *et al.* 2015). Bycatch in pelagic longlines is relatively rare and occasionally involves large depredating delphinids (e.g. *Globicephala macrorhynchus*, *Grampus griseus*, *Pseudorca crassidens*), particularly in the western tropical Indian Ocean (Poisson *et al.* 2001, Sabarros *et al.* 2013, see Kiszka 2015 for a review). Areas of high co-occurrence between cetaceans and purse seine fisheries have been identified, particularly east of the Seychelles (December to March) and in the

Mozambique Channel (April and May; Escalle *et al.* 2015). However, relatively low bycatch rates have been reported, particularly for pantropical spotted dolphins (*Stenella attenuata*) and large balaenopterids such as humpback whales (*Megaptera novaeangliae*) and sei whales (*Balaenoptera borealis*) (Romanov 2002, Escalle *et al.* 2015). Nevertheless, further investigation is needed to assess the magnitude of cetacean bycatch in Indian Ocean purse-seine and pelagic longline fisheries, particularly since 100% observer coverage should soon be available (IOTC, personal communication, September 2017).

The rise of gillnet fisheries in the Indian Ocean

At least 21 countries are engaged in drift gillnet fishing in the Indian Ocean Tuna Commission (IOTC) area of competence (Aranda 2017; IOTC data), and Indian Ocean tuna drift gillnet fisheries contribute to the catches attributed to 6 countries in the IOTC area (MRAG 2012). The fleets are mostly based in India, Iran, Indonesia, Pakistan, Sri Lanka, Yemen, and Oman (Aranda 2017). The prevalence of artisanal fishing throughout this region underlines the great uncertainty about the scale of bycatch, particularly in gillnet fisheries. Drift gillnet fishing in the Indian Ocean is not yet officially defined as semi-industrial and therefore it is not subject to the same restrictions as are applied to industrial vessels (Vessel Monitoring System and restrictions on fishing capacity). The inability to enforce controls on the high seas and in national EEZs, the relative ease of entry to gillnet fishing and the ability of gillnet fishermen to sell their relatively low-quality catch in local markets all tend to encourage the expansion of the artisanal and semi-industrial sectors, which are dominated by gillnetting (Aranda 2017).

The number of gillnet fishing boats has been increasing for several years (Fonteneau 2011), likely due, at least in part, to the low cost of operating gillnets compared to other gears. IOTC nominal catch data suggest that artisanal fisheries are expanding, while industrial fisheries are declining (Aranda 2017; Fig. 1).

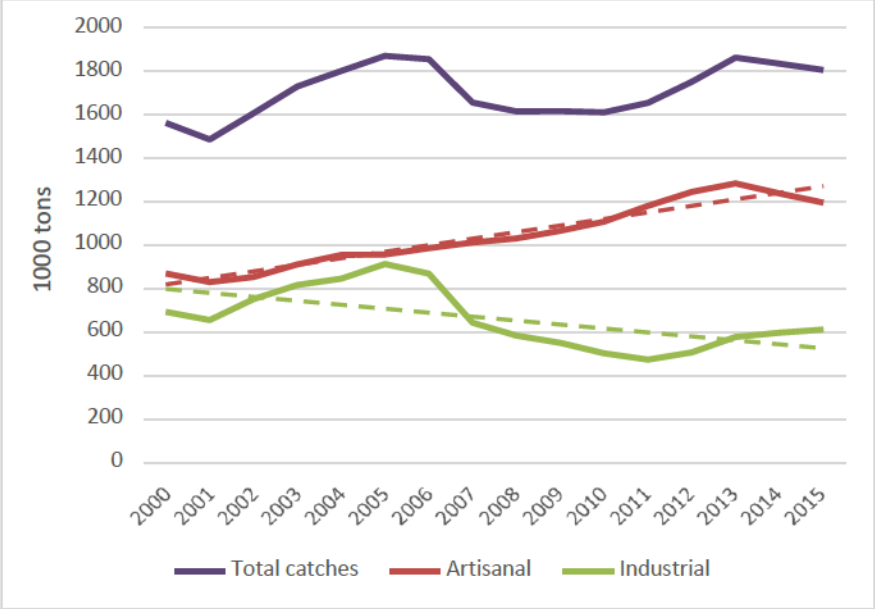

Fig. 1: Annual trends in nominal tuna catches in the IOTC area of competence between 2000 and 2015 (source: IOTC nominal catch database; Aranda 2017).

Gillnet fisheries contribute about 35% of nominal IOTC catches, and this proportion continues to increase, raising concern over the potential effects of bycatch on cetaceans and other marine megafauna in the region, including elasmobranchs, sea turtles and a diversity of large fishes. Anderson (2014) suggested that about 60,000 cetaceans were caught every year in the western and northern Indian Oceans, including 24,000 off Iran, 10,000 off India and 7,000 off Pakistan. However, these estimates were preliminary and based on extrapolations from a limited number of fisheries.

The IOTC

The IOTC is an intergovernmental Regional Fisheries Management Organization (RFMO) which is responsible for the management of tuna and tuna-like species in the Indian Ocean. The creation of the IOTC was approved by the Council of the Food and Agriculture Organization (FAO) of the United Nations in 1993. The agreement is open to countries bordering and/or fishing in the Indian Ocean, and there are currently 32 member states. The Commission includes several subsidiary bodies: the compliance committee, the standing committee on administration and finance, and the scientific committee. The scientific committee meets annually and provides advice to the Commission on the status of stocks and the management actions necessary to ensure the sustainability of fisheries. Several working parties have been created to analyze problems related to the Commission's management goals, and they usually provide technical solutions to the scientific committee for management recommendations to the Commission.

The IOTC Working Party on Ecosystems and Bycatch

The Working Party on Ecosystems and Bycatch (WPEB) annually reviews and analyzes information on non-target species affected by Indian Ocean tuna fisheries (particularly sharks, sea turtles, seabirds and cetaceans).

The IOTC-WPEB last met from 4-8 September 2017 in San Sebastian, Spain in order to adopt policy recommendations and agree upon future priorities. While the primary focus was assessment of the blue shark (*Prionace glauca*) stock in the IOTC Area of Competence, some time was devoted to other bycatch species as well as ecosystem-based fishery management initiatives.

The stated goals for the 2017 WBEP Meeting relative to marine mammals were to "Review new information on marine mammal biology, ecology, fisheries interactions and bycatch mitigation measures (all); Develop management advice on the status of marine mammal species (all)." Prior to the 2017 meeting, the IOTC had no documentation expressing a need for marine mammal bycatch mitigation or assessment. Papers had been presented on these issues irregularly, but no formal recommendations had ever been developed. A report presented by Kiszka *et al.* (2017) highlighted marine mammal bycatch interactions in the Indian Ocean with a particular focus on the threat posed by tuna gillnet fisheries. By the conclusion of the 2017 WBEP meeting, the importance of considering marine mammal bycatch (particularly of cetaceans) had been clearly expressed and work plans as well as research priorities had been formally adopted (see below). While there remains a lack of data, the stage is now set for further collaboration on data collection with the IOTC and ultimately for mitigating bycatch in the region.

The following text was included in the report of the 2017 IOTC WBEP Meeting (IOTC WPEB 2017):

1.1 Marine mammals

1.1.1 Review new information on marine mammal biology, ecology, fisheries interactions and bycatch mitigation measures

1. The WPEB **NOTED** paper IOTC–2017–WPEB13–40 which provided an updated review on the bycatch of marine mammals in the western Indian Ocean, including the following abstract provided by the authors:

   "Here we review available information on cetacean bycatch in all commercial fisheries known to occur in the western Indian Ocean. In coastal waters of the region, the magnitude of bycatch has only been quantified for driftnets targeting large pelagic fish off Zanzibar. Based on bycatch levels and abundance of coastal dolphins, it has been shown that the removals are unsustainable, particularly for Indo-Pacific bottlenose dolphins (*Tursiops aduncus*) and Indian Ocean humpback dolphins (*Sousa plumbea*). Elsewhere in the region, bycatch is known to involve other species as well, including coastal, oceanic and migratory species such as humpback whales (*Megaptera novaeangliae*), mostly in bottom-set and drift gillnets. In open-ocean fisheries, bycatch in pelagic longlines has particularly involved small and medium-sized delphinids (*Globicephala macrorhynchus*, *Grampus griseus*, *Tursiops truncatus*, *Pseudorca crassidens*, *Stenella* spp.) although data are sparse. In tuna purse- seine fisheries, captain logbooks (1980-2011) and observer data (1995-2011) recorded high co- occurrence with cetaceans, particularly east of the Seychelles (December to March) and in the Mozambique Channel (April and May). However, few cetacean deaths were reported. Captures of large whales (*Balaenoptera* spp.) in purse-seines in the western tropical Indian Ocean have been reported. This review also presents information on bycatch in coastal and offshore tuna gillnets from various locations. Overall, cetacean bycatch is very poorly documented in the region and more systematic assessment is critical, particularly for those fisheries that use gear known to entangle or entrap cetaceans." (see paper for full abstract)

2. The WBEP **RECALLED** Resolution 13/04 *On the conservation of cetaceans*, which includes data collection and reporting requirements at the species-specific level, where possible, and the banning of intentional sets on marine mammals. Although these are mandatory requirements for all CPCs there is still a lack of data regarding species-specific marine mammal bycatch in the IOTC Area of Competence, particularly for tuna gillnet fisheries where interactions are of particular concern.

3. The WBEP **NOTED** the vulnerability of marine mammals to population decline after relatively few fishery interactions due to their highly conservative life histories and, at times, demographic isolation.

Family	Common name	Species	IUCN Red List status	by Gear Type*
Balaenidae	Southern right whale	*Eubalaena australis*	LC	**GN**
Balaenopteridae	Common minke whale	*Balaenoptera acutorostrata*	LC	**GN**
	Antarctic minke whale	*Balaenoptera bonaerensis*	DD	**GN**
	Sei whale	*Balaenoptera borealis*	EN	PS
	Bryde's whale	*Balaenoptera edeni/brydei*	DD	**PS**, GN
	Blue whale	*Balaenoptera musculus*	EN	PS
	Fin whale	*Balaenoptera physalus*	EN	PS
	Omura's whale	*Balaenoptera omurai*	DD	PS
	Humpback whale	*Megaptera novaeangliae*	LC**	PS, **GN**, LL
Physeteridae	Sperm whale	*Physeter macrocephalus*	VU	**GN**, LL
Kogiidae	Pygmy sperm whale	*Kogia breviceps*	DD	**GN**, LL
	Dwarf sperm whale	*Kogia sima*	DD	**GN**, LL
Ziphiidae	Arnoux's beaked whale	*Berardius arnuxii*	DD	Unknown
	Southern bottlenose whale	*Hyperoodon planifrons*	LC	Unknown
	Longman's beaked whale	*Indopacetus pacificus*	DD	**GN**
	Andrew's beaked whale	*Mesoplodon bowdoini*	DD	Unknown
	Blainville's beaked whale	*Mesoplodon densirostris*	DD	Unknown
	Gray's beaked whale	*Mesoplodon grayi*	DD	Unknown
	Hector's beaked whale	*Mesoplodon hectori*	DD	Unknown
	Deranigala's beaked whale	*Mesoplodon hotaula*	NA	Unknown
	Strap-toothed whale	*Mesoplodon layardii*	DD	Unknown
	True's beaked whale	*Mesoplodon mirus*	DD	Unknown
	Spade-toothed whale	*Mesoplodon traversii*	DD	Unknown
	Shepherd's beaked Whale	*Tasmatecus shepherdi*	DD	Unknown
	Cuvier's beaked whale	*Ziphius cavirostris*	LC	**GN**
Delphinidae	Common dolphin	*Delphinus delphis*	LC	**GN**
	Pygmy killer whale	*Feresa attenuata*	DD	**GN**
	Short-finned pilot whale	*Globicephala macrorhynchus*	DD	**LL**, **GN**
	Long-finned pilot whale	*Globicephala melas*	DD	Unknown
	Risso's dolphin	*Grampus griseus*	LC	**LL**, **GN**
	Fraser's dolphin	*Lagenodelphis hosei*	LC	**GN**
	Irrawaddy dolphin	*Orcaella brevirostris*	VU	**GN**
	Australian snubfin dolphin	*Orcaella heinshoni*	NT	**GN**
	Killer whale	*Orcinus orca*	DD	**LL**, **GN**
	Melon-headed whale	*Peponocephala electra*	LC	LL, **GN**
	False killer whale	*Pseudorca crassidens*	DD	**LL**, **GN**

Delphinidae	Indo-Pacific humpback dolphin	*Sousa chinensis*	VU	**GN**
	Indian Ocean humpback dolphin	*Sousa plumbea*	EN	**GN**
	Australian humpback dolphin	*Sousa sahulensis*	VU	**GN**
	Pantropical spotted dolphin	*Stenella attenuata*	LC	**PS**, **GN**, LL
	Striped dolphin	*Stenella coeruleoalba*	DD	**GN**
	Spinner dolphin	*Stenella longirostris*	DD	PS, **GN**, LL
	Rough-toothed dolphin	*Steno bredanensis*	LC	LL, **GN**
	Indo-Pacific bottlenose dolphin	*Tursiops aduncus*	DD	**GN**
	Bottlenose dolphin	*Tursiops truncatus*	LC	**LL**, **GN**
Phocoenidae	Indo-Pacific finless porpoise	*Neophocaena phocaenoides*	VU	**GN**

* Documented mortality within the IOTC area of competence is **in bold**
** Arabian Sea population: EN
IUCN Red List of Threatened species. Version 2017-01. <www.iucnredlist.org>
Downloaded on 6 September 2017

4. The WBEP **NOTED** that limited data indicate declines for several marine mammal species in the Indian Ocean (e.g. Indian Ocean humpback dolphins *Sousa plumbea*, Indo-Pacific humpback dolphin *Sousa chinensis*, Indo-Pacific bottlenose dolphin *Tursiops aduncus*) and that capture in tuna gillnet fisheries is an important source of mortality. The WBEP **REQUESTED** that CPCs collect data on the effectiveness of mitigation techniques intended to reduce bycatch in these fisheries and implement successful mitigation strategies.

5. The WBEP **NOTED** the likelihood of gillnet entanglement on the high seas, particularly during IUU fishing, where gillnets of greater than 2.5 km could still be in use.

6. The WBEP **REQUESTED** the Chair and the IOTC Secretariat begin discussions on the potential for collaboration with the International Whaling Commission and other national and international institutions to facilitate capacity building within CPCs regarding the establishment of marine mammal bycatch mitigation programs.

1.1.2 Development of management advice on the status of marine mammal species

7. The WPEB **NOTED** that to-date there has been no advice developed by the WPEB for marine mammals, however, the WPEB **AGREED** that cetacean bycatch assessment and mitigation is an important issue for consideration.

8. Therefore, the WPEB **ADOPTED** the management advice developed for cetaceans, as provided in the draft status summary and **REQUESTED** that the IOTC Secretariat update the draft stock status summary with the latest 2016 interaction data, and for the summary to be provided to the SC as part of the draft Executive Summary, for its consideration:

- Cetaceans (Appendix XVII).

The following text was adopted by the IOTC Scientific Committee. This is the first Executive Summary specifically directed at marine mammals and is expected to be the foundation for marine mammal research and bycatch mitigation discussions at future IOTC meetings.

EXECUTIVE SUMMARY: CETACEANS

Status of cetaceans in the Indian Ocean

TABLE 1. Cetaceans: IUCN Red List status and records of interaction (including entanglements and, for purse seines, encirclements) with tuna fishery gear types for all cetacean species that occur within the IOTC area of competence.

INDIAN OCEAN STOCK – MANAGEMENT ADVICE

Stock status. No assessment has been undertaken by the IOTC WPEB for cetaceans due to the lack of data being submitted by CPCs. However, the current International Union for Conservation of Nature (IUCN) Red List status to date for each of the cetacean species reported in the IOTC Area of Competence is provided in Table 1. Information on their interactions with tuna fisheries in the IOTC is also provided. It is important to note that a number of international global environmental accords (e.g. Convention on Migratory Species (CMS), Convention on Biological Diversity (CBD), International Whaling Commission (IWC)), as well as numerous fisheries agreements obligate States to provide protection for these species. The status of cetaceans is affected by a range of factors such as direct harvesting (documented for several countries, e.g. Sri Lanka, Indonesia, Madagascar and the Seychelles) and habitat degradation, but the level of cetacean mortality due to capture in tuna drift gillnets is likely to be substantial and is also a major cause for concern (Anderson 2014). Many reports (e.g. IOTC-2013-WPEB07-37) also suggest some level of cetacean mortality for species involved in depredation of pelagic longlines, and these interactions need to be further documented throughout the IOTC Area of Competence. Recently published information suggests that the incidental capture of cetaceans in purse seines is low (e.g. Escalle *et al.* 2015), but should be further monitored.

Outlook. Resolution 13/04 *On the conservation of cetaceans* highlights the concerns of the IOTC regarding the lack of accurate and complete data collection and reporting to the IOTC Secretariat of interactions and mortalities of cetaceans within tuna fisheries in the IOTC Area of Competence. The IOTC adopted that CPCs shall prohibit their flagged vessels from intentionally setting a purse seine net around a cetacean if the animal is sighted prior to the commencement of the set. The IOTC also adopted that CPCs using other gear types targeting tuna and tuna-like species found in association with cetaceans shall report all interactions with cetaceans to the relevant authority of the flag State. It is acknowledged that the impact on cetacean populations from fishing for tuna and tuna-like species may increase if fishing pressure increases (which is already demonstrated for tuna gillnet fisheries) or if the status of cetacean populations worsens due to other factors such as an increase in external fishing pressure or other anthropogenic or climatic impacts.

The following should be noted:

- The number of fisheries interactions involving cetaceans is highly uncertain and should be addressed as a matter of priority as it is a prerequisite for the WPEB to determine a status for any Indian Ocean cetacean species.
- Available evidence indicates considerable risk to cetaceans in the Indian Ocean, particularly from tuna drift gillnets (Anderson 2014)
- Current reported interactions and mortalities are scattered, but are most likely severely underestimated.
- Maintaining or increasing fishing effort in the Indian Ocean without appropriate mitigation measures in place will likely result in further declines in a number of cetacean species. An increasing effort by tuna drift gillnet fisheries has been reported to the IOTC, which is a major cause of concern for a number of species, particularly in the northern Indian Ocean.
- Appropriate mechanisms should be developed by the Compliance Committee to ensure CPCs comply with their data collection and reporting requirements for cetaceans.

The following text was adopted by the IOTC WBEP Program of Work, which provides an outline of requests for funding and management of project timelines for the IOTC Scientific Committee. Essentially, IOTC work will not take place unless it appears on this Program.

CETACEANS

8.1 Review and development of cetacean bycatch mitigation measures	**Priority**
8.1.1 Historical data mining for key species interacting with IOTC fleets (e.g coastal gillnet, longline fisheries)	High
8.1.2 Creation of identification cards for cetacean species in IOTC Area of Competence	High
8.1.3 Conduct ecological risk assessments for cetaceans	High
8.1.4 Assess marine mammal bycatch interactions, develop marine mammal bycatch standards, and support mitigation efforts through collaborative partnerships	Very High

Conclusions

Gillnet bycatch in the Indian Ocean remains poorly quantified, but likely poses a major threat to cetacean populations, particularly in the coastal fisheries of all countries, and in offshore tuna drift gillnet fisheries. There is a clear need for greater inter-governmental and inter-organizational collaboration to accurately assess and address cetacean bycatch in Indian Ocean fisheries. Current protections for cetaceans in the Indian Ocean are patchy at best. The

International Whaling Commission (IWC) established the Indian Ocean Sanctuary in 1979 to protect whales from whaling. The sanctuary still exists, but currently does nothing to mitigate fisheries bycatch, a significant modern threat to all cetaceans.

While the IWC is limited in its ability to influence fishing practices, a bycatch mitigation initiative is ongoing and includes plans to collaborate with other intergovernmental organizations. Among the recommendations of the IWC Scientific Committee at its 2017 annual meeting were the following (IWC 2017):

- Support the IOTC to encourage and help member states more effectively implement the UN and IOTC resolutions banning large-scale, high-seas drift-net fishing (nets greater than 2.5 km in length).
- Support the IOTC and other regional bodies in efforts to implement cetacean bycatch data collection and reporting protocols.

Given the limited data, improvements in bycatch data collection, particularly in drift gillnets, are greatly needed. The IOTC's production and distribution of identification cards in 2018 to improve species identification onboard vessels should have a positive effect on data collection and reporting.

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