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PINGERS: can be the eyes of blind ganges dolphins (*Platanista Gangetica Gangetica*, Roxburgh 1801)

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Abstract

The growing need for fish extraction for livelihood is resulting in the by-catch mortality and injury of the aquatic mammals through fishing gear entanglement. It is one of the most significant issue of conservation of Ganges Dolphin. The inability of Ganges dolphins to identify the presence of monofilament gill nets results in entanglement and death due to suffocation. In this study, the interactions of Ganges dolphin with fishing gear (Gill net) by attaching Pingers have been investigated. It was assumed that the proximity zone around the fishing gear is the risk zone for the Ganges dolphin. A visual observation was made in an experimental set up of: Control Net (Without reflectors or Pingers), Net with reflectors (used locally to attract fish), Pinger with frequency and source level lower than what is used by Ganges dolphins (10KHz and 132 decibel) and Pingers with Ganges dolphin frequency (70KHz and 145 decibel). A significant difference in mean sighting distance of Ganges dolphins from different experimental set upss has been estimated. Nearest proximity in control net was <1m with a sighting rate of 1.41 sightings/hr whereas for Dolphin Pingers it was 5 to 10m with a sighting rate of 0.12 sightings/hr. Dolphins seem to avoid fishing gear with active Pingers and hence the experiment was to be carried forward to the next level of estimation for determining whether there was any attraction or change in catch per unit effort (CPUE) of fish or habituation of dolphin. Popularising the efficiency of Pingers among management stakeholders and introducing it to the fisher communities can be the next significant step to conserve the species.

Key words: Ganges dolphin, echolocation, entanglement, Pingers, reflectors.

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INTRODUCTION

Interaction of aquatic mammals and commercial fisheries is an age-old history (Reeves *et al.*, 2001). However, increasing demand for fish in the market with growing human population caused depleting fish population for aquatic mammals as well as for humans. The increasing fishing pressure results in the by-catch mortality and injury of the aquatic mammals and becoming the most significant issue of conservation of these animals (Mitchell, 1975; Woodley and Lavigne, 1991; Perin*et al.*, 1994; Broadhurst, 1998; Secchi and Vaske, 1998; Read *et al.*, 1998; Donoghue *et al.*, 2002; Noke and Odell, 2002; Cox *et al.*, 2004; Lauriano*et al.*, 2004; Read *et al.*, 2006; Brotons*et al.*, 2008; Read, 2005; Sigler *et al.*, 2008; Read, 2008). Hall (1996) defined it in a more negative connotation for the fishers or environmentalists, who says 'it is that part of the capture that is discarded in the water, dead (or injured to the extent that death is the result).' The incidences came to the notice when millions of dolphins got killed in tropical eastern Pacific (NRC, 1992) with the growing commercial fishing industries and the evolved purse seines fishing of the pelagic fishes (IWC, 1980).

Since then various experiments were carried out with passive and active methods to reduce the fishery interactions in marine fisheries (reviewed in Jefferson and Curry, 1996). The passive methods include net modification (Barham *et al.*, 1977; Leatherwood *et al.*, 1977; Norris, 1978; Pryor and Norris, 1978, Coe *et al.*, 1985) and some add-on-reflectors (Au and Jones, 1991; Au, 1994) which make them detectable to dolphins. Although few experiments showed some behavioural responses of small cetaceans towards passive reflectors (Goodson *et al.*, 1994; Silber *et al.*, 1994), however, the sample sizes and absence of controlled experiments to compare with the reality, made studies inconclusive (Hasegawa *et al.*, 1987). Most of the trials did not end up with any significant differences (Snow *et al.*, 1988; Jones, 1990; Goodson and Datta, 1992; Dawson, 1994; Goodson *et al.*, 1994; Hatakeyama*et al.*, 1994) or work only other way round (Hembree and Harwood, 1987; Goodson, 1990) or too expensive to continue (Peddemors*et al.*, 1991).

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The active methods do not rely on animal echolocation behaviour but produce sounds which are audible to the animal to deter them from the gears. People have tested gunshots to keep Australian Fur seals (Pemberton and Shaughnessy, 1993), dolphins in the Mediterranean (Ravel, 1963), Killer whales of Alaskan waters (Matkin, 1986; Dahlheim, 1988) at bay from the fish farms or explosives such as "seal bombs, Thunderflash, Beluga firecrackers, Cracker shells", etc. were manufactured commercially (Mate and Miller, 1983; Awbrey and Thomas, 1987) to deter seals or pinnipeds. These techniques however never worked out and were found that the animals got habituated to them with time (Shaughnessy, 1981; Mate and Miller, 1983; Matkin, 1986; Matkin*et al.*, 1987; Awbrey and Thomas, 1987; Scholl and Hanan, 1987; Steiner, 1987; Dahlheim, 1988). Eventually, by 1990s, these methods have been banned from US waters on the basis that it could cause serious harms to the animals (Myrick *et al.*, 1990; Myrick *et al.*, 1990).

Other active methods were more mechanical like playing biological sounds (Cummings *et al.*, 1971; Fish and Vania, 1971; Anderson and Hawkins, 1978; Shaughnessy *et al.*, 1981) or placing mechanical sound generators like non- electronic clangers, rattles, bell bouys and bang pipes (Kasuya, 1985; Peddemors*et al.*, 1991; Nasaka, 1979) underwater. They showed the minimum or no- response and were considered outdated (Fish and Vania, 1971; Anderson and Hawkins, 1978; Shaughnessy *et al.*, 1981; Coe *et al.*, 1985; Matkin*et al.*, 1987; Dahlheim, 1988).

The recent development in the technology is the production of electronic active sound generators which were previously categorized under two sets, viz. acoustic deterrent devices (ADDs) to address the problem of bycatch and acoustic harassment devices (AHDs) to mitigate depredation (Dawson, 2013). These devices are more abrasive emitters and hence were used initially in commercial fisheries to deter pinnipeds (Johnston and Woodley, 1998; Quick *et al.*, 2004) or harbour seals (Mate and Greenlaw, 1987). The effectiveness of the technology was experimented and the significant reduction in depredation and bycatches were observed later (Kraus *et al.*, 1997; Tripple*et al.*, 1999; Barlow and Cameron, 2003; Leeney, 2007; Carretta*et al.*, 2008; Gazo*et al.*, 2008; Buscaino*et al.*, 2009; Carretta and Barlow, 2011). With the increasing concerns about bycatch and depredation (Read, 2008), its use has become mandatory in some of those commercial fisheries (Anderson *et al.*, 1996; Bordino*et al.*, 2002). However, 100% efficacy of Pingers on Commercial fisheries is still questioned (Dawson *et al.*, 1998; Dawson *et al.*, 2013). There are also incidents which suggest no complete elimination of by-catch or depredation interactions (Brontons *et al.*, 2008b; Wapples*et al.*, 2013) and two other incidences when entanglement happened in nets loaded (Northridge *et al.*, 2003; Read and Wapples, 2010) with active Pingers.

This article, deals with the efficacy of Pingers on freshwater Ganges dolphins for the first time. Since the animal is almost blind (Herald *et al.*, 1969) and relies continuously on sonar clicks for echolocation, get entangled very often in fishing gears (Sinha, 2002; Mansur *et al.*, 2008) which were made of materials acoustically transparent, in this case, monofilament gillnets. Although, the intensity of getting entangled is not comparable to the marine odontocetes, the entire remaining population of Ganges dolphins, which is about 3000 individuals, is to be considered. (Sinha and Kannan, 2014). In 2008, out of 21 dolphin mortality reported from Brahmaputra, 20 were the victims of gillnet entanglement (Wakid, 2010). Hence, gillnet entanglement can be considered as a serious concern for the conservation of the species. In a developing country like India, with growing competition for resource extraction, where the socio-economic condition and awareness levels among fishers community are so low, that logistical loss of gear damage due to dolphin entanglement, is given priority to dolphin life. Hence it is essential to work out to reduce the interactions of fisheries and dolphins for the conservation of the species, and this is an attempt towards that goal.

Study area

Kulsi River flows through the lower Kulsi basin (extends latitudinally from 25°45'N along the Northern foothills of the Meghalaya Plateau to 26°10'N along the southern bank of Brahmaputra and longitudinally from 90°55'E to 91°35'E) in the western part of Kamrup rural district in Assam. The river originates on the West Khasi Hills ranges of Meghalaya (25°38' N and 91°38' E) at an elevation of about 1500m from the sea level and flows down to finally discharge into the Brahmaputra at Nagarbera. The length of the river is about 120 km in Meghalaya, and about 135km in Assam (Kalita, 1991). In Meghalaya, the river comprised of three important streams, viz., the Khri, the Krishniya and the Umsiri which originate on the same hill ranges. These three streams again joined with several hilly rills, streams and rivulets, and meet at Umkiam*beel* (25°38' N and 91°38' E) and is known as Kulsi from this point.

The experiment was carried out with a group of 4-5 dolphins at Kulsi River in a 3.95km stretch of Kulsi River near Malibari village (from N 26°3'36.22'' and E 91°7'46.7'' to N 26°3'19.04'' and E 91°9'40.43''). The stretch is also frequently used by the fishers of the area.

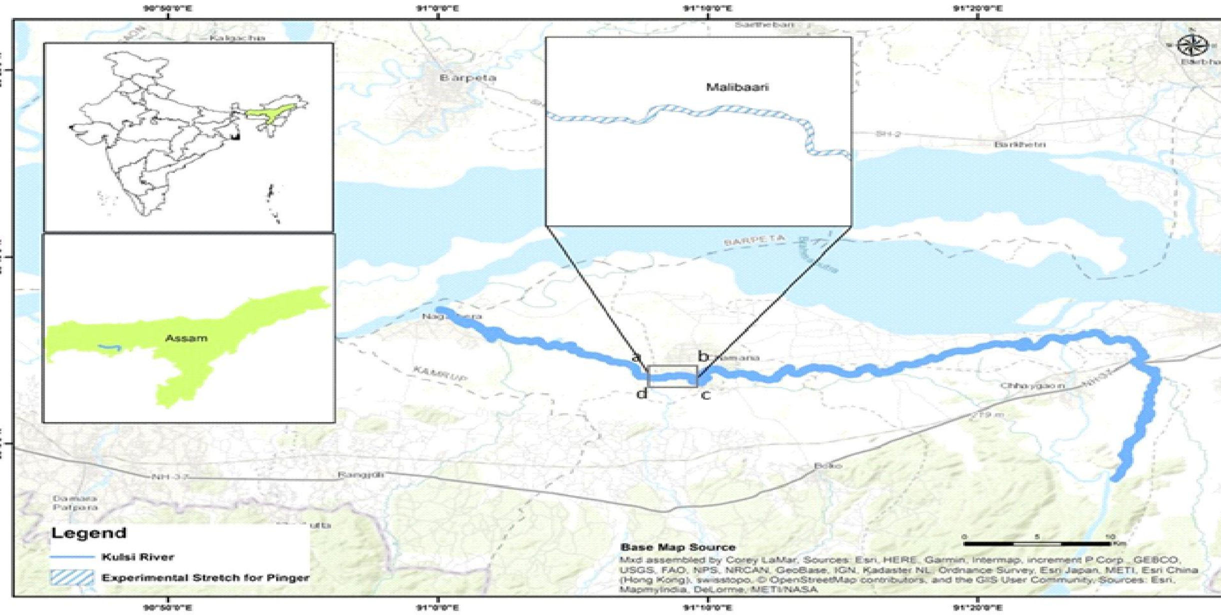

Fig. 1. Kulsi river and study area (Box)

MATERIALS AND METHODS

Field Methods and Data Analyses

A monofilament gill net of 150m length and 4cm mesh size was used for the experiment, which is also a commonly used dimension of gillnet by the fishers' community of Kulsi River. The study was carried out from January- March 2017. Four fishing gear set ups were made to test the interaction of Ganges dolphin:

(i) Gill net without any reflectors or Pingers loaded on it (Control)

(ii) Gill net loaded with different reflectors used locally by the fishermen, which could make noise in water (thermocol pieces / empty plastic bottles / banana plant bark).

(iii) Gill net loaded with active Pingers with frequency and sound source level (10kHz, 132 decibels) lower than used by Ganges dolphins (70kHz, 145 decibels)

(iv) Gill net loaded with active Pingers with frequency and sound source level similar to Ganges dolphins.

The Pingers were developed by the group of Future Oceans Pingers (www.futureoceans.com) (Fig.2). The power supply to the Pinger was a 3.6volts, 8500mAh lithium-ion non- rechargeable battery. Pingers turn on automatically when submerged in water and within 60 seconds of start-up delay. In each 100m of the net one Pinger was loaded to maintain the covering range of the Pinger (100m radius). The Pinger emits the signal at 4 seconds interval.

Fig. 2 a. Pinger,b. deploying in Freshwater

The gill net in each set up was fixed in a position, and the dolphin movement was observed with the help of two experienced observers on both upstream and downstream of the net (Fig. 3). Since in case of Ganges dolphin, the entanglement rate is lower to that of Marine cetaceans, the proximity of the dolphins to the fishing gear was considered as the line of threat in this study. With every dolphin sighting the observer recorded the time of the sighting, the distance of the individual from the net, age structure of the individual (new-born / calf / non- calf) and surfacing patterns (away / towards / along the line) (Dawson and Lusseau, 2005). The surfacing pattern of Ganges dolphin was recorded to understand the movement of the dolphin towards or away from the net, or turning away from or towards the net. The direction of the appearance of the rostrum of the dolphin confirms the position of the dolphin around the net. Along with these other anthropogenic activities occurring in the area were also recorded with each sighting.

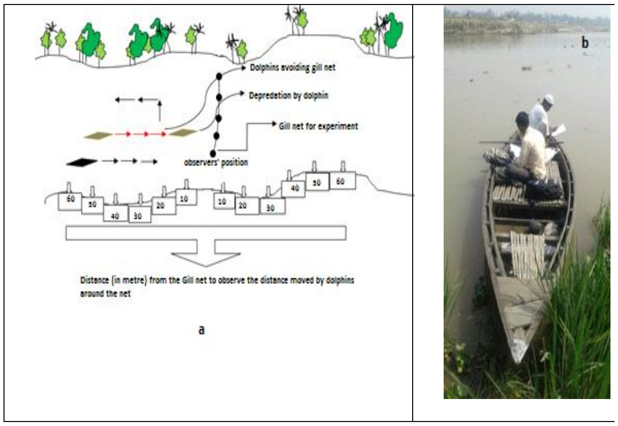

Fig. 3. Field set-up for Pinger experiment (a. showing the gill net and observers' position to record the sighting distance frequencies of dolphins, b. observers' recording data).

The frequency of sighting distances from the fishing gear was estimated to compare the proximity of Ganges dolphins to the control of fishing gear set up with rest of the three experimental set upss. The mean distance of the Ganges dolphin from different experimental set up was estimated. A Chi-square test was made to compare the frequency of distance observed between control and different experimental set upss. Data were analysed by using MS Excel and R software.

The upstream (towards the net) and downstream (away from the net) and the turning point from the net was estimated for all the four experimental set upss.

RESULTS

The dolphin behaviour around the control and experimental set ups was observed for 375 hrs (Table 1). The sighting rates declined at a minimum range of 1-2m and at a maximum range of 80-85m onwards from the net (Fig 2- 4). The sighting intensity declined near the net because of the presence of fishing net itself, whereas on the other hand, as the animal moved away, the sighting intensity declined again because of the observers' limitation. Hence the distance recorded beyond 30m was discarded.

Table.1. Total duration of observation around different experimental set-ups

Experimental Set up	Total observation time (hh:mm:ss)
Control net	69:54:00
With reflectors	59:34:00
With Porpoise Pingers	36:36:00
With Dolphin Pingers	21:43:00

The nearest proximity of dolphin was recorded minimum (<1m) for Control net with a sighting rate of 0.01 sightings/hr, and highest was for experimental set up with active Dolphin Pingers (4-5m) with a sighting rate of 0.02 sightings/hr (Fig. 4- 7). The probable reason behind this was that the reflectors used for the experiment were locally used by the fishermen on the nets as floats or attractant for the fishes (plastic bottles, the bark of banana plant) which could probably act as an attractant for dolphins too. Chi-square test has shown a significant difference between the distance frequencies obtained in control and three experiments (Table 2).

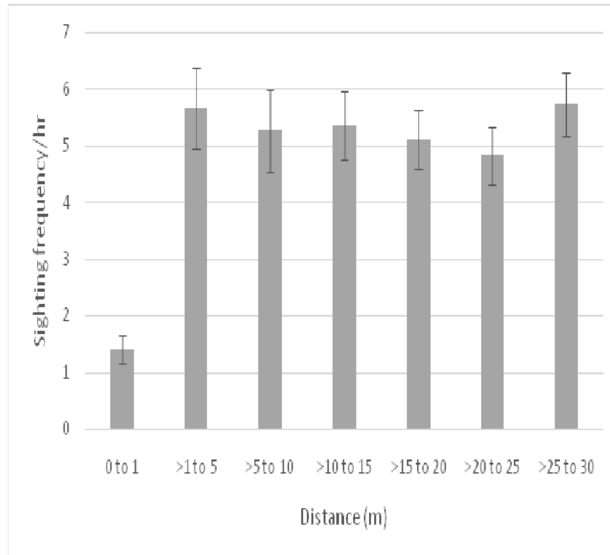

Fig.4. The frequency of dolphin sightings in different distance ranges with control Gear set ups (without Pingers and reflectors)

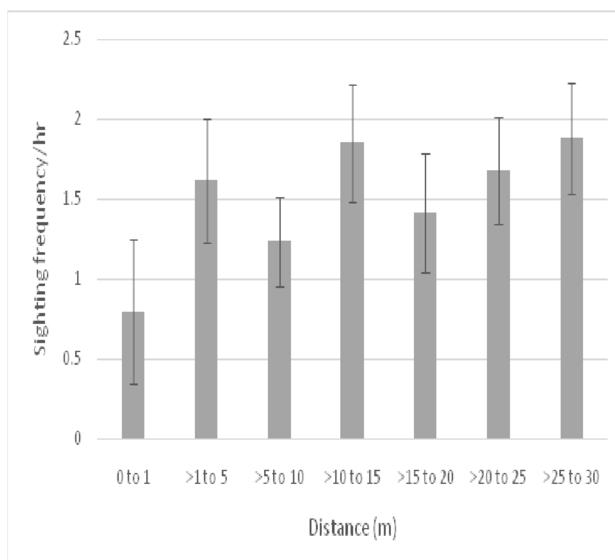

Fig.5. The frequency of dolphin sightings in different distance ranges with Gear set upss loaded with reflectors (bark of the banana plant, plastic bottles)

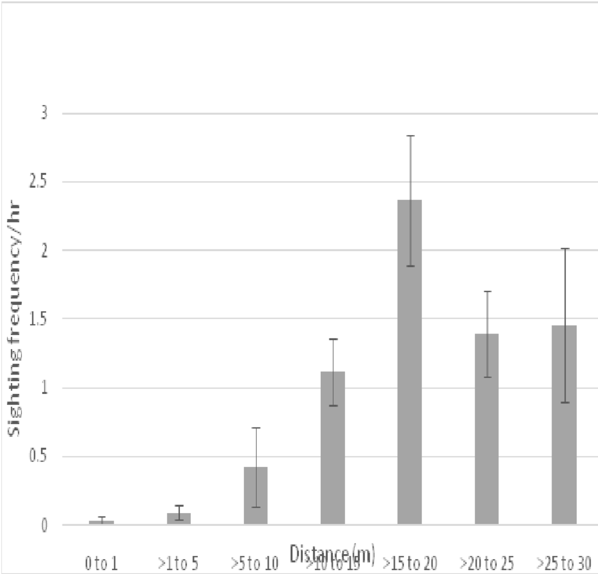

Fig.6. The frequency of dolphin sightings in different distance ranges with Gear set ups loaded with Porpoise Pingers (10kHz)

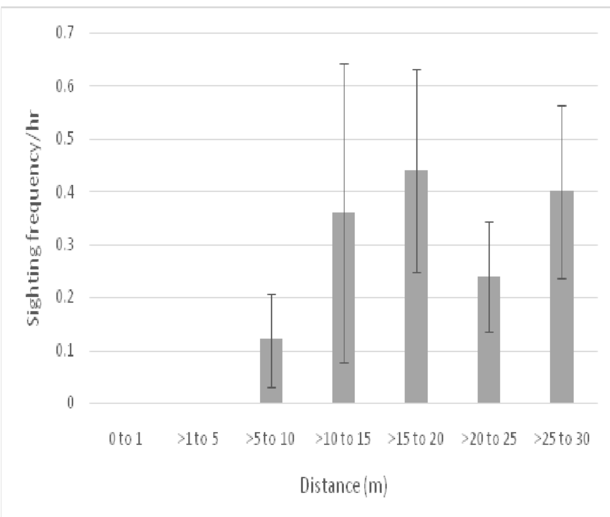

Fig.7. The frequency of dolphin sightings in different distance ranges with Gear set upss loaded with Dolphin Pingers (70kHz)

Table.2. Comparison of sighting distance frequency between different experimental set-ups

Comparisons	Chi-square	df	p- value
Control- Reflector	14.72	6	0.02
Control- Porpoise Pinger	48.12	6	0.001
Control- Dolphin Pinger	13.26	6	0.04
Reflector-Porpoise Pinger	35.47	6	0.001
Reflector-Dolphin Pinger	8.08	6	0.23
Porpoise Pinger- Dolphin Pinger	7.59	6	0.27

The frequency of sighting distance of Ganges dolphins and different patterns of movement around the experimental set upss for Pinger experiment

The dolphins were seen turning back and swimming away from the net during the trial, which could be considered as their range of detecting the net while approaching. The minimum distance recorded from where the dolphins turned back was <1m while using the controlled net. However, this detectability range increased to 6- 7 m when Pinger loaded net was introduced.

Age structure wise behaviour around the nets set ups

The distance for new-born and calves near the control net was recorded from 1 m and above from the net whereas adults were recorded <1m from the net. In the net with reflectors, a similar pattern of movement among the three age structures of dolphins was recorded, i.e., about a 1m distance from the net. In net with Porpoise Pingers, the nearest proximity of the new-born was at a range of 8 to 9 m from the net; calves were recorded at a distance of 4 to 5 from the net and adults were recorded at about 1m distance from the net. In the net with active Dolphin Pingers, the nearest proximity of the new-born was 9 to 10 m from the net, calves were recorded at 4 to 5 m from the net, and the adults were recorded 6 to 7m from the net. The average frequency estimation for new-born and calf was found more in different distance ranges with the active dolphin Pingers (Fig. 8).

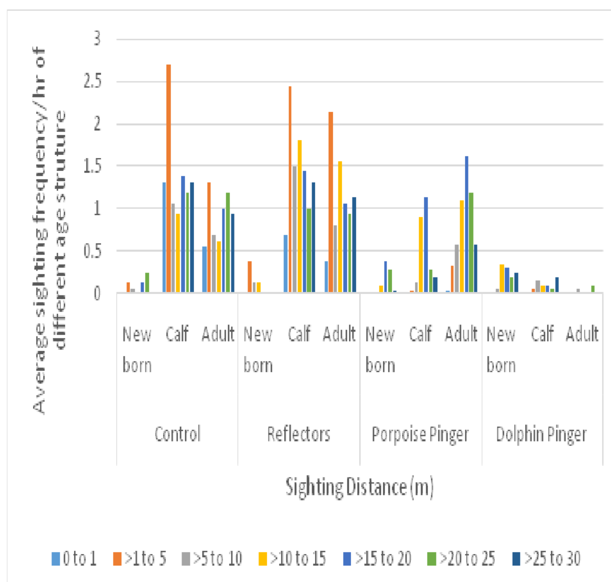

Fig.8. Average sighting frequency (per hour) of different age classes of dolphin in different experimental set ups.

DISCUSSION

Significant results (70% reduction in bycatch) were also observed in the controlled experiments addressing bycatch in Argentina (Bordino*et al.*, 2002), off California (Barlow and Cameron, 2003) and off Peru (AlferoShighuetu, 2010) with Netmark 1000 Pingers. However, consistent results were not seen for another two Pinger types (Aquamark 200 and Femunda10kHz) (Imbert*et al.*, 2007). The probable reasons cited were sparingly loaded nets and not in correct spacing (than the one instructed from the company), depleted batteries and sometimes fatal attraction of the animals than displacement (Dawson *et al.*, 2013). Hence, it is vital to properly space the Pingers on the net since a bigger gap in signals in between can mislead the dolphins, which can give them an impression of narrow escape and can lead to entanglement or increase in bycatch rate (Palka *et al.*, 2008; Carretta and Barlow, 2011). Also a low level of battery will lead to decreased sound pressure level and frequency which ultimately will not displace the dolphins.

In our study, in all the experimental set ups, it was observed that the dolphins turned back from the nearest proximity of the gear without getting entangled. The probable reason behind it could be related to the time of the experiment, which was done during winter or low water season. The low water depth also allows to increase their detectability ranges, as we had seen that the maximum casualties always happened during Monsoons or high water season when the water volume and velocities were on its peak. This might be due to high water velocity which could make dolphins deaf and make them near impossible to echolocate the fine monofilaments of Gill net.

Though our study has shown some impact of Pingers on Ganges dolphins, the experiment was of short duration. Hence carrying forward the Pinger experiment on fresh water dolphins to the next level is necessary. Specific questions such as effect in CPUE of the fish in active gears, behavioural responses of Ganges dolphins towards Pinger, either they would habituate or entirely avoid their critical habitats in the long run; the seasonal efficacy of Pingers; how readily would the fisher community accept it, etc., needed to be addressed in the future. However, questions such as CPUE of fish in active nets in marine habitat did not show significant differences (Barlow and Cameron, 2003). But on the other hand, it has been reported that there is always an issue of compliance in the fisheries, and hence proper implementation is difficult even for the most sophisticated fisheries of developed countries (Dawson *et al.*, 2013). Many insignificant studies on Pinger were the results of such inconvenience (Tripple*et al.*, 1999; Dawson and Slooten, 2005; Orphanides, 2012). However, proper channelization of education and outreach programmes for the communities and enforcement, whenever required, would be some critical points for effective implementations (Dawson *et al.*, 2013). It is always suggested that employing Pingers along with other mitigation approaches such as time-area closure and gear modification could lead to successful implementation (Dawson *et al.*, 2013). The state's fishery department has to play a vital role for handling such a crucial issue of Ganges dolphin conservation which will be a holistic approach towards saving the entire freshwater habitats.

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