Title: Bycatch in Drift Gillnet Fisheries: a sink for Indian Ocean cetaceans

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Tweetable Abstract

Cetacean bycatch in Indian Ocean gillnets is a critical and largely overlooked conservation issue but has received considerably less attention than other bycatch hotspots.

Abstract

In 1992, the UN banned the use of large-scale pelagic driftnets on the high seas (UNGA 46/215). Three decades later, however, drift gillnets remain one of the primary fishing gears in the Indian Ocean, representing roughly 30 percent of tuna catches in this ocean. Recent estimates indicate that several million small cetaceans have been killed in Indian Ocean gillnets over the past few decades. National agencies and the regional fisheries management organization charged with managing tuna fisheries, the Indian Ocean Tuna Commission, have yet to comprehensively document the bycatch of small cetaceans in these fisheries. Here we review current information on cetacean bycatch in Indian Ocean drift gillnets and present potential solutions to this important conservation issue.

MAIN TEXT

Introduction

The incidental capture of non-target species in fisheries ("bycatch") has been described in hundreds of technical documents and the peer-reviewed literature since the 1960s. Decades later, bycatch remains the primary threat to many species of marine megafauna and is driving several small cetacean species towards extinction (Brownell et al., 2019; Read et al., 2006). One of the most well-known case studies is the U.S. dolphin-set purse seine fishery for yellowfin tuna (*Thunnus albacares*) in the Eastern Tropical Pacific (ETP), which caused the mortality of several million dolphins during the 20th century (Ballance et al., 2021; Hall 1998; Wade et al., 2007).

Public outcry over this issue was one of the primary issues that led to passage of the first legislation focused on marine mammals – the U.S. Marine Mammal Protection Act (MMPA) in 1972 (Ballance et al., 2021). Later developments included the implementation of market measures, such as the 'dolphin-safe' tuna label requirements, and a multilateral Agreement on the International Dolphin Conservation Program. Together, these management actions significantly reduced observed dolphin mortality and are often lauded as some of the most successful attempts to reduce bycatch – although this is a unique example as the fishery *intentionally* set on dolphins to capture tuna (Ballance et al., 2021).

Here, we highlight another cetacean bycatch issue that is comparable in scale to the ETP purse seine fishery in terms of dolphin mortality, but which has generated relatively little policy or scientific attention (Anderson et al., 2020). In the Indian Ocean, over 4 million cetaceans are estimated to have been killed in pelagic drift gillnets ("gillnets") targeting tuna and tuna-like species between 1950-2018, peaking at 100,000 cetaceans per year from 2004 to 2006 (Anderson et al., 2020). The data underlying this estimate are scattered and incomplete, but the available information suggests that bycatch in tuna gillnet fisheries are likely unsustainable for many cetacean species (Anderson et al., 2020; Kiszka et al., 2021). Our knowledge of bycatch, fishing effort, and even the catch of targeted species in Indian Ocean tuna gillnet fisheries is fragmented. In addition, there is very little information on the distribution, abundance, population structure, and demography of most cetacean species in the Indian Ocean, information necessary to assess the population-level impacts of bycatch. Here we summarize available knowledge of bycatch, catch, and governance for the Indian Ocean tuna gillnet fisheries and then propose four action items to address this conservation issue.

Background

Indian Ocean tuna fisheries boast the second-largest tuna production in the world, contributing to about one-fifth of global production (International Seafood Sustainability Foundation, 2021). Overseeing these fisheries is the Indian Ocean Tuna Commission (IOTC), one of five of the world's tuna regional fisheries management organizations (RFMOs). The IOTC's 30 Commission Contracting Parties ("Members") conduct multilateral science and negotiate management measures for 16 tuna and other tuna-like species in the region's fisheries, and consider ecosystem and bycatch impacts of these fisheries.

A. Regional governance

A suite of negotiated Conservation and Management Measures (CMMs) form the backbone of the IOTC and set the rulebook for target catch limits, bycatch reporting, observer coverage, and other requirements (Supplementary Material, Table 1)[1]. A critical issue is that many IOTC measures do not apply to gillnet vessels less than 24 meters in length overall (LOA) fishing in Exclusive Economic Zones (EEZs) (Supplementary Material, Table 1).

[1] Note: For the purposes of this paper, we use the term "tuna fisheries" to refer to gillnet fisheries targeting the 16 tuna and tuna-like species (e.g. billfish and seerfish) managed by the IOTC. These managed species are: yellowfin tuna (*Thunnus albacares)*, skipjack tuna (*Katsuwonus pelamis)*, bigeye tuna (*Thunnus obesus)*, Albacore tuna (*Thunnus alalunga)*, Southern bluefin tuna (*Thunnus maccoyii)*, longtail tuna (*Thunnus tonggol*), kawakawa (*Euthynnus affinis*), frigate tuna (*Auxis thazard)*, bullet tuna (*Auxis rochei)*, narrow barred Spanish mackerel (*Scomberomorus commerson*), Indo-Pacific king mackerel (*Scomberomorus guttatus)*, blue marlin (*Makaira nigricans)*, black marlin (*Makaira indica)*, striped marlin (*Tetrapturus audax)*, Indo-Pacific sailfish (*Istiophorus platypterus)*, and swordfish (*Xiphias gladius*).

Classification of fishing vessels in the IOTC carries implications for data reporting and observer coverage (Supplementary Material, Table 1). The IOTC categorizes vessels as "artisanal" if they are under 24 m LOA and fishing in EEZs (Resolution 19/04). The IOTC recently developed voluntary, finer-scale reporting requirements for gillnet vessels as "artisanal," "semi-industrial," or "industrial" to work towards enhanced information on gillnet vessels, but all publicly available data is currently reported as either "artisanal" or "industrial" (IOTC 2023; IOTC 2022a).

A measure relevant to cetaceans (Resolution 13/04) was adopted in 2013 and updated at the 2023 IOTC annual meeting (Resolution 23/06). This measure requires Members to report details of any capture or entanglement of cetaceans through logbooks or observer coverage to the relevant authority of the flag state. However, the measure does not apply to artisanal fisheries operating in the EEZs.

Other conservation measures have invoked formal objections from certain Members, which renders them exempt from their requirements. For example, Pakistan objected to Resolution 17/07, which prohibited the use of driftnets longer than 2.5 km, in congruence with UN General Assembly Resolution 46/215, in the entire IOTC Area of Competence, including the high seas and EEZs. This objection means that Pakistan may continue to use large-scale driftnets within its EEZ. Another recent, interim conservation measure called for IOTC Members to require that all gillnets are set 2 meters below the water surface by 2023 (Resolution 21/01 and 19/01) to reduce bycatch of small cetaceans and other non-target species. Recent studies have indicated that this measure may help to reduce the bycatch of some taxa in Pakistan (Kiszka et al., 2021), including small cetaceans, but some of the primary gillnetting nations – India, Indonesia, I.R. Iran, Oman, and others – objected to the measure.

B. The fishery

In the Indian Ocean, tuna gillnet fishing is widespread on both the high seas and in EEZs (IOTC 2023). Between 2000 and 2020, the highest gillnet catches were reported by I.R. Iran, India, Indonesia, Pakistan, and Sri Lanka (IOTC 2023). Over half of IOTC Members fish with gillnets, but these five countries represent roughly 85 percent of the total gillnet catches in the Indian Ocean since 2000 (IOTC 2023).

Gillnets are an attractive gear because their use does not require sophisticated equipment or bait, so they can be operated relatively inexpensively. They are typically deployed overnight and are unselective — they entangle any large-bodied organism, such as whales, dolphins, sea turtles, large fishes, and sharks. Gillnets are widely recognized as the most dangerous fishing gear for cetaceans (Brownell et al., 2019; Northridge et al., 2016; Roberson et al., 2022).

Pelagic gillnets catch over a third of the tuna harvest managed by the IOTC and catches have been increasing (Anderson et al., 2020). This is unusual in two respects. First, gillnets are responsible for the greatest proportion of total catch of tuna in the Indian Ocean, unlike other regions where purse seines and longlines dominate tuna fisheries (Miyake et al., 2010). Second, most Indian Ocean tuna gillnet fisheries are considered "artisanal," although some of their characteristics, such as vessel length and inboard motorization, posit them towards the "semi-industrial" category (IOTC 2022a). The UN banned large-scale driftnets (over 2.5 km in length) on the high seas (Resolution 46/215[2]). Gillnet use continues to increase in the IOTC area, but it is unlikely that artisanal or semi-industrial vessels would violate the ban given their length.

[2] All IOTC CMMs can be accessed via the current compendium of active CMMs: https://iotc.org/cmms.

Furthermore, we possess only a vague understanding of how many gillnet vessels operate in the Indian Ocean. In the past five years (2016-2020), only three countries (Indonesia, I.R. Iran, and Sri Lanka) have registered gillnet vessels with the IOTC – possibly due to the fact registering of vessels is required only for vessels fishing on the high seas (IOTC 2022b).

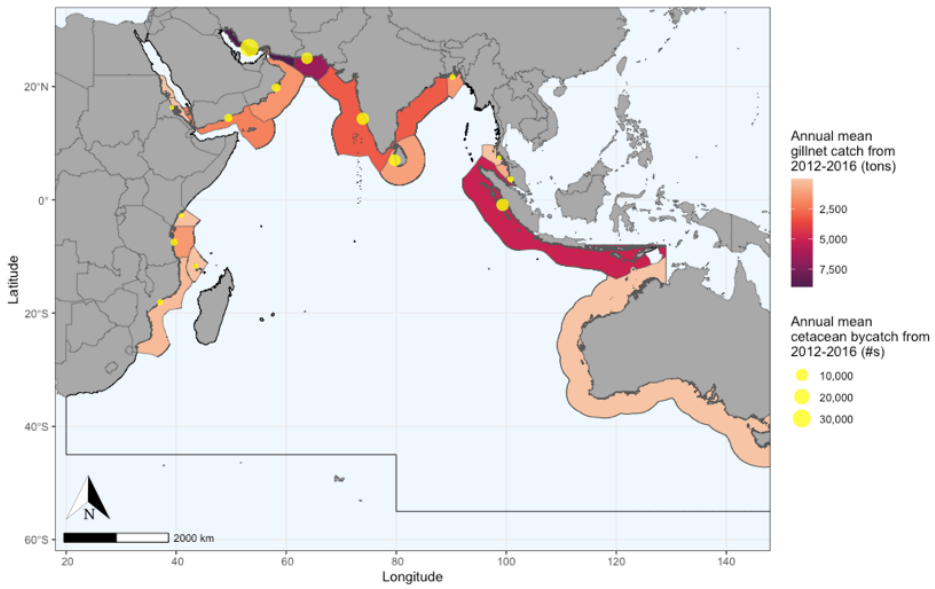
C. Cetacean bycatch

Underreporting of cetacean bycatch is a pervasive problem in the Indian Ocean, particularly for gillnets. The IOTC database contains 143 records of cetacean bycatch between 1996 and 2022 – but only from pelagic longline vessels collected by scientific observers (IOTC 2022c). To date, no bycatch records for any species in gillnets have been reported to the IOTC (IOTC 2022c), although such bycatches are common (e.g., Anderson et al., 2020; Kiszka et al., 2021).

The limited information on cetacean bycatch in Indian Ocean tuna gillnet fisheries suggest that it is very large. The available information suggests that the countries with the highest cetacean bycatch are those with the highest gillnet tuna catches (Anderson et al., 2020, Figure 1). The estimates of 100, 000 individuals killed per year (Anderson et al., 2020) were derived from small samples and limited information, and thus contain a considerable degree of uncertainty, but they are supported by other independent analyses (Kiszka et al., 2021).

At the present time, it is impossible to estimate the population-level impact of bycatch mortality due to the dearth of information on affected populations. Information on population structure and estimates of abundance are lacking for almost all whales, dolphins, and porpoises in the northern Indian Ocean, where the highest concentration of gillnet use occurs. The last major survey of the entire Arabian Sea area was conducted in 1998, although the International Whaling Commission (IWC) is currently planning a survey of Indian Ocean cetaceans *(*IWC 2021).

Figure 1. Annual mean gillnet target catches (tons) reported to the IOTC from 2012-2016 overlaid with annual mean estimated cetacean bycatch from 2012-2016 as reported in Anderson et al. (2020) (*3*) for the IOTC Area of Competence. *Note: Figure 1 depicts annual mean retained catches (t) from 2012-2016 for "gillnets" and "offshore gillnets" by IOTC Members reported in the IOTC nominal catch database as of April 11, 2023 (*6*), overlaid with cetacean bycatch estimates reported in Table 2 of Anderson et al. (2020) (3). The figure depicts bycatch and catch in EEZs only, but fishing and bycatch occurs outside EEZs, although information is unavailable to spatially portray it. FAO (2023) and Flanders (2019) provided the IOTC and EEZ shapefiles used in this image, respectively.*

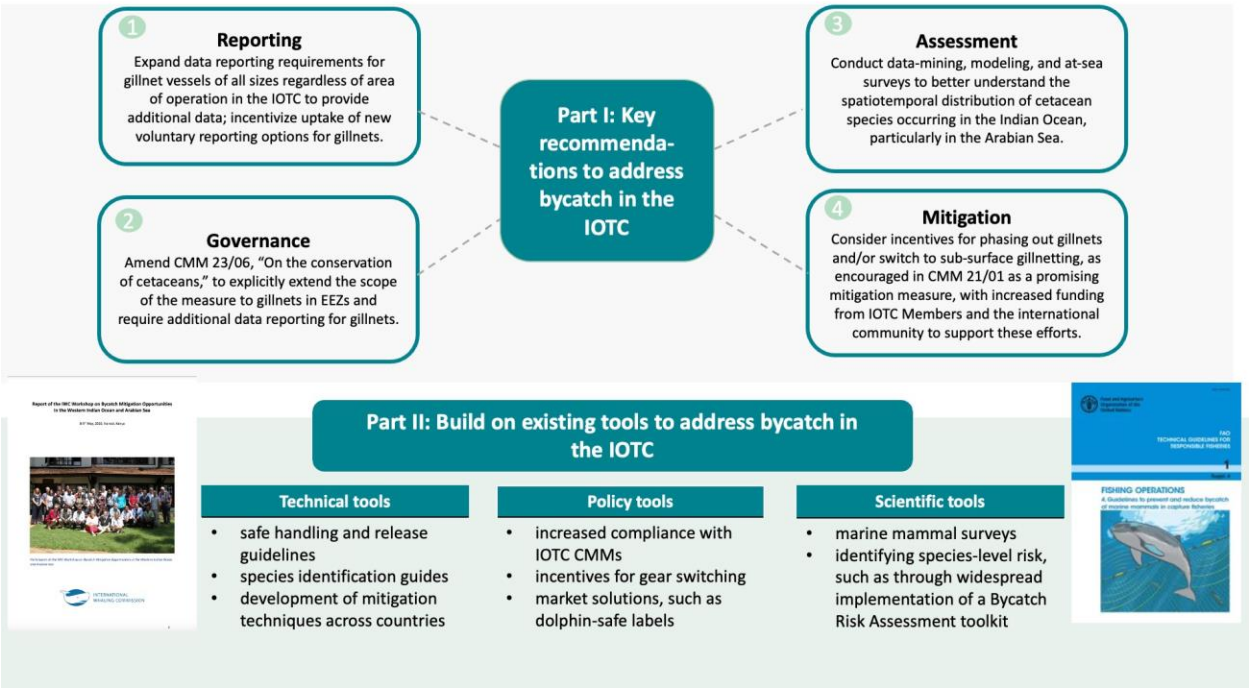


Current progress

The FAO developed a global set of voluntary marine mammal bycatch reduction guidelines in 2021 (FAO 2021), providing a foundation to address cetacean bycatch in the Indian Ocean. The IOTC has been addressing bycatch through its Working Party on Ecosystems and Bycatch, with assistance from the International Whaling Commission's Bycatch Mitigation Initiative (IWC BMI). In 2023, the IOTC endorsed an agreement for enhanced bycatch cooperation with the IWC to foster initiatives to reduce cetacean bycatch in Indian Ocean tuna fisheries (IOTC-IWC 2021). The IWC has also been developing bycatch regional mitigation pilot projects under the FAO Common Oceans ABNJ Tuna Project (IWC 2021).

The United States recently implemented a set of Import Provisions under the MMPA, requiring over 100 fishing nations, including some IOTC Members, to demonstrate that their marine mammal bycatch regulatory programs are "comparable in effectiveness" to those in the United States (81 FR 54389, Bering et al., 2022; Johnson et al., 2017; Williams et al., 2016). This Rule, which is expected to fully take effect by 2024, offers an additional incentive to develop bycatch mitigation policy at national levels, but it is unclear how countries with low levels of technical capacity will be able to meet these provisions (Bering et al., 2022). The full impacts of these Import Provisions on cetacean bycatch in gillnet fisheries in the Indian Ocean are yet to be determined.

Figure 2. Recommended solutions and existing tools through the FAO and IOTC/IWC Bycatch Mitigation Initiative to address cetacean bycatch.



Recommendations

Several potential practical, low-cost solutions are available to reduce cetacean bycatch through gear modification or alternative deployment of existing gear. For example, sub-surface gillnet trials have been successful at reducing cetacean bycatch in Pakistani gillnet fisheries without a large reduction in target species catch (Kiszka et al., 2021). Building off previous work (Figure 2), we make four specific recommendations to strengthen scientific knowledge and management:

1) require registration and reporting of catch, incidental catch, and fishing effort for gillnet vessels under 24m in length fishing within EEZs and encourage the voluntarily reporting of more information on the vessel type used in gillnet fisheries. This includes working towards enhanced cooperation per a new voluntary reporting scheme proposed by the IOTC Secretariat in November 2022 (IOTC 2022a);

2) revise the conservation measure adopted to address the bycatch of cetaceans in IOTC fisheries (CMM 23/06) to include additional reporting for gillnets operating in EEZs;

3) improve knowledge of cetacean species' occurrence, distribution, and abundance to assess the impact of bycatch on these populations; and

4) develop incentives for testing mitigation measures; transition to sub-surface setting building off successful trials in Pakistan (Kiszka et al., 2021); and develop alternative gear adapted to local conditions to allow communities to phase out the use of gillnets in the Indian Ocean. This will require significant funding from Members and the international community.

Conclusion

The bycatch of cetaceans in the Indian Ocean is very large and likely unsustainable for some species, particularly in the northern Indian Ocean (Anderson et al., 2020). Our ability to monitor and mitigate bycatch in the Indian Ocean is hampered by widespread data gaps and insufficient policy, enforcement, and compliance (Anderson et al., 2020; Kiszka et al., 2021).

Cetacean bycatch in the Indian Ocean remains understudied and poorly understood, particularly compared to other fisheries. Solutions, however, are available to address bycatch in the region. The collaborative work already undertaken by the IOTC and IWC hold significant promise for the development of further actions to address this critical issue.

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