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Longman's beaked whale *Indopacetus pacificus* and *Mesoplodon* sp. entanglements off Pakistan: are pelagic gillnet fisheries a potential threat ?

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ABSTRACT

Beaked whales (Ziphiidae) are rarely reported in the Arabian Sea. Four new cases (five individuals) were documented in deep waters offshore Pakistan through a pilot programme in 2015-2018 where trained fishers video-recorded net entanglements in the pelagic tuna drift gillnet fishery. Videos were analysed frame-by-frame. The large body size (est. 5-6m) of one specimen, its moderately bulbous melon, long tubular rostrum and a large falcate dolphin-like dorsal fin, indicated Longman's beaked whale *Indopacetus pacificus.* It represents the first record for Pakistan (EEZ), and with a stranding at Gujarat, India, a second for the northern Arabian Sea. The other 4 ziphiids were significantly smaller (est. 3– 4.5m), with a decidedly non-bulbous melon, variable short to moderately short rostra, falcate to subtriangular dorsal fin and a nondescript greyish colouration, identified as *Mesoplodon* spp. Video quality was poor but none of the specimens showed tusks, arched mandible lines or noticeable linear tooth rakes, practically excluding adult males. The successful release of all the live net-entangled beaked whales is unprecedented. The simultaneous bycatch of two mesoplodonts in the same net set is equally exceptional. This citizen science strategy adds to our understanding of the distribution of *I. pacificus* and mesoplodonts, which may be more common in the Arabian Sea than the scarce literature suggests. If significant bycatch of beaked whales is confirmed, the massive tuna gillnet fishing effort in the Arabian Sea could have negative implications for their conservation status.

Key words:

Longman's beaked whale, *Indopacetus pacificus*, *Mesoplodon* spp., tuna gillnet fishery, bycatch, citizen science, Arabian Sea

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INTRODUCTION

Beaked whales (family Ziphiidae) are some of the least known cetaceans due to their close association with deep oceanic waters, their spending little time near the surface and generally elusive nature. Some species have not, or rarely, been confirmed at sea and ziphiid taxonomy continues to be in flux with new species described or nomenclature revised every few years *(e.g.,* Reyes *et al.,* 1995; Dalebout *et al.*, 1998, 2002, 2014; van Helden *et al.,* 2002). Much of available knowledge on ziphiids is still derived from strandings, beach cast remains, opportunistic sightings and anecdotal records (Reeves *et al.*, 2002; MacLeod, 2018; Pitman, 2018a,b). One species, the Peruvian or Lesser beaked whale *Mesoplodon peruvianus* Reyes, Mead & Van Waerebeek, 1991 was described based mainly on bycatch specimens . The number of dedicated research programmes on beaked whales are limited due to the logistical difficulties in studying these cryptic mammals. Hence any well-supported new evidence on ziphiids merits reporting.

Longman's beaked whale *Indopacetus pacificus* (Longman, 1926) represented one of cetology's longest standing mysteries until recently (Reeves *et al.*, 2002). The IUCN (International Union for Conservation of Nature) Red List of Threatened Species version 2019.1 categorizes *I. pacificus* as "Data Deficient" (Taylor *et al.*, 2008). Knowledge on this species, also named Indo-Pacific beaked whale, was long based only on two skulls, one from a beach in Queensland, Australia, in 1882, and another from Somalia in 1955 (Pitman *et al.*, 1999). However, more information has since been collected from about a dozen strandings from various localities in the Indo-Pacific region and about 65 sightings, previously often equivocally identified as southern bottlenose whale *Hyperoodon planifrons* Flower, 1882 (Pitman *et al.*, 1999; Dalebout *et al.*, 2003; Pitman, 2018a). Recently, more strandings have been reported from the Philippines, Maui (Hawaii), Taiwan, Myanmar, Andaman Islands (Pitman, 2018a), South Africa (Best, 2007) and Japan (Kobayashi *et al.*, 2021). Longman's beaked whale, as reflected by its scientific name, is found exclusively in the tropical and subtropical Indo-Pacific region and despite an increasing number of records it remains relatively uncommon (Culik, 2004; Pitman, 2018a). The species was assigned a separate, monotypic genus *Indopacetus* (previously *Mesoplodon*) on morphological grounds (Moore, 1968), later supported by molecular genetics (Dalebout *et al.*, 2003).

There are only a few records of *I. pacificus* known from the Arabian Sea and adjoining water bodies. These include the skull from Danane, Somalia (Azzaroli, 1968), one sighting each in the Gulf of Aden, off Socotra Island, Yemen (Mörzer Bruyns, 1971) and in the southern Bay of Bengal, India (Afsal *et al.*, 2009), one stranding at Veraval, Gujarat coast of India (Kaladahran *et al.*, 2014), five records from Sri Lanka of which three were 'probable' (Pitman, 2018a) reported as bycatch (Dayaratne and Joseph, 1993; and see below) and two as live sightings (Anderson *et al.*, 2006). Finally, 15 records from the Maldives included one stranding and 14 sightings (Anderson *et al.*, 2006).

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The Gujarat coast specimen (Kaladahran *et al.*, 2014) represented the only previous case of this species from the Arabian Sea *sensu stricto.*

No *I. pacificus* are reported from the Persian Gulf, Gulf of Oman, Iran or southern Omani waters (Baldwin *et al.*, 1999; Collins *et al.*, 2002; Baldwin, 2003; Braulik et al., 2010). The species has no mention in tentative catalogues of marine mammal species of Pakistan (Pilleri and Gihr, 1972; de Boer *et al.*, 2002). It neither was recorded during boat and beach surveys carried out in Pakistan from 2005 to 2008 (Gore *et al.*, 2012; Kiani *et al.*, 2014; Iqbal, 2014). Findings of fisher community interviews conducted during the same period neither resulted in any evidence of *I. pacificus* in the Pakistani EEZ (Gore *et al.*, 2012; Kiani *et al.*, 2014).

Fishing activities provide a useful and economical platform of opportunity for studying cetaceans due to their wide spatial and temporal coverage. Fisheries observer programmes are operating in many parts of the world and generating information on bycatch, which is assisting in fisheries monitoring, management and ecosystem and biodiversity conservation (*e.g.*, Baird *et al.*, 2002; Ferrero *et al.*, 2002; Porter, 2009; Mangel *et al.*, 2010; Van Waerebeek *et al.*, 2017). Ancillary data collected by observers helps in updating knowledge on various marine species and completing the biodiversity record in poorly studied areas.

This paper reports on ziphiid net entanglements, including a first positive record of *I. pacificus* and three bycatch cases of *Mesoplodon* spp. in offshore Pakistani waters. We document the circumstances of these unusual records and underscore the potential threat that tuna gillnet fisheries may pose to beaked whales in the Arabian Sea.

MATERIAL AND METHODS

Pelagic drift gillnet fisheries for tuna (Thunnidae) are notorious worldwide for a high rate of bycatch of various taxa of large marine vertebrates including cetaceans, and particularly in the western Indian Ocean (Lewison *et al.*, 2004; Kiszka *et al.*, 2009; Reeves *et al.*, 2013; Temple *et al.*, 2018; Anderson *et al.*, 2020). This type of fishery is wide-spread in Pakistan and offers a welcome opportunistic platform for information gathering on cetacean distribution, especially of evasive offshore species like beaked whales (Nawaz and Moazzam, 2014). Through a joint project with WWF-Pakistan, several of the authors established good working relationships with fishermen on pelagic gillnet tuna vessels, de facto introducing a citizen science strategy (Irwin, 1995; Mwango'mbe *et al.*, 2021).

Fishermen were trained by WWF-Pakistan personnel to collect data on bycatches during fishing operations, resulting in reports of four incidents of live net entanglements of beaked whales. Video evidence for the first record was shared by the boat captain with the Pakistani authors who tentatively identified it as *I. pacificus*, later confirmed by international experts (including KVW). Videos for three other beaked whale encounters was shared by observers on different vessels. Recorded with standard

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cellphones, image resolution was low but useful. Videos were analysed frame-by-frame by KVW using the open-source VLC Media Player (v.3.0.11 Vetinari). Key external features including colouration and scar type and density, body size and shape, presence/absence of visible tusks and morphology of rostrum, melon and dorsal fin were studied. However not all features were evident from the available evidence.

RESULTS

Case 1

On 10 February 2015, early morning, fishermen onboard tuna fishing vessel *Al-Azaan* found a live beaked whale entangled in their tuna gillnet at about 95 km west from the southern tip of the 'Swatch' or Indus undersea Canyon (Kolla and Coumes, 1985) and *ca.* 177 km from the nearest Pakistan's Sindh coast baseline, at GPS coordinates 23°09'N, 65°57'E (Fig. 1). The water depth at the location of first encounter was 1,571 m. A video[1] , archived by the authors, showed a fairly large beaked whale, estimated to measure 5-6 m in length with a slender body, moderately prominent melon and a long distinct rostrum ('beak'), without protruding teeth. The lack of visible teeth, the limited linear body scarring (tooth rakes) and low bulbosity of melon (Fig. 2) rather suggests a female (Carwardine, 2020) assuming the animal was adult. It had a slightly paler head against an otherwise plain brownish-grey dorsal colouration and a large, falcate, dolphin-like dorsal fin, set two-thirds of the way along the dorsum (Fig. 2).

These characteristics in combination with the tropical Indian Ocean biotope are indicative of *I. pacificus*. Cookiecutter shark (*Isistius* sp.) bite scars were not evident. The whale became entangled during net retrieval, allowing fishers to respond in time. The crew initiated a 30 min. long rescue operation by cutting a part of the gillnet resulting in the successful release of the animal, without any apparent injury. However, one of the rescuers was slightly injured approaching the flukes when disentangling the whale.

Case 2

An unidentified beaked whale, initially tentatively assigned to *I. pacificus*, became live entangled in a drift gillnet in deep offshore water (3,066m) at 21°31'N,65°15'E, at 207 nmiles from nearest Pakistan coast baseline, on 31.03.2017. Its release was filmed [2]. This record is offshore 'Swatch' area but still falls within the Pakistan continental shelf. The beaked whale showed morphological features more

1 https://vimeo.com/11952377 or https://www.youtube.com/watch?v=BFJvMrEn5GU

2 https://www.youtube.com/watch?v=slo6o-z6DLQ

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consistent with *Mesoplodon* sp., such as potentially *M. ginkgodens* or *M. hotaula*. Its body length was guesstimated at *ca.* 4 m. It had a noticeable but non-bulbous melon, a moderately long, poorly defined, rostrum and a fairly low, medium-sized, subtriangular, only slightly falcate (at tip) dorsal fin, set backwards. Dorsally and on the flanks the colouration was an even grey, darker on the tailstock, without any visible linear scars, cookiecutter shark bites or other marks. The small head appeared only slightly paler than the upper trunk. No obvious linear scarring or cookie-cutter shark bites were noticeable. The video shows [2], as the fishermen reported, that the animal was released alive.

Case 3

A moderately small to mid-sized beaked whale, identified as a *Mesoplodon* sp., was recorded entangled at 20°51'N, 65°43'E in far offshore, deep (3,194 m) waters, 256 nmiles from nearest Pakistan coastline, on 18.01.2018. Body size was estimated at 3.5 - 4.5 m, with a medium-length rostrum and a non-bulbous head. The flukes showed no median notch. Colouration, as well as the absence or presence of tooth rakes and other scars, was not possible to determine because of adverse lighting conditions and low resolution. However the rostrum appeared to be slightly paler than the body. The fishermen who filmed the event[3] reported that the whale was successfully disentangled and released alive.

Case 4

A unique incident of two beaked whales entangled alive simultaneously in the same gillnet occurred at 23°59'N, 65°51'E in continental slope waters (depth 295 m) off Churna Island (west of Karachi) and 51.7 nmiles from the nearest Pakistani coastline, on 19.03.2018.

Estimated body size of the smaller animal was comparable to, or only slightly larger than, an adult common bottlenose dolphin *Tursiops truncatus*, *i.e.* ~3 - 3.5 m. Dorsum was fairly dark grey and ventrum was whitish. The rostrum was very short and there was no indication of a bulbous melon. Hence, we confidently identify these are *Mesoplodon* sp., not *I. pacificus*. The dorsal fin of the smallest individual was falcate. Except for its flukes, the larger animal (to tell from relative fluke width) is not shown in the footage. The fate of the animals could not be confirmed from the video evidence[4] though the fishers reported that they were released alive.

3 https://www.youtube.com/watch?v=dKp6GG_Pztg&t=6s

4 https://drive.google.com/file/d/1y5k2nzbfVXAeB3SfYOuSMK_zrRNNpTxb/view?usp=drive_web

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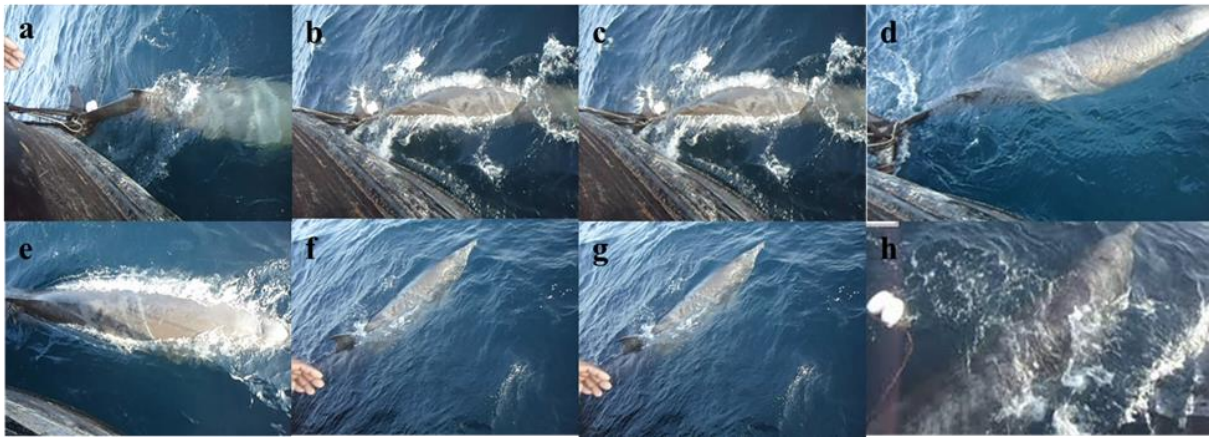

Figure 1: Location of drift gillnet entanglements of *Indopacetus pacificus* (1) and *Mesoplodon* sp. (2-4) in offshore Pakistani EEZ, northern Arabian Sea. See text for circumstances.

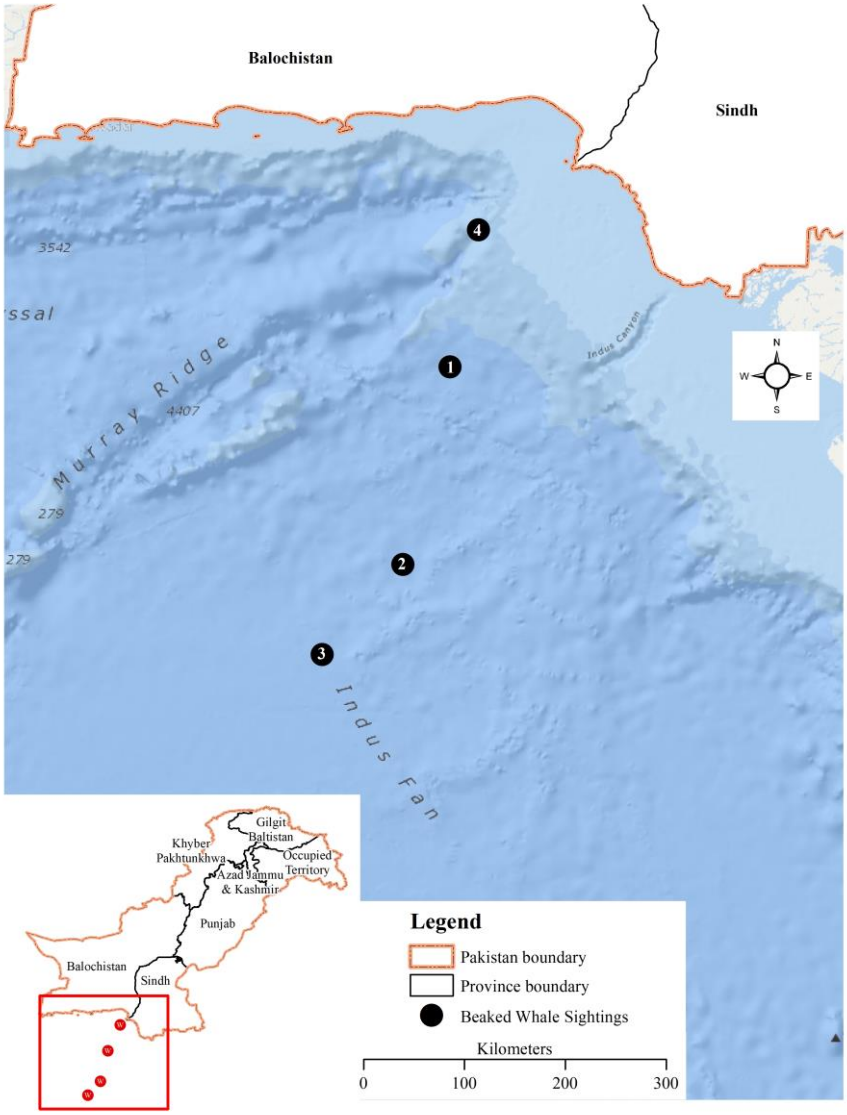

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Figure 2 (a-h): A composite figure showing successive steps in gillnet disentanglement operation of a Longman's beaked whale *Indopacetus pacificus* (Case 1). Note the head with moderately bulbous melon (e,h), long rostrum (f,g,h) tubular in dorsal view(h), limited linear scarring (e) and large falcate dorsal fin (f,g). A video (see text) demonstrates this in more detail.

DISCUSSION

Case 1 represents the first documented record of *I. pacificus* in Pakistan's EEZ waters and considering the earlier stranding at Gujarat, India (Kaladahran *et al*., 2014) a second case for the northern Arabian Sea, which until recently was considered merely 'possible range' (Jefferson *et al*., 2015; Pitman, 2018a). A similar argument can be construed for the *Mesoplodon* spp. (cases 2-4) for which, so far we know, no former authenticated records exist in the study area (see Pilleri and Gihr, 1972; Baldwin *et al.*, 1999; Collins *et al.*, 2002; Baldwin, 2003; Braulik *et al.*, 2010; Kiani *et al*., 2013). Unfortunately the photographic evidence is insufficient to identify these beaked whales to species level. However, some of the middle-sized mesoplodonts known to be distributed in the tropical parts of the Indian Ocean such as ginkgo-toothed beaked whale *Mesoplodon ginkgodens* Nishiwaki and Kamiya, 1958 and Deraniyagala's beaked whale *Mesoplodon hotaula* Deraniyagala, 1963 (Dalebout *et al.*, 2014; Pitman, 2018b; Carwardine, 2020) come to mind. There was no indication of erupted tusks, a strongly arched mandible line or noticeable linear tooth rakes in any of the specimens, strongly suggesting none were adult males.

Three incidental captures of small beaked whales, initially identified as southern bottlenose whale *Hyperoodon planifrons* were reported from Sri Lanka, two off Beruwela, Western Province, and one off the south coast, in 1991-1992 (Dayaratne and Joseph, 1993). No photos or morphological descriptions are available, except that the body lengths ranged between 270 and 330 cm (Dayaratne and Joseph, 1993; p.18). Incongruously, southern bottlenose whales are very large, up to 780 cm, are cold-water adapted and not confirmed to occur in (sub)tropical waters (Best, 2007). Dozens of reported cases of 'tropical bottlenose whales' have since been re-assigned, almost by default, to *I. pacificus* (Pitman *et al.*, 1999; Dalebout *et al.*, 2003; Best, 2007). However in some instances convincing morphological evidence was lacking and the exclusion of other possible ziphiids was premature. With respect to the Sri Lanka animals, Anderson *et al.* (2006) and Pitman (2018a) more carefully referred to 'probable' Longman's beaked whales.

Calves of *I. pacificus* may be just under 3 m at birth (Best, 2007). The smallest known live neonate, from South Africa, measured 291 cm (Best, 2007). If indeed *I. pacificus*, then all three Sri Lanka specimens had to be neonates or small calves, the likelihood of which seems rather remote. Bycatches of this age cohort are extremely scarce in the global ziphiid record. For instance, till date none are registered for *M. peruvianus*, the most frequently net entangled mesoplodont (Reyes and Van

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Waerebeek, 2018). We conclude that the Sri Lankan beaked whales cannot be positively identified and should remain *incertae sedis.*

This work documents the first case of a successful rescue and release of a Longman's beaked whale entangled in fishing gear anywhere in the world. The location (Fig. 1) is oceanic and in the relative vicinity (*ca*. 90 km) of the 'Swatch' or Indus undersea Canyon (Kolla and Coumes, 1985). The Swatch and surrounding deep waters are very important as fishing ground for tuna and other large pelagic fishes and for biodiversity, specifically deep water species of fish, cetaceans and other large marine vertebrates (e.g., Ahmed, 1985; Mikhalev, 1997, 2000; Kiani *et al.*, 2013). Tuna fishery is important in Pakistan contributing about 40,000 metric tons annually. Only five out of eight species of tuna known from Pakistani waters are caught in commercial quantities including yellowfin *Thunnus albacares*, longtail *Thunnus tonggol*, skipjack *Katsuwonus pelamis*, kawakawa *Euthynnus affinis* and frigate mackerel *Auxis thazard*. Other species *viz.* bigeye tuna *Thunnus obesus*, bullet tuna *Auxis rochei* and striped bonito *Sarda orientalis* are not so common in Pakistan (Moazzam and Nawaz, 2014).

Overlapping distribution of these beaked whales with commercial tuna fishing grounds off Pakistan is a matter of concern. There is a need to involve more trained observers onboard tuna gillnet vessels (currently only 80-90) and increase spatial and temporal coverage, in order to obtain more robust data for devising a mechanism of precluding or minimizing conflict with fisheries, as suggested by the National Plan of Action for Conservation of Marine cetaceans of Pakistan (Gore, 2008). It should be noted that the Pakistan continental shelf area (and thus EEZ) has been increased from 200 nm to 350 nm as per decision of the United Nations' Commission on the Limits of the Continental Shelf (CLCS) in 2010. [5]

The Pakistani tuna gillnet fleet consists of about 700 locally manufactured wooden boats. The boats operating in the east, from Karachi, Sindh coast, are usually large, 15-20 m in length, as compared to smaller boats, some 10-15 m, in Balochistan, on Pakistan's west coast (Moazzam and Nawaz, 2014). These vessels (Fig. 3) have 50-500 hp inboard engines and, usually, two hydraulically operated net haulers. Moreover they are equipped with fish finders, GPS system, satellite phone and occasionally VHF radios.

5 https://tribune.com.pk/story/856375/pakistan-granted-extension-of-continental-shelf-fo

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Figure 3 : Pakistani tuna fishing vessels: (a) large (23 m length) fishing boat in open sea, and (b) a smaller boat (12.5 m) beached at Jiwani, Balochistan. (Photo credit: Muhammad Moazzam).

Surface deployed multifilament twisted twine polyamide gillnets with mesh sizes ranging 130-170 mm, with a hanging ratio of 0.5, are commonly used for catching tuna in Pakistan. The lengths of these nets depend on the area of operation, water depth and target species and may vary from 2.4-12 km in inshore and neritic waters and up to 6.0-12.6 km in offshore waters. Infrequently, some boats operating at high seas may even deploy 13-20 km long nets. The depth of the nets is a uniform 14 m, independent of length. Nets are set in the afternoon at around 16:00 for 12 hours and retrieval is started at 04:00.

In Pakistan, tuna fishing starts in mid-August and reaches its peak in March-April (Nawaz and Moazzam, 2014). Catches drop slightly in December-January due to the prevalence of low oxygen levels. Fishing curtails considerably in May and no fishing is carried out in June and July due to peaking of the turbulent southwest monsoon period (Nawaz and Moazzam, 2014).

Drift gillnets are considered the most harmful fishing gear for cetaceans in Pakistan (Moazzam and Nawaz, 2014), as elsewhere (*e.g.*, Jefferson and Curry, 1994; Perrin *et al.*, 1994; Mangel *et al.*, 2010; Anderson *et al.*, 2020). Niazi (1990) first speculated that cetacean deaths are inflicted in gillnet fisheries off Pakistan due to entanglement. A voluntary monitoring programme was started in 2012, through which four observers were posted on tuna gillnetters operating in coastal and offshore waters of Pakistan (Nawaz and Moazzam, 2014; Moazzam and Nawaz, 2014). It not only generated a wealth of information on the marine biodiversity of Pakistan including some previously unrecorded species such as striped dolphin *Stenella coeruleoalba,* rough-toothed dolphin *Steno bredanensis* (Kiani *et al.*, 2013) and an Indo-Pacific common dolphin *Delphinus delphis tropicalis* (M.S. Kiani, unpublished data), but also provided insights into the extent of mortality of cetaceans and other large marine vertebrates in this fishery. It was estimated that approximately 12,000 cetaceans, mainly dolphins and occasionally large whales, are killed annually (Nawaz and Moazzam, 2014). Most mortalities occurred

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in the month of November (n=3,300), while another peak was observed in March. Other affected species included: Indian Ocean humpback dolphin *Sousa plumbea*, bottlenose dolphins *Tursiops* spp., spinner dolphin *Stenella longirostris*, pantropical spotted dolphin *Stenella attenuata*, Risso's dolphin *Grampus griseus*, Bryde's or Eden's whale *Balaenoptera brydei/edeni* and the Arabian humpback whale *Megaptera novaeangliae* (Moazzam and Nawaz, 2014). All entangled cetaceans were killed except on a few occasions when the captured animals, like the beaked whales reported on here, were rescued by fishers.

Major known threats to beaked whales include underwater noise related to seismic surveying and military activities, plastic debris and directed takes of some of the larger species (Scott *et al.*, 2001; Cox *et al.*, 2006; Yang *et al.*, 2008; Kaladahran *et al.*, 2014; Pitman, 2018b). Gillnet entanglements are neither commonly documented nor have been thought to rank among top threats to ziphiids in general, with the notable exception of *M. peruvianus*. Most study specimens in Peru are derived from bycatches in coastal artisanal drift gillnet operations (Reyes *et al.*, 1991; Reyes and Van Waerebeek, 2018). Other species that suffer a certain level of bycatch in gillnets globally include Cuvier's beaked whale *Ziphius cavirostris*, Baird's beaked whale *Berardius bairdii*, ginkgo-toothed beaked whale *Mesoplodon ginkgodens* (Reeves *et al.*, 2002) and *I. pacificus* (this paper). Pitman (2018b) called bycatch in high seas fishing gear an important human-caused threat for *Mesoplodon* spp. Concerns have been raised previously about beaked whale entanglements in gillnet fisheries in the Arabian Sea and contiguous waters based on the above-mentioned incidents off Sri Lanka (Dayaratne and Joseph, 1993; Anderson *et al.*, 2006). Presently, the 7 known bycatch cases (8 individuals) support the warnings that drift gillnets deployed in pelagic offshore waters of the western Indian Ocean are a potential threat to beaked whales, although true levels of mortality are unknown (Anderson *et al.*, 2006; Pitman, 2018b).

Fishers allege that one of the factors that may cause entanglements of toothed cetaceans in tuna drift gillnets is their tendency of depredation on catch. However, no beaked whales are known to feed on tuna or other large fishes (McLeod, 2018; Pitman, 2018a,b), but likely they share with tuna some prey species such as mesopelagic squid and smaller fishes, which could explain the apparent association. These accumulating ziphiid bycatch incidents are a new challenge for Pakistan's Biodiversity Action Plan and for the development of an efficient strategy for cetacean conservation in Pakistan. The Action Plan for Conservation of Marine Cetaceans of Pakistan (Gore, 2008) discusses the various dynamics of fisheries interactions with cetaceans in both inshore and offshore waters and proposes a set of logical and coordinated actions as mitigation measures.

While the rescue actions by fishers are a welcome sign for cetacean conservation and welfare in Pakistan, they also highlight the need for greater awareness among the wider fishers communities about the proper methodology for releasing entangled cetaceans. The fisheries observer programme

run by WWF-Pakistan was discontinued in September 2019 due to lack of funding, however the trained participants still share some information opportunistically. Unfortunately government departments do not implement any regular observer effort on tuna vessels. A long-term national cetacean disentanglement programme should be developed to guide fishers as well as fisheries observers to address future incidents. In the meantime a continuation of video-recording of cetacean entanglements by fishers is greatly encouraged. A larger-scale awareness-building programme that can convince fisheries managers and fishers to modify current fishing techniques and gears or switch to more eco-friendly ones as to reduce bycatch, could help mitigate the impact on populations of rare ziphiids, including the Longman's beaked whale, in the Arabian Sea.

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