STATUS OF GANGES RIVER DOLPHINS, THREATS AND BEST PRACTICES FOR CONSERVATION 2021

भारतीय वन्यजीव संस्थान
Wildlife Institute of India

Status of Ganges River Dolphins, Threats and Brest Practices for Conservation 2021

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1 Status of Ganges River Dolphins in India

The South Asian river dolphin is a widely distributed apex predator in Ganga and Brahmaputra river systems. The Gangetic Dolphin ranges into most of the large tributaries in the Ganga Basin: the Chambal, Ramganga, Yamuna, Gomti, Ghaghara, Rapti, Son, Gandak and Kosi, besides the main channel of the Ganga. In the Brahmaputra valley, it ranges into the major tributaries such as the Tista, Adadhar, Champamat, Manas, Bhareli, Subhansiri, Dihang, Dibang, Lohit, Disang, Dikho and Kulsi rivers. Dolphins in the main channel of the Ganga were split into two subpopulations in 1975, when the Farakka Barrage was commissioned. Today they occur in 5 subpopulations within India, the Brahmputra, Bijnor–Narora, Narora–Kanpur Barrage, Kanpur Barrage – Farakka, and Farakka to Ganga Sagar. Anderson also confirmed the presence of the species from Gangetic delta and the Sundarbans, his records also confirm the absence of the species from the northern rocky reaches of Ganga and Yamuna and complete absence of the dolphin from southern peninsular rivers (Anderson 1878).

Dolphin has undergone a major decline from the late 1800s in their range especially in the upstream areas of Ganges system and tributaries. A survey in December 1996 recorded no dolphins between the 100-km stretch of the Ganges River from Bhimgoda Barrage at Haridwar and Bijnor, where this stretch was considered the upstream limit of their historical range (Sinha et al. 2000). Historically, dolphins occurred year-round in the Yamuna River at Delhi (Anderson 1878), and this distribution continued downstream till the Chambal confluence. However, after 1967, dolphin signings have become rare in the Yamuna River above the Chambal River confluence (Sinha et al. 2000). Dolphins have also been extirpated from a 163-km stretch of the Sarda River (Mahakali River in Nepal) between Lower Sarda Barrage at Sardanagar in Uttar Pradesh state and Upper Sarda Barrage (Banbasa Barrage) at Tanakpur along the India-Nepal border in Uttarakhand state during the dry season (Sinha & Sharma, 2003).

What was once thought to be abundant with an estimated population of tens of thousands (Anderson, 1878; though this estimation included the Indus river dolphins), the numbers of these Ganges river dolphins were reported to lie somewhere between 4000 and 5000 towards the end of the 20th century (Jones 1982 and survey in 1986 by Mohan et al., 1997). This was later reported to have dropped to 1800 individuals including the population in the river tributaries by the beginning of the 21st century (Behera et al.,

2008; Bashir et al., 2012; estimated between 1200-1800 by IUCN, 2006; less than 2000 by Mazumder et al., 2014; Smith and Braulik, 2012).

Though due to survey limitations, population trends are not visible for all the stretches, Narora to Allahabad, Chausa to Maniharighat stretch, Farakka to Kakadwip stretch, Chambal and Brahmaputra main survey seem to have a stable population. On the other hand, surveys have confirmed extirpation of populations from many of the tributaries in the last 10-20 years, *viz.,* Son(e), Ken, Betwa, Punpun and Barak. The dolphin populations have been reported to have had a decline of 1/3rd of its population in just 4 generations (Paudel and Koprowski, 2020). Reports have noted the possibilities of more than 50% decline only between 1944 and 1974 (Smith, Braulik and Sinha, 2012). Beyond that, at least 500 known mortalities have occurred since 1980, a considerable proportion from by-catch in the fishing net and intentional killing. Recent studies have also shown a decline of at least 26% of the population over 12 year period in the Brahmaputra region alone (Wakid, 2007; Paudel et al., 2015).

The recent most estimation in the Ganga river basin along with its tributaries stand at 2644 and in Brahmaputra along with its tributaries stand at 987 (survey in 2017-2018 by Qureshi et al., 2018) indicating at least a 50-65% loss since the 19th century. While it needs to be clarified that all these numbers are not estimated using standardised methodology across the range, the decline is however very much indicative of the status of the population.

1.1 Ganga

1.1.1 Uttar Pradesh

A survey in December 1996 recorded no dolphins between the 100-km stretch of the Ganges River from Bhimgoda Barrage at Haridwar and Bijnor (Figure 2.1), this stretch was considered the upstream limit of their historical range (Sinha et al. 2000). The total estimated population in the Uttar Pradesh part of Ganga is around 500 dolphins (extrapolated from encounter rates given in GACMAC, 2018).

For dolphins, there is an unnegotiable need of minimum depth and flow of water, which are critical for their survival. Along with the aforementioned parameters, prey availability and quality of water play an important role in ensuring that the habitat is optimum for them. Along the ganga, however, there is a reduction of flow due to several barrages,

depletion of pray and increased pollution due to very high human density (829 persons/km^2: Source: GOI, 2011), sand mining, and pesticide and chemical runoffs that are untreated in many places. All these factors threaten the very survival of our aquatic animal in the Ganges River. There are many checks that are in place already to control these threats (like treatment of sewage, filtration of chemical waste, ban of particular types of nets etc.,), however it is difficult to monitor the implementation of these on a regular basis on the huge stretch of river, without a proper mechanism in place. Another strategy that could safeguard Ganges river dolphins and other species in this stretch would be to identify critical population hotspots, and ensure protection, monitoring and neutralisation of threats in these areas.

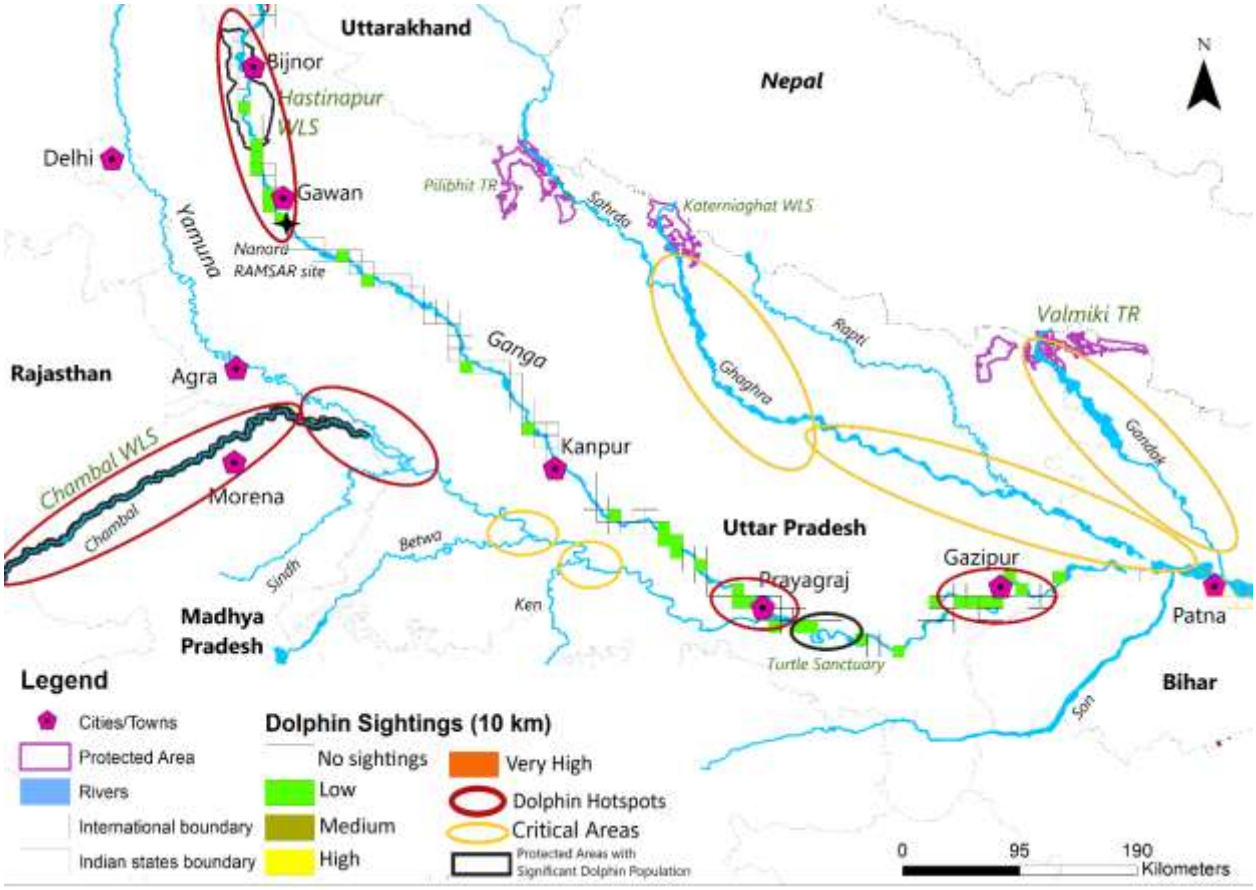

Figure 1 Dolphin hotspots in Uttar Pradesh based on population encounters at every 10km, and critical habitats (in yellow). The categories are classified by pooling population estimates across the entire population of Ganga and Brahmaputra, and dividing the quartiles into the categories depicted here

The Wildlife Institute of India, under the NMCG-WII Project "Biodiversity Conservation and Ganga Rejuvenation" conducted ecological assessment of the Ganga River from Bijnor

to Balia in Uttar Pradesh, covering a total of 1300 km. On the basis of occurrence and distribution of priority species such as Gangetic dolphin, two main river stretches along the mainstem Ganga River were identified (1) Bijnor (N 29.39°, E 78.04°) to Narora (N 28.19°, E 78.40°) (152 km) which is protected as Hastinapur WLS and Upper Ganga Ramsar Site, and (2) Prayagraj (N 25.44°, E 81.87°) to Ballia (N 25.75°, E 84.39°) (395 km) of which a 30 km stretch between Maija in Prayagraj and Gyanpur in Bhadohi is protected as newly created Kachhua Sanctuary.

Apart from population hotspots, it is critical to ensure connectivity to tributaries, as this forms a lifeline of the population during monsoon as well as summer, for local migration of dolphins. Based on population encounter rate, and critical habitats for dolphin, like confluences which are essential to maintain connectivity of mainstem to tributaries, several regions have been identified for concerted action (Table 1), special attention is needed for especially those stretches where no protection infrastructure or mechanism exists currently. For example, Balliya – Buxar – Bhojpur, Amroha – Anupsharhr, the confluence of Ganga and Yamuna at Allahabad, the confluence of Yamuna – Chambal, Yamuna – Ken and Yamuna – Betwa. The Ghaghara river which is a tributary of the Ganga harbours a very good population, and conservation monitoring of this area is absolutely essential to maintain not only its own population but also the population in Ganga. Another important facet of this action would be that, by maintaining the connection between the tributary and main stem, we are ensuring maintainance of critical water flow, necessary for the survival of aquatic biodiversity.

Table 1 Population hotspots and critical conservation regions in Uttar Pradesh stretch of Ganga

State	River	Tehsil	Status	Town/Village/Landmark & Remarks
Uttar Pradesh	Ganga	Bijnor, Jansath, Mawana, Hasanpur	Protected	Hastinapur WLS to Narora
Uttar Pradesh	Ganga	Anupsharhr Amroha	Non Protected	Gawan Town, Downstream of Hastinapur WLS

Uttar Pradesh	Ganga	Soraon, Allahabad, Phulpur	Non Protected	Prayagraj (Ganga - Yamuna Confluence)
Uttar Pradesh	Ganga	Prayagraj	Protected	Maija to Gyanpur (Turtle sanctuary)
Uttar Pradesh	Ganga	Gazipur, Saidpur, Zamania	Non Protected	Gazipur Town
Uttar Pradesh	Rapti	Shravasti, Balrampur, Siddarth Nagar, Maharajganj, Gorakhpur, Deoria (Districts)		Tributary
Uttar Pradesh	Yamuna	Auriya, Jalaun	Protected/ Non Protected	Yamuna Chambal Sindh confluence & Part of Chambal WLS
Uttar Pradesh	Yamuna	Ghatampur, Hamirpur,Bindki, Banda	Non Protected	Yamuna Betwa confluence t
Uttar Pradesh	Yamuna	Bindki, Banda	Non Protected	Ken Yanmuna confluence
Bihar, Uttar Pradesh	Ganga	Buxar, Ballia, Bhojpur	Non Protected	Ballia Town, Along UP-Bihar
Rajasthan, Madhya Pradesh, Uttar Pradesh	Chambal	Morena, Dhaulpur, Agra	Protected	Chambal WLS, Morena

Uttar Pradesh, Bihar	Ghaghara	Lakshimpur Kheri, Bahraich, Sitapur, Gonda, Bara Banki, Basti, Faizabad,Ambedkar Nagar, Gorakhpur, Mau, Ballia, Siwan (Districts)		Tributary

1.1.2 Bihar

In contrast to the declining range in the tributaries, dolphin range in mainstem Ganga of Bihar, seems fairly stable with high population densities across the stretch (Qureshi et al., 2018). Here Vikramshila Dolphin sanctuary at the confluence of River Koshi and the Ganges forms an important habitat for the species and may be acting as a source population of the river stretch (Qureshi et al., 2018).

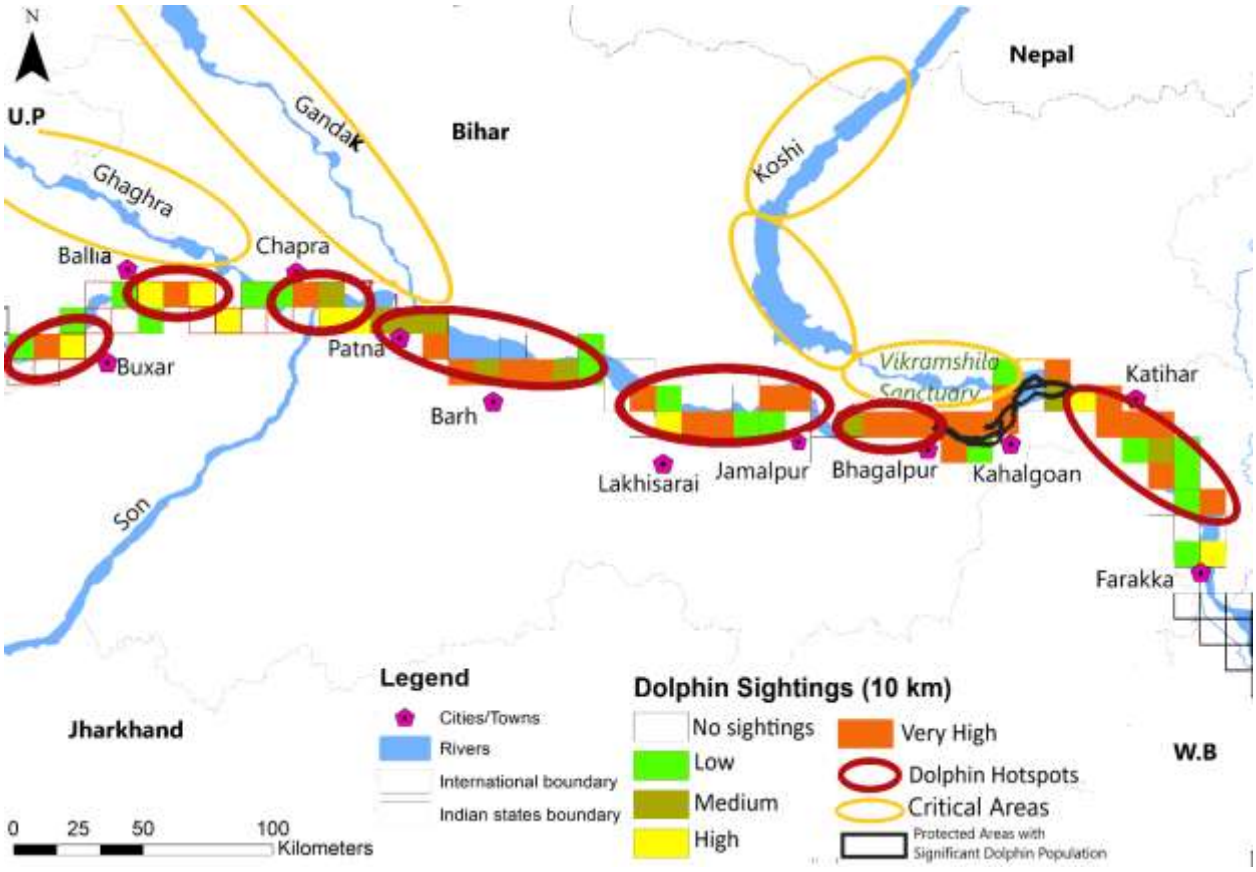

Figure 2 Dolphin hotspots in Bihar based on population encounters at every 10km. The categories are classified by pooling population estimates across the entire population of Ganga and Brahmaputra, and dividing the quartiles into the categories depicted here.

The stretch between Chausa and Maniharighat in Bihar seems to be the strongest hold for this species in the Ganges river basin with a best estimate of about 1096 individuals (Figure 2). While the dolphin sanctuary in Bihar it self serves as a good habita, where dolphins thrive in the region, the stretch surrounding Katihar (Near Maniharighat) seems to be another major hotspot. Similary other stretches (Table 13) which include Ghaghara and Gandak confluences also have a good population of Ganges Dolphin. They are also critical links to maintain a viable dolphin population, as they connect the rivers of Nepal with Ganga. Begusarai, Barh, and Naugacchia form other critical hotspots that require regular monitoring and infrastructure, to ensure the survival of dolphins in the future. Kos(h)i and Gandak are the most important tributaries for dolphin, gharial and other aquatic fauna. No development like navigation or barrages should be planned for these tributaries.

Table 2 Population hotspots and critical conservation regions in Bihar stretch of Ganga.

State	River	Tehsil	Status	Town/Village/Landmark & Remarks
Bihar	Gandak	Pashchim Champaran, Gopalganj, Purba Champaran, Muzaffarpur,Saran, Vaishali (Districts)		Tributary
Bihar	Ganga	Buxar	Non Protected	Buxar Town
Bihar	Ganga	Chhapar	Non Protected	Chapra town,Son and Ghaghar Confluence
Bihar	Ganga	Patna, Hajipur, Barh, Samastipur	Non Protected	Patna and Barh Towns, Gandak Confluence
Bihar	Ganga	Barh, Khagaria, Munger,	Non Protected	Lakshiharia town, Jamalpur
Bihar	Ganga	Naugachhia, Bhagalpur	Non Protected	Bhagalpur town (just upstream of Vikramshila)
Bihar	Ganga	Virkarmshila Sanctuary	Protected	Vikramshila WLS Koshi confluence
Bihar	Koshi	Supaul, Saharsa, Samastipur, Khagaria, Bhagalpur (Districts)	Non Protected	Tributary
Bihar, Uttar Pradesh	Ganga	Buxar, Ballia, Bhojpur	Non Protected	Ballia Town, Along UP-Bihar
Bihar, Jharkhand, West Bengal	Ganga	Katihar, Sahibganj, Maldah	Non Protected	Bihar-Jharkhand-WB (Katihar to before farakka)

1.1.3 West Bengal

In West Bengal, the Farakka Barrage (24.7891°N, 87.8878°E) located on the Ganges River 400 km downstream of Patna, close to India–Bangladesh border, acts as a barrier (Sinha & Kannan, 2014). Although a sizeable population (~ 250 individuals) exists in the Hooghly river (Qureshi et al., 2018), studies and surveys conducted in recent past are of the opinion that the range of the dolphin in West Bengal is severely fragmented (Mitra et al. 2018).

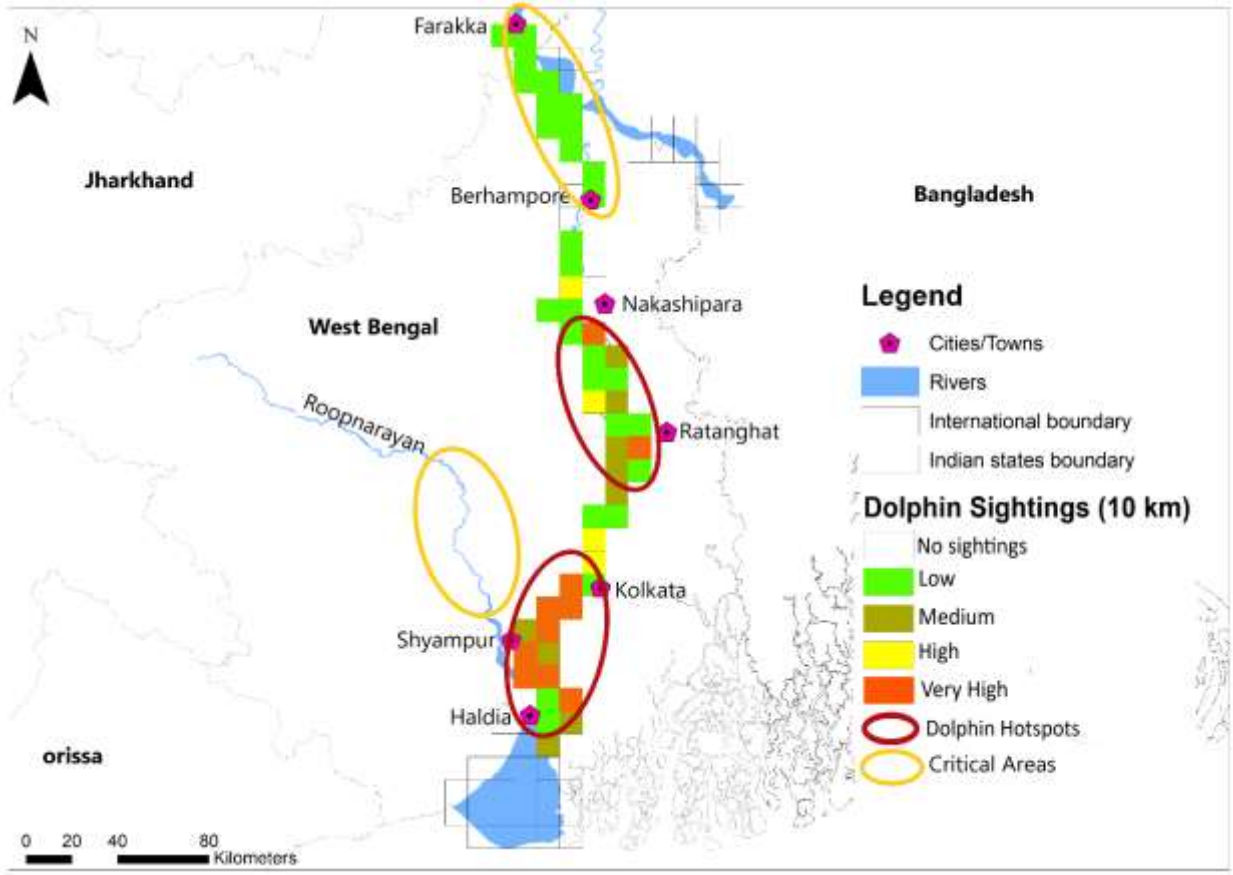

Figure 3 Dolphin hotspots in West Bengal based on population encounters at every 10km and critical habitats (in yellow). The categories are classified by pooling population estimates across the entire population of Ganga and Brahmaputra, and dividing the quartiles into the categories depicted here.

The stretch between Farakka feeder canal and Kakdwip in West Bengal sustains a population of about 358 dolphins (Qureshi et al., 2018). The population in West Bengal is understood to be stable, however, there are increasing incidences of poaching of dolphins for oil, and death due to net entanglement reported in the area. With increase in navigation, and motorized boats, there is further stress to the dolphins which rely on

acoustic clues for survival. There is a huge disturbance to the dolphin habitat underwater with increased movement of ship traffic.

Table 3 Population hotspots and critical conservation regions in West Bengal stretch of Ganga.

State	River	Tehsil	Status	Town/Village/Landmark & Remarks
Bihar, Jharkhand, West Bengal	Ganga	Katihar, Sahibganj, Maldah	Non Protected	Bihar-Jharkhand-WB (Katihar to before farakka)
West Bengal	Ganga (Hooghly)	Kishannagar, Kalna,Ranaghat, Chunchura	Non Protected	Nakshipara to Ratanghat
West Bengal	Ganga (Hooghly)	Jangipur, Murshidabad	Non Protected	Farakka to Berhampore
West Bengal	Ganga (Hooghly)	Shrirampur, Barakpur, Kolkata, Alipu, Haora, Uluberiya, Tamluk, Diamond Harbour,Kanthi	Non Protected	Kolkata to Haldia (roopnarayan confluence included)
West Bengal	Roopnarayan	Bankura, Barddhaman, Hooghly, West Midnapore (Districts)		Tributary

The confluences at Roopnarayan, and the stretch between Nakshipara to Ratanghat should especially be conserved, as these are the two major hotspots of dolphins in Hooghly.

1.2 Brahmaputra:

The Brahmaputra river system remains on of the major population strongholds of the Ganges river dolphin today, harbouring 30% of the world's population. Although tributaries like Kulsi and Subansiri also harbours dolphin population, these populations experience a seasonal rise-and-fall which coincides with the flood cycle (Sinha & Kannan, 2014). Across the years, the population of dolphins in the main stretch of the river seems stable. This river plays an important role for the long term survival of not only dolphins but also other river fauna, being relatively less affected by development and pollution, as compared to Ganga river. The range of the dolphins in Brahmaputra is continuous from Assam-Arunachal border in the north to the Assam-Bangladesh border in the south, with certain points harbouring a good population of dolphins (especially at Kaziranga National Park and Guwahati) (Wakid, 2009; Qureshi et al., 2018). The A very high encounter rate of calves in the Kaziranga stretch of the Brahmaputra (calf encounter rate – 1.32 per km), compared to that of the other sectors (0.34±0.16, mean±sd) was observed (Qureshi et al., 2018). This shows that this particular stretch could be acting as a source population, where there is high recruitment. Such stretches, as explained before are critical for ensuring that the dolphin populations survive and thrive in any river. Using acoustic and visual data, it was observed that dolphin encounters were significantly correlated with river morphology and level of water flow. Dolphins preferred mid-channel islands, meanders and confluences, and a minimum flow of 1000 cubic. For a species whose ecology is unknown, this information helps us prioritise critical habitats for conservation planning.

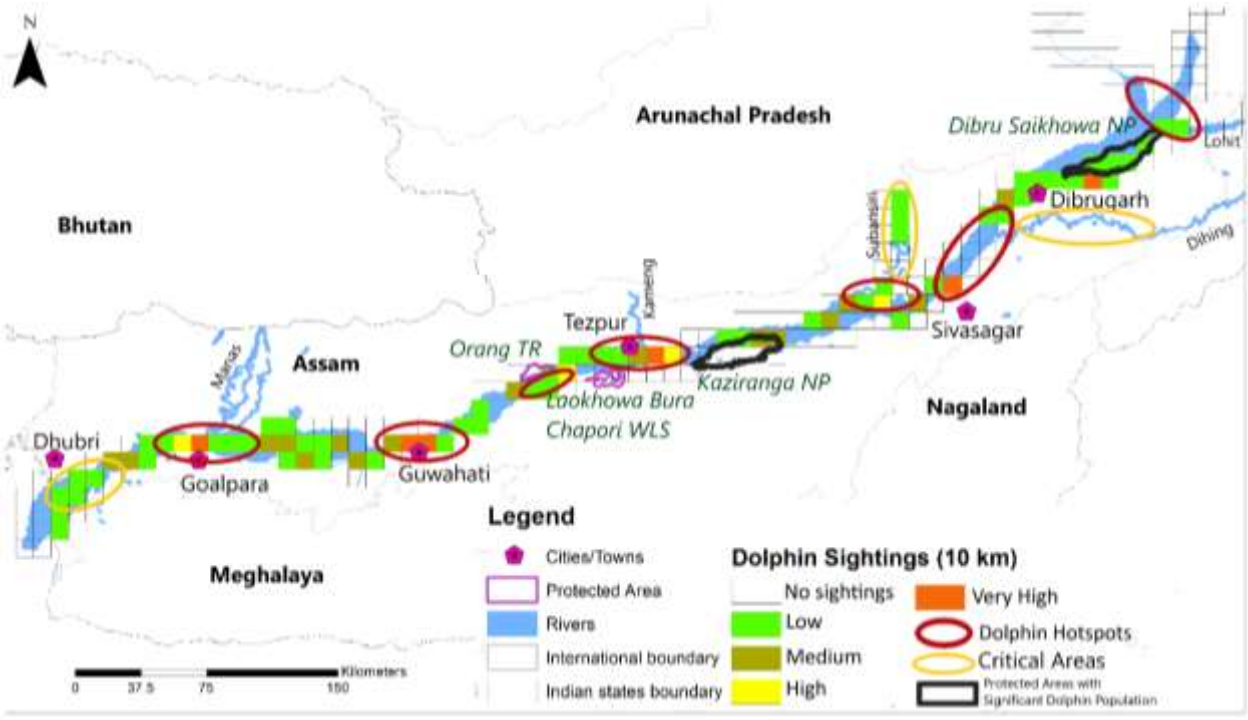

Figure 4 Dolphin hotspots in Brahmaputra, based on population encounters at every 10km and critical habitats (in yellow). The categories are classified by pooling population estimates across the entire population of Ganga and Brahmaputra, and dividing the quartiles into the categories depicted here, Barak is also included but is not featured in the image

Brahmaputra boasts of certain stretches where still there is natural habitats that persist, for eg., Dibru Saikhowa National Park, Kaziranga National Park, and Orang National Park. These provide a safe haven for biodiversity in general. But from existing data, there is also an indication that these form a very important habitat for aquatic fauna like Ganges river dolphin, where the recruitment rate of calves is much higher in the protected area stretch of Kaziranga than other stretches. Not only is the disturbance minimum in this area, there is also infrastructure existing in this stretch to regularly monitor and eliminate any threats to the aquatic habitat.

Table 4 Population hotspots and critical conservation regions in Brahmaputra

State	River	Tehsil	Status	Town/Village/Landmark & Remarks
Assam	Brahmaputra	Chapakhowa, Pasighat	Non Protected	Brahmaputra Lohit Conflulence (Upsteam of Dibru saikhowa)

Assam	Brahmaputra	Tinsukia, Pasighat	Protected	Dibru Saikhowa Np (Dibru river Confluence)
Assam	Brahmaputra	Dibrugarh, Sibsagar	Non Protected	Dihing confluence to Sivasagar (includes Confluences of Dikhow and Jhnaji)
Assam	Brahmaputra	Jorhat, Gopalghat	Non Protected	Subansiri confluence
Assam	Brahmaputra	Gopalghat, Tezpur	Protected	Kaziranga NP
Assam	Brahmaputra	Tezpur, Naogoan	Non Protectet/ Protected	Tezpur (Kameng Confluence)+Laokhowa WLS protected
Assam	Brahmaputra	Mangaldia, Tezpur	Protected	Orang TR
Assam	Brahmaputra	Guwahati	Non Protected	Guwahati
Assam	Brahmaputra	Barpeta, Kokarjhar	Non Protected	Goalpara town Manas Confluence
Assam	Brahmaputra	Dhubri, Gauripur	Non Protected	Dhubri
Assam	Dihing	Dibrugarh (District)	Non Protected	Tributary
Assam	Kulsi	Kamrup (District)	Non Protected	Tributary
Assam	Subansiri	Dhemaji, Lakhimpur, Jorhat (Districts)		Tributary

The dolphin hotspots in Brahmaputra are at Sivasagar, Kaziranga-Tezpur, Guwahati, and Goalpara, where the population is high and also calf encounters are high. There are other

areas like the confluence of Lohit and Brahmaputra, confluence of Manas, confluence of Subansiri, amongst others (Table 4).

Tributaries of Dihing, Subansiri and Kulsi are most important for long term conservation efforts. Unless these populations are secure, the main stream population of Brahmaputra will be in jeopardy. These and many other tributaries play an important role during flood time by acting as refuges for the population in the main stream of Brahmaputra, where flood is an annual occurrence.

1.3 Tributaries

1.3.1 Ganga Tributaries:

1.3.1.1 Chambal

Chambal is an important strong hold of Ganges river dolphins, with an estimated population of around 70 dolphins. Over the past few years, the dolphin population has ranged between 85 – 65, in the 425km stretch that harbours dolphins. There is a high contraction in the seasonal range of the species in Chambal. A more continuous range is observed during the wet season as compared to isolated pockets of populations in the dry season.

1.3.1.2 Kosi

In the 156 km stretch of Kosi river, a total of 132 dolphins were encountered. Presence of calves also indicate this to be an important habitat for dolphins.

1.3.1.3 Roopnarayan

In the 32km stretch of Roopnarayan, 25 dolphins were encountered.

1.3.1.4 Other tributaries of Ganga

Rapid assessment surveys were conducted in 12 tributary rivers, out of which the river Ghagra, Gandak, Budhi Gandak, Punpun, Ajay, Jalangi, and Mahananda are tributaries of Ganga, river Bagmati and Bhutai Balan are tributaries of river Kosi, Kamla Balan is a tributary of river Bagmati and river Douk is a tributary of river Mahananda. Dolphins were observed only in three tributaries, Budhi Gandak (5 dolphins),Bagmati (2 dolphins) and Bhutai Balan (3 dolphins). No dolphins were seen in Punpun, Kamla Balan, Ajay, Jalangi and Douk rivers. Seasonal distribution of dolphins in these tributaries is being assessed currently.

1.3.2 Brahmaputra Tributaries:

Two of the major river dolphin populations in Brahmaputra river systems exist in the tributaries of Kusli and Subansiri.

1.3.2.1 Kulsi

A total of 32 dolphins (SE = 4) was the most recent estimate of this river (Qureshi et al., 2020). The population estimate across the years was found stable with a shift in the distribution pattern of the animals towards the downstream compared to previous years distribution. Kulsi River is exposed to various unregulated fishing activities, use of monofilament gill nets of less than the permissible mesh sizes mentioned under Assam Fishery Rules (AFR, 1953), which is also responsible for dolphin net entanglement (Sinha 2002, Mansur *et al* 2008). Use of mosquito nets which affects the prey availability of dolphins (Mohan *et al* 1998), which is banned under AFR, 1953, is recorded throughout all surveys conducted by WII. We can consider the permanent lift net set ups as a threat in small tributaries like Kulsi where the entire width of the river is barricaded with bamboo poles to direct the fishes towards the nets, and also restrict the movement of dolphins.

Unregularized sand mining activities is increasing in Kulsi. Sand mining using motorised pumps is gradually increasing. About 70% of the river bank of Kulsi is covered with agricultural lands. During dry season crops, Kulsi river water is exclusively used for the purpose of irrigation. Water pumps were used to lift water which alongwith creating loud noise in the environment, also extract water from the river exceeding the minimum flow of the river, often leave the river bed exposed. This is a major cause of concern for the dolphins of this river. The recent development of wall by ITC factory in 2019 on the dolphin hotspot of Kulsi River (Kulsi- Batha confluence), is another arising threat for the dolphins of Kulsi River. The consecutive surveys shows that the dolphins were consistently avoiding the hotspot now and were spread towards the downstream of the river (Qureshi et al., 2020b).

Kulsi harbours a good population of dolphins, and there is a need to reduce the pressure it is currently undergoing. The wall of ITC needs to be removed at the Kusi-Batha confluence, and monitoring and regularisation of sand mining, especially with mechanised pumps needs to be taken up.

1.3.2.2 Subansiri

Subhansiri is the largest tributary of Brahmpautra, and harbours close to 48 (SE = 6) dolphins, in a 93 km stretch (Qureshi et al., 2018). It is known that there is a fluctuation of population, with dolphins moving to main stream during the leanest months, where the population falls to as low as 14 (Qureshi et al., 2020; Kasuya and Haque, 1972). The 2000MW Subansiri Lower Hydroelectric Project (SLHEP) is an under construction gravity dam in Subansiri River whose work has resumed in October 2019, and the water flow regime or the progression with this needs to be very carefully considered, given the example of Ranganadi in the region. Due to the construction of Ranganadi concrete gravity Dam in the river Ranganadi in Arunachal Pradesh, the river loses its connectivity with Subansiri River during its lean period. Once present, the population of Ganges dolphin in Ranganadi has completely wiped out. We need to make sure that such a fate does not occur with Subansiri. It was estimated that when SLHEP will start functioning, the water discharge in Subansiri River during dry months would come down to 6 cumecs from the present average of 450 cumecs and will also lead to heavy siltation in the downstream affecting the deep pools which are also preferred habitats of Ganges dolphins (Baruah *et al* 2012).

1.3.2.3 Other tributaries of Brahmaputra

During high water season, Ganges river dolphins migrates from the main stream rivers towards the tributaries (Kasuya and Haque, 1972). Monsoon season occupancy was recorded for 31 tributaries of Brahmaputra (Table 5) during June-August, 2019 by Wildlife Institute of India under the Species recovery programme, CAMPA dolphin component (Qureshi et al., 2020). Opportunistic dolphin observations along with secondary information collected from the river bank fishermen. Out of these 31 tributaries, dolphin were recorded from 16 tributaries (Table 5).

Table 5: Distribution of dolphins in tributaries of Brahmaputra (Qureshi et al., 2020)

Sr no.	Tributary name	Dolphin sighting date	Dolphin sighting place / village	Number of dolphins sighted	Distance of sighting location from Brahmaputra confluence (km)

1	Dibru	23-07-2019	Maguri beel (Natun Gaon)	2	4
2	Burhi-Dihing	08-07-2019	Nagaghat (Joypur)	3	123
3	Disang	17-07-2019	Dimowmukh	3	17
4	Dikhow	10-07-2019	Borduwarmukh	2	62
5	Jhnaji	07-07-2019	Simoluguri Dhamaji chawk	3	26
6	Dhansiri	14-07-2019	Dhansirimukh ghat	2	8
7	Sarikaria	20-06-2019	Khatorbari	1	90
8	Ranga nadi	14-07-2019	Kabali Pamuwa	1	3
9	Jiabharali	10-08-2019	Garsinga Biha Gaon	2	7
10	Kollong	18-07-2019	Hariamukh	1	78
11	Pahumara	07-09-2019	Morisapathar	3	65
12	Manas	15-06-2019	No. 1 Nawapara	3	45
13	Beki	07-09-2019	Sengelia	2	41
14	Gauranga	25-06-2019	Hakama Part-1	2	15.5
15	Tipkai	15-07-2019	Mahamaya Sthan Ghat	3	43
16	Gadadhar	08-06-2019	Ratiya Dhoha Part3	2	22

2 Knowledge gaps, threats and conservation actions

It is most important to note that, for a wide ranging species like River Dolphins, which inhabit the most pressured habitat in the world, under varied threats, the effort of even beginning to understand the current status is a conservation victory. The current estimates of River Dolphins in India is ~3200 (including 8 Indus river dolphins). However, it is important to note that only 60% of the range has been covered using standardised methodology. Morever, only a few stretches have regular population monitoring survey, which is critical to inform conservation, some stretches have not been surveyed at all. This highlights the uncertainity in numbers, and puts the state of dolphins in the country in a precarious position. The take home message from tiger conservation in the country was that a methodology with a wide margin of error kept us under a false sense of security, until the extinction of tigers in Sariska and Panna was discovered. Given that a standardised method exists(Smith et al., 2006; Braulik et al., 2012 & Qureshi et al., 2018), which takes into account the bias of observer, and bias due to the biology of the species, where dolphins are unavailable to count due to non-surfacing, it is imperative to follow this method across the range, where possible, to understand population trends and status of species.

With only 10% of the dolphin population lying within protected area network, it is imperative that there exists a mechanism to enable monitoring of species, especially population hotpsots and critical conservation areas mentioned (see section on status). These areas need to be either monitored regularly with appropriate infrastructure and support from forest department and fisheries department or declared as conservation reserves to minimise threats to biodiversity in the area. By institutionalising a regular monitoring mechanism, we are ensuring the long term well being of river health.

From status surveys, and mortality data, the most devastating threats is dolphin poaching for oil, used for bait fishing and traditional medicine and dolphin entanglement in gill nets, especially mono-filament gill nets. We have already witnessed the extinction of dolphins in Barak due to these pressures. Around 50 dolphins per annum were estimated to be used for dolphin oil extractionjust between Patna to Rajmahal (~460 km) on the river Ganga (Mohan and Kunhi, 1996), and in Brahmaputra, 100 boats were involved per annum in fishing using dolphin oil between Dhubri to Goalpara (~80 km) (Bairagi, 1999). It is imperative that this threat be tackled, by monitoring the use of dolphin oil

(Kolipakam et al., 2020), discourage bait fishing, discourage use of monofilament gill nets, and use of acoustic deterrents like pingers, which will help dolphin avoid nets. Indus dolphin decline is also being attributed to unabated and dangerous fishing practices.

The other issue specific to dolphins is that of navigation, and sound pollution in rivers. Given that dolphins have rudimentary eyes, and rely on acoustic communication for their survival, the soundscape of the river forms an important feature of their habitat. Preliminary studies have shown that dolphins do get affected by movement of ships, and a behavioural response is seen (Dey et al., 2019; Qureshi et al., 2019). Before proceeding with large scale regular navigation, it is important to understand its impact on dolphins.

Population decline or local extinctions of dolphins in the country have largely occurred due to decline in water flow. This is particularly important for tributaries which harbour small populations, but form the lifeline for dolphins during flood times. The connection between tributaries and main stem also ensure that when flow of water during lean period is less in tributaries, dolphins can navigate to main stream. Indus dolphins are also dependent on a particular amount of flow, and it forms a critical parameter for their survival. It is important to ensure optimal flow for the survival of not only dolphins but also associated species like Gharial, where sudden dispensing of water drowns their breeding grounds. The connection of main stream Ganga, with rivers of Nepal is crucial, as all these tributaries bring large amount of water which is a crucial lifeline for middle and lower Ganga. International and inter-state cooperation is absolutely essential to manage popualtions, with agreements regarding water flow and drawal.

3 Threats & best practices

3.1 Dolphin oil

Dolphin oil use for medicine and bait fishing is widespread across the Ganga and Brahmaputra river systems (Sinha, 2002). Apart from deliberate killing of River dolphins, even non-targeted deaths due to net entanglement, contribute to the dolphin oil market for oil-bait fishing, and medicinal purposes. Dolphin oil is said to cure rheumatism, nervous disorders, asthma and is also believed to be an aphrodisiac (Choudhary et al., 2006). Further, this oil is used as bait to enhance capture of cat-fishes in the river (Faruqui and Sahai, 1943). In India, the use of dolphin oil for catfish (Clupisoma garua and Eutropiicthys vacha) lure is an age old practice, and was first reported by Faruqui and Sahai (1943), and later confirmed by several others (Bairagi, 1999; Job and Pantulu, 1953; Motwani and Srivastava, 1961; Wakid, 2009). Dolphin oil is used in combination with charcoal, entrails of goat/cattle/fish/chicken and their fat, and is sometimes also mixed with dung of cattle/buffalo (Bairagi, 1999; Mohan and Kunhi, 1996; Motwani and Srivastava, 1961; Sinha, 2002;Wakid, 2009). **Around 50 dolphins per annum were estimated to be used for dolphin oil extraction just between Patna to Rajmahal(~460km)on the river Ganga (Mohan and Kunhi, 1996), and in Brahmaputra, 100 boats were involved per annum in fishing using dolphin oil between Dhubri to Goalpara (~80 km) (Bairagi, 1999).**

Dolphin blubber is 30–40%of its total body weight and one dolphin on an average yields about 25Lof oil (Bairagi,1999; Tsuyuki and Itoh, 1972). **It is reported 1–1.5 L of dolphin oil is being used on an average, per boat**. While fisherfolk are aware of the conservation status and precarious population size of species, they still engage in capture and killing of river dolphins, which continues unhindered due to the difficulty in implementation and enforcement of law. It is needless to reiterate that the extent of mortality is quite high, despite the protected status of the species.

Majority of social surveys with fisher folk are of a negative opinion regarding the role of dolphin oil, where more than 40% of the respondents indicated conflict between fisher folk and dolphins (Figure 5).

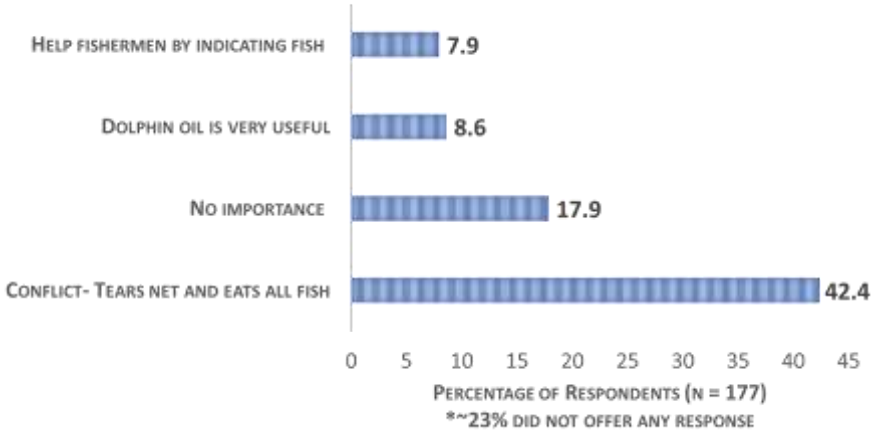

Figure 5: Fisher folk responses on role of Ganges river dolphins

In our surveys, 86% of the respondents encountered or have had a personal experience relating to dolphin in their lifetime. It was evident that many fishermen were aware that using river dolphin oil was illegal (64.6%), but were actively involved in bait oil fishery using dolphin oil. Additionally, of the fishermen who had experienced entanglement of dolphin in fishing nets, 57.8% admitted to selling the carcass for oil (Figure 6). When asked about the effectiveness of the alternate oils for bait, 61.9% of the respondents had responded as saying they have used these alternatives for fishing but still consider river dolphin oil as a better bait for catching cat fish. An overwhelming 91% percent of the oil bait fishermen (of the 64.6% involved in bait fishing) responded that they are willing to leave this occupation if better alternatives are available. Overall fishing was perceived as a trade with uncertain income and high risk, and many of the responded expressed desire for shifting to alternative trade.

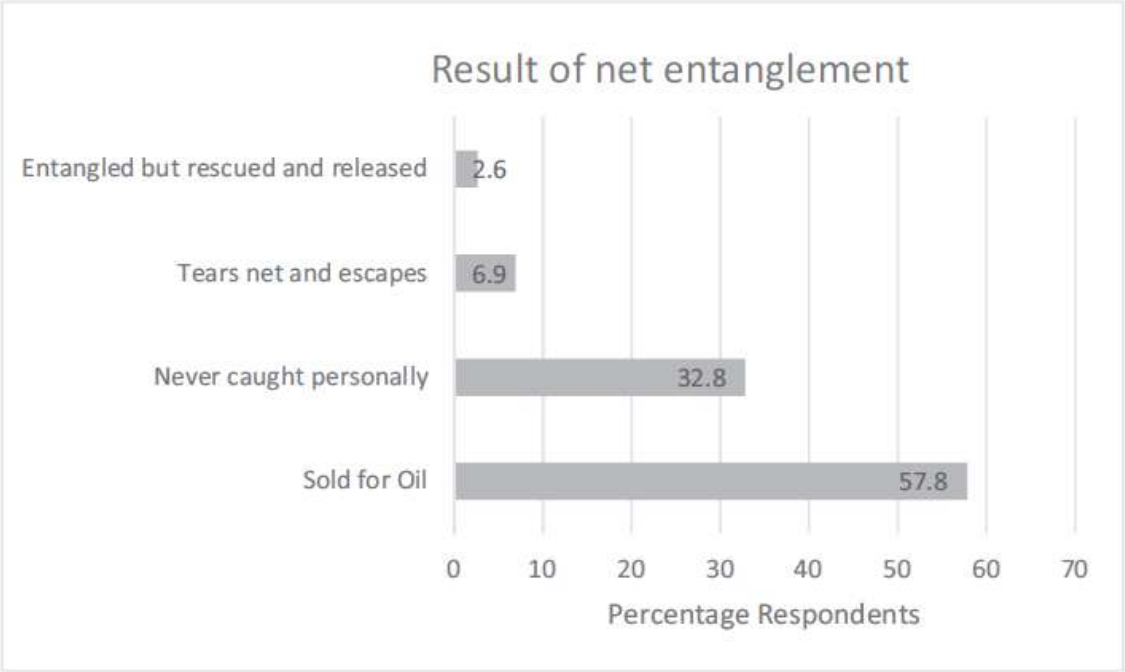

Figure 6 Social survey results indicating fishermens response to their actions when a dolphin gets entangled in their nets

Considering the prevelance of this practise of using dolphin oil, an alternative to dolphin oil was proposed to reduce the poaching of dolphins for bait oil, in the form of shark oil, sardine oil, and fish oil (Mohan and Kunhi, 1996; Sinha,2002). These alternative oils have not been able to completely replace the use of dolphin oil by fishermen (Figure 7).

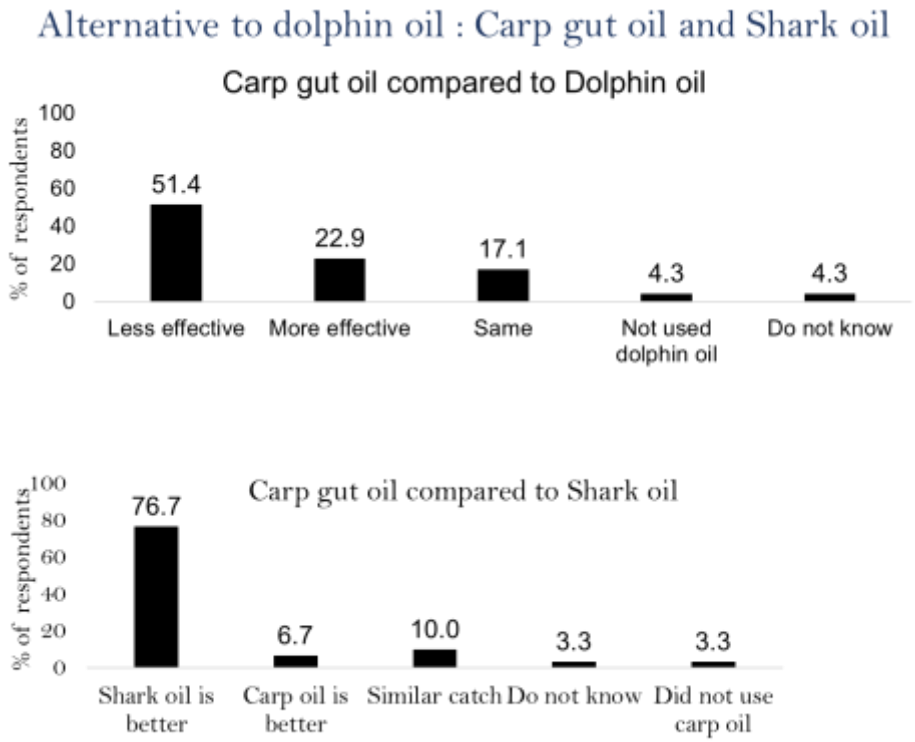

Figure 7: Response of people towards use of alternatives to dolphin oil

Another aspect of using bait oil is the species they target. Whether it is dolphin oil or alternate oils, they target native cat fish species, C. garua and E. vacha, whose population continues to decline at a rapid rate (Gupta and Banerjee, 2016; Patra et al., 2005). Use or sale of dolphin oil is illegal, however the oil is marketed under the guise of fish or livestock fat, or other alternate oils. In order to understand if dolphin oils are still being used, it is important to develop a technique to monitor and accurately identify whether the oil used by fishermen is derived from dolphins. In this context, we have developed a molecular technique to detect the presence of dolphin oil in any bait oil (Kolipakam et al., 2020).

While the use of alternative oil to dolphin oil is a proximal solution to curtailing the hunting of dolphins, one needs to also explore the implications of promoting alternate bait oils. Alternative bait oils definitely seek to combat the immediate threat of targeted dolphin killing, however, long term implications of this solution threaten to endanger two other species, E. vacha and C. garua, the native catfishes targeted by bait oils. Vacha and Garua species are extremely profitable, with an average return of >300₹ per kg. Both the species of cat fish being hunted are on decline (Gupta and Banerjee, 2016; Patra et al., 2005). The unintended consequences of the alternate bait oils is the over harvesting of

particular fish species. While dolphin oil might be costly (~825₹ per litre–(Qureshi et al., 2017)) to procure, or increased enforcement might halt the use of dolphin oil for bait, alternate oil from fat of other animals is being used to target the same species. **Therefore, this alternate bait oil cannot address the concern of overfishing of native cat fishes.**

Another dimension to this challenging task is the involvement of economically backward societies which are dependent for their livelihood on fishing. Bait fisheries is a skill that is practised largely by Bin community, and given that 90% of fishermen are willing to leave bait fisheries, a targeted weaning off of this practise is possible. Providing skill development in a targeted manner, with strong legal discouragement of bait fisheries, encouragement of hatcheries and pisciculture for consumers and restocking, along with campaign for sensitising fishermen on the perils of targeted fishing of catfish in the long run could be possible solutions to curtail this practise. Until a way forward is determined to address this problem of bait fishing, enforcement agencies can periodically monitor lures for the presence of dolphin DNA using the protocol developed here. This can act as an index of continued threat to the survival of dolphin population, and can provide insights on areas to monitor for illegal use of dolphin oil

3.2 Net entanglement – pingers

The accidental entanglement in fishing gear and manmade capture of Ganges river dolphin is one of the major threats impacting the species in the river ecosystem (Fig. 1). In 2005, the number of gillnets in the Brahmaputra River was estimated to be five times higher than in 1993 (Wakid,2009). During the 2004-2005 Brahmaputra fishing season, 24 of the 28 recorded dolphin deaths were found to be due to gillnet entanglement (Wakid, 2005). Dolphin entanglement in fishing gear, particularly gill nets, occur as the dolphin's preferred habitat generally coincides with primary fishing grounds (Smith & Braulik,2009; Bashir et al 2010; Smith & Braulik 2012). In 2008, out of 16 dolphin mortalities reported from Brahmaputra, 12 were victims of gillnet entanglement (Wakid, 2009). It has been observed that the dolphins seem to prefer area with counter-current pools below confluences and meanders where gillnets are most densely deployed, putting them at an increased risk (Smith, 1993; Smith et al., 1998). The entanglement in the fishing gear prevents the dolphin from surfacing out of the river and this will lead to drowning and possibly death (Biswas & Boruah 2000; Moore et al., 2009). Net entanglement causes much more than just direct injury or mortality to the species.

Limited studies have been carried out in the Ganges river dolphin in the context of using acoustic deterrents to prevent dolphin bycatch in nets which is an important step towards conservation of this species.

Figure 8: Dolphin entangled in a gill net

Dolphin pingers, which are an acoustic alarm used to deter the Ganges river dolphins, were developed by the Future Oceans group (www.futureoceans.com) (Figure 9). The pingers, when tied to fishing nets, emit sounds that are in the audible range of the Ganges river dolphins which aids in helping them perceive the presence of nets, which are otherwise difficult for them to echolocate.

Figure 9 Dolphin pinger

We carried out a study to test the efficacy of the pingers in deterring dolphins in Brahmaputra and Kulsi river.

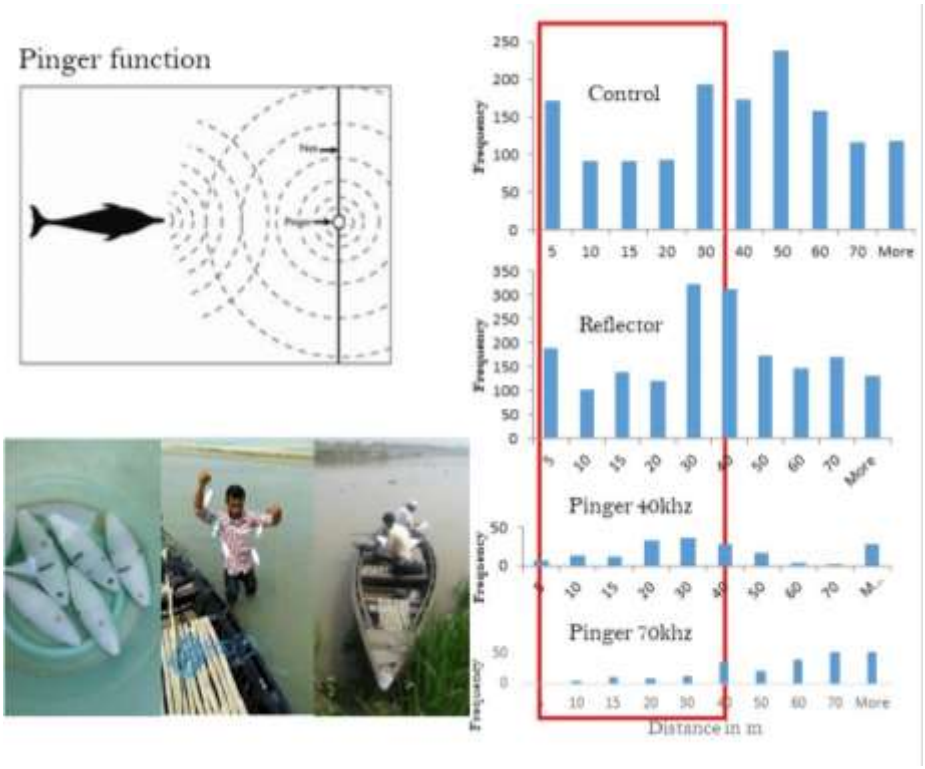

Figure 10 Experimental set up to test the efficacy of pingers, using visual observations

As described in figure 10, experiments were set up initially at a site, to understand the presence of dolphins, and later, acoustic reflectors (air filled plastic cans), as well as 40khz and 70khz pingers were tested on nets deployed in the same control site. As is evident in Figure 10, 70kz pingers were most effective in deterring dolphins from the site.

A second experiment was set up, similar to the aforementioned setup, and along with visual observers, CPODs (acoustic detectors) were also deployed to understand the use of the area by dolphins, when pingers were deployed. In this set up, a cpod was deployed in the immediate vicinity of the fishing net with pingers, and two CPODs were deployed on either side of the net, around 300m away. In Figure 11, it is noticeable that the pingers are effective within 150m – 300m range of the pingers. Even after 30 days of deployment, the effectiveness of the pingers does not seem to reduce.

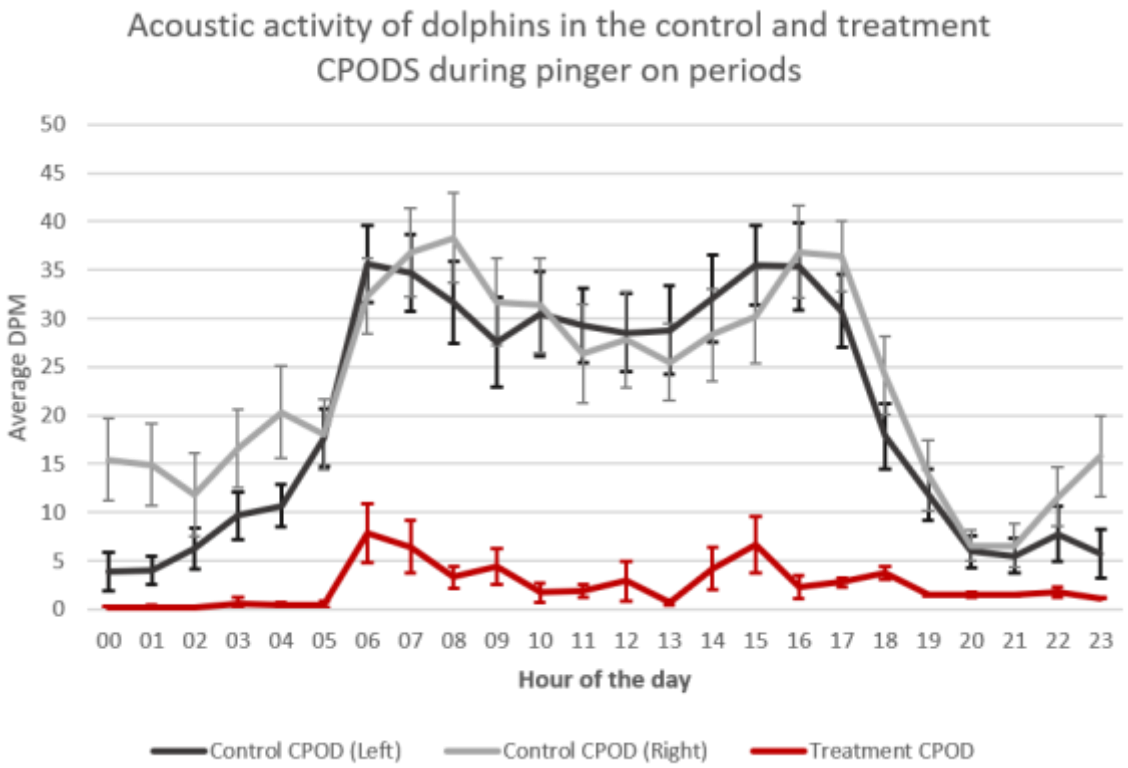

Figure 11

The effect of pinger is local, and will not affect the larger use of the area by dolphins. Because the fishing activity will keep shifting, the habituation of dolphins to pinger is unlikely, as is also evidenced by the experiment, where use of these pingers beyond 30 days does not show a difference in response by Dolphins. It is also worth noting that no fish catch reduction was observed through use of pingers. Neverthless, the long-term experiments are underway and a more clearer picture will emerge after a few months.

3.3 Navigation

To understand the effect of vehicular traffic on dolphin communication, we selected different river stretches to sample commercial ships and boats used by local communities for various activities.

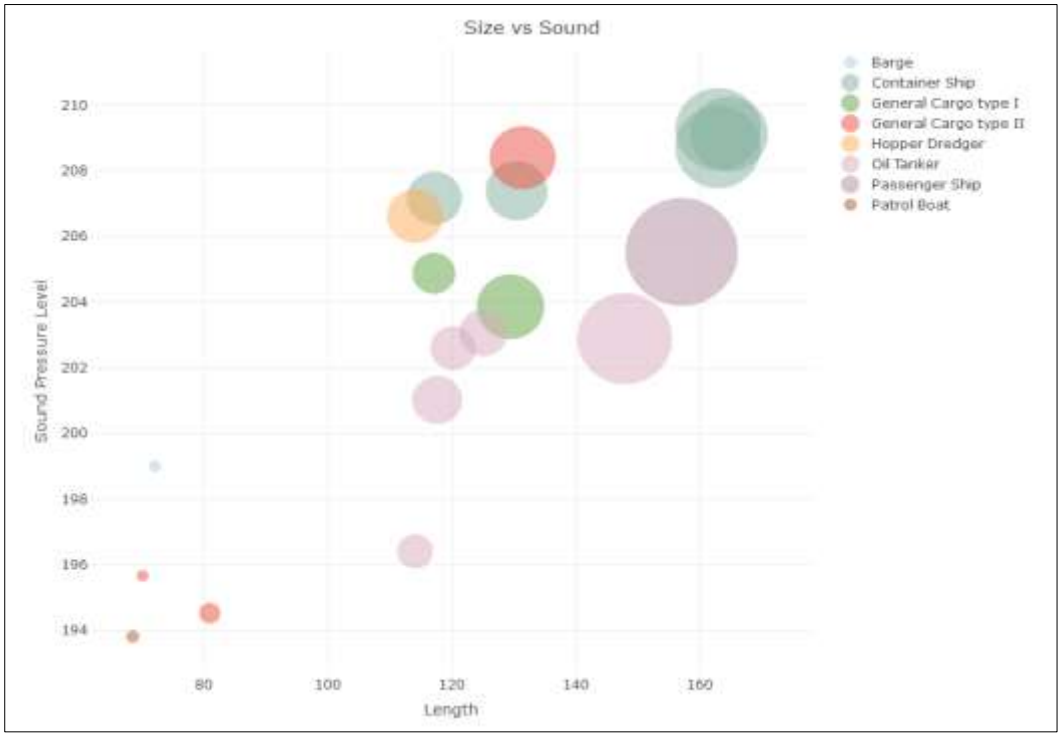

Figure 12: Graph showing vehicle size-noise relationship; diameter of the bubble represents the size of the ship

The motorized vessels were divided into 22 vehicle categories. After accounting for transmission loss based on the distance of the source from the recording unit, it was found that vehicles, on an average, produce an increase of 55dB than the ambient noises. The mean SPL level of ambient is 140 dB, while the loudest was that of the passenger/cargo ship producing about 210 dB. Country boats were also found to be noisier than most commercial ships. However, larger boats generally produced louder noises (Figure 13). Overlap in higher frequency bands that are used by dolphins (61.4 + 4.9 kHz) is also observed. Dolphin responses to boats (Qureshi et al., 2020)

When boats pass, we observed significant differences in maximum sound pressure level of vocalisation of dolphins (loudness) ($p=0.003$). The maximum sound pressure level was found to be significantly different during and before a boat passes and that it increases SPL when boats are crossing (Figure 13). There was also a shift in higher frequency range detected towards lower frequencies when boat passed.

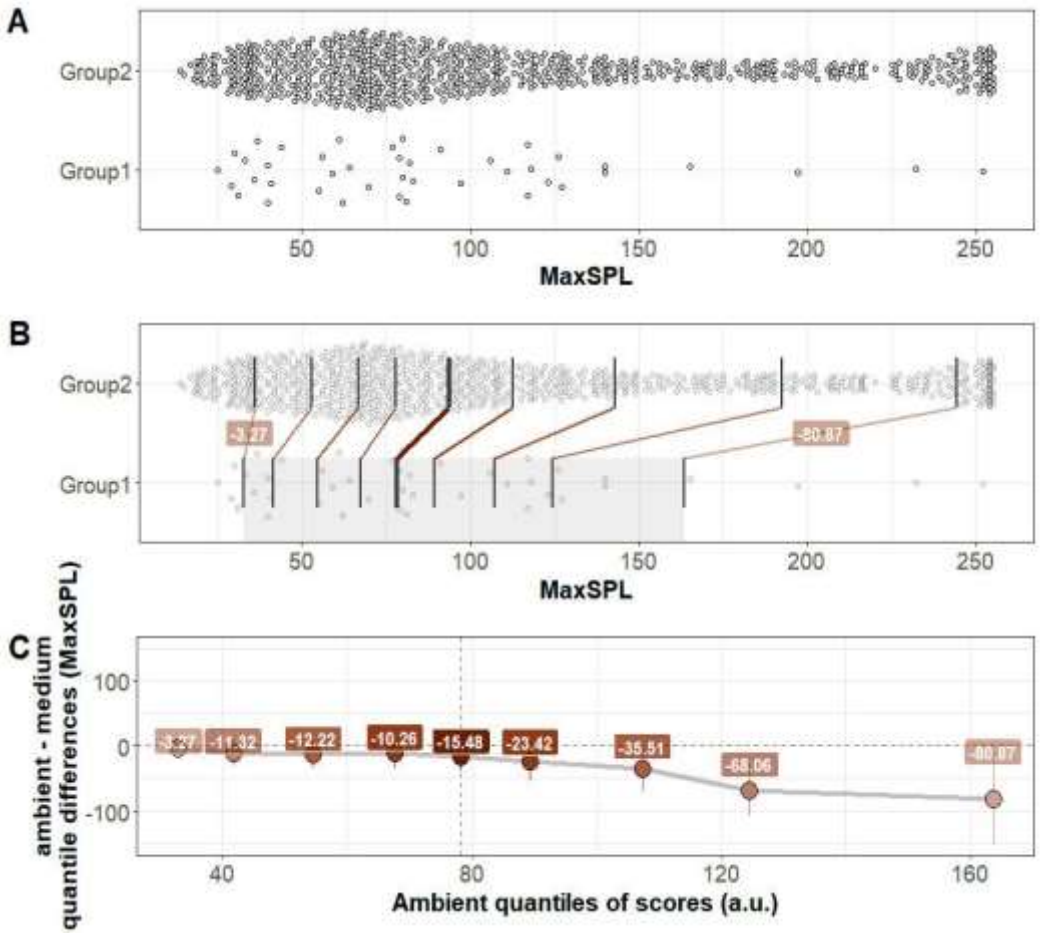

Figure 13: Difference in sound pressure level before and during boat passages (p=0.003) (based on shift function). Here the Group one is ambient noise and Group two is Medium boats. Similar pattern was observed for all boat size classes.

Frequency and SPL are biologically constrained in the acoustic properties of clicks and even minor shifts may result in disproportionately high metabolic costs, than enhanced click-rates (Papale et al., 2015). The metabolic costs for creating more amplitude is, hence, expected. The effect of the boat noise on marine mammals is studied more compared to freshwater species. On encountering boats, they show responses like avoidance (Tsujii et al. 2018; Palka and Hammond, 2001), change in the social structure- In response to ice breakers, beluga whales lost pod integrity, change in vocalization- In the presence of ships and boats, grey whales increased their vocalization rate, and received levels from it were higher (Dahlheim and Castellote,2016). Odontocetes (Bottlenose Dolphin) have been observed to alter their whistle characteristics, such as their frequency range, in high noise conditions or the presence of vessels (Morisaka et al., 2005; Papale et al.,2015; Marley et al., 2017) and high level of stress- North Atlantic right whale faecal samples suggested that noise from large commercial vessels might increase stress levels (Rolland et al., 2012). There is an apparent lack of publications addressing

the responses of river dolphins to vessel traffic noise. The river systems utilized by these species are known to have high levels of vessel traffic and, in some cases, there is evidence of river dolphins being the target of tourism activities (e.g., boto, Inia geofrrensis, in Brazil). Ganges river dolphins have showed mixed responses to approaching vessels, including changing direction to orient away from the boat, prolonging dive times, and displaying attraction toward the ship, as well as no obvious effect (Bashir et al., 2013). Recent studies show altered acoustic responses during noise exposure from vessel passage (Dey et al., 2019) i.e. they get louder (increase in mean SPL) when a boat approach. Such variability, again, explains the importance of context in behavioural interventions.

The evidence that is available with us now, indicates that there is an effect of noise from vessel traffic on dolphin acoustics. We recommended that international standards should be used for ship designs and engines, traffic should be regulated in hotspots and dredging or river training should not be done in dolphin hotspot areas.

3.4 Developmental activities on rivers

A suite of developmental activities on the rivers have come up in the recent past, for e.g. bridge construction, industrial construction on river banks, mechanised sand extraction. These activities not only alter flow regimes, but also modify natural river morphology and severely impact the habitat and productivity of aquatic ecosystems. There have been several instances of such activities resulting in local extinctions of dolphins or change in distribution patterns.

We have developed brief guidelines to ensure that dolphin critical habitats are secured. During the course of our work, we have managed to map dolphin distribution, hotspots and crucial areas for species of conservation concern in the mainstream of Ganga and Brahmaputra and their major tributaries (See section on status). This knowledge will help in guiding developmental activities in these areas. For bridge construction, the broad guidelines include ensuring adequate gap between pillars (of atleast 5m), adequate water flow and depth (more than 2m), no obstruction of escape channels, and minimum disturbance in these channels. Based on activity pattern, construction agencies also need to regulate their construction activity, specifically noise producing under water activities (piling, drilling, and dredging). It is also important to ensure that debris from

construction activity is not deposited within the river and does not alter the flow or depth of the river. For constructions on the banks of river, we have observed specifically in the tributaries the developmental activities are occupying the riparian zones, and major part of streams and altering the flow (Qureshi et al., 2021a). While policies for maintaining minimum distance from stream banks exists in some states or districts, it is not all encompassing nor is it uniform across states. This policy needs to be developed keeping in mind the shifting course of the river and to ensure that riparian zones are not destroyed, and in ensuring that river morphology and natural flow is not modified.

3.5 Monitoring

For cetaceans which are surface breathing aquatic mammals relying largely on echolocation for its movement, both visual and acoustic surveys have been commonly employed (Richman et al 2014). With visual surveys, though the number of animals missed can be modelled, the number unavailable for detections despite present is unknown. Acoustic surveys have a small range and the issues are vice-versa of the visual surveys. Estimation methods for both river and marine dolphins invlove visual as well as acoustic surveys or combination of both (Dawson et al, 2008; Braulik et al 2012, Wakid et al 2013; Richman et al 2014, Qureshi et al 2018). There is substantial bias due to observer error and it is absolutely must to use double observer based surveys involving double platform or boat in tandem methods depending upon the navigability of medium or small size boats. This method is very easy similar in operational aspect as earlier methods but differ in a way of data collection and analysis.

We standardised the use of combined visual and acoustic surveys for Ganges river dolphins in India, tested it through varied river widths, depths and river morphology. The average observer error was determined to be around 0.4 ± 0.17 and unavailability error was estimated to be around 0.35 ±0.05 (Qureshi et al.,2021b). The visual-acoustic method is best and can only work in areas with good water depth where medium size boats can ply. The correction factor developed for unavailability can be used to correct the visual survey and it is not necessary to do acoustics with all surveys. In absence of acoustic survey, the counts will be negatively biased but have persistent error and thus will not have affect on temporal trend of dolphin monitoring. The quantified unavailability error was found to be consistent not only across different rivers within India, but also in studies conducted independently (Richman et al.,2014). In simpler surveys where double

observer or acoustic detectors cannot be used due to logistic or financial constraints, these estimates for detection can be used for correcting the dolphin counts, while maintaining prescribed boat speeds i.e., >6kmph. We have developed protocols, field guides and android app for implementation of monitoring exercise by forest department staff. This app is in field testing currently and is to be implemented from winter of 2021.

3.6 Community participation

Developing a stakeholder platform requires a patient iterative process of identifying stakeholders, their interests, building trust, empowering weak stakeholders and, for powerful stakeholders, to accept new rights and roles for other stakeholders (CBD 2011). Currently, there are several models in place, for example, the Ganga Prahari program by the National Mission for Clean Ganga and Wildlife Institute of India, Dolphin conservation network by Aaranyak and Wildlife Institute of India, and Dolphin Mitra by WWF. In all these programs, local community networks are built, which engage with different stake holders, enable a platform for dialogue and awareness, as well as for information gathering. Such community initiatives are absolutely essential, and will play a pivotal role for any conservation program. Continuing support for these networks is needed. There is also a need to identify target groups which are heavily dependent on the river system, and have no alternative sources of livelihood. Awareness campaigns identifying threats, and especially with fishermen and river side communities is needed to not only engage with the community to ensure the conservation of aquatic biodiversity, but also understand threats existing and the road blocks that exist to eliminate these threats.

Dolphin conservation network by Aaranyak and WII currently engages with local fishing communities regarding use of banned fishing gear like mono-filament gill nets, ghost nets and mosquito nets as well as harmful fishing methods like use of poisons, hook fishing, electro-fishing and dynamiting. Regular workshops are conducted to educate them regarding Fisheries acts and policies, so that they are aware of the legal implications. Understanding of why unsustainable fishing practices exist, and the ways to avoid this can only be achieved through discussions and long term dialogue. Regular trainings are conducted to prepare people for immediate course of action during dolphin entanglements, or stranding. Through these networks 87% of the mortalities in Brahmaputra were reported by network members to concerned authorities and atleast 2 dolphins per annum were rescued.

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