Monitoring Ganges and Indus River Dolphins, Associated Aquatic Fauna and Habitat

Field Guide

2021-22

Monitoring Ganges and Indus River Dolphins, Associated Aquatic Fauna and Habitat

Field guide
2021-22

Citation: Qureshi, Qamar., Kolipakam, Vishnupriya., Wakid, Abdul, Deori, S., Gayathri, A., Jacob, M., Singh, G., Bettaswamy, A., Roy, K., Das. S, Sharma, S., Dutta, A., Singh, V., Sarma, H., Negi, R., Roy, G., Ray, S., Choudhary, S.K., Choudhury, B.C & Hussain, S.A. (2021). Monitoring Ganges and Indus River Dolphins, Associated Aquatic Fauna and Habitat: Field Guide 2021-22. Wildlife Institute of India.

Image credits: Kanad Roy & Ayan dutta

Illustrations: Kanad roy

Cover design: Paritosh Barti

Table of Contents

Acknowledgements

We are grateful for the support extended by Sh. Soumitra Dasgupta (ADG, WL), Dr. Dhananjai Mohan (Director, WII), and Dr. YV Jhala (Dean, WII). We also acknowledge the inputs by Sh. Rohit Tiwari (IG, WL), Sh. Rakesh Jagenia (DIG, WL), Sh. Sasikumar and Sh. Aditya Bisht, during the course of preparation of this document. We would like to thank the CWLWs of Uttar Pradesh, Bihar, West Bengal, Assam, Madhya Pradesh and Punjab for their support and inputs. We are thankful to Dr Nita Shah, Dr Swati Saini & Harshini Jhala for their inputs.

Preface

Dolphins are charismatic species that have always evoked human curiosity, along with being an integral part of our cultural milieu. However, they are in need of immediate conservation effort to safeguard their future, and the future of human society. Hon'ble Prime Minister Shri Narendra Modi has initiated a very timely and important step towards ensuring a future for dolphins in the country, by announcing the idea of 'Project Dolphin' on 15th August, 2020. The Project Dolphin is envisaged to bring both river dolphins and marine dolphins under its conservation program. This project aims to address existing conservation concerns and to empower the stakeholders to participate in conservation of dolphins. As part of the Project Dolphin initiative, a range-wide population monitoring of dolphins and other associated biodiversity is to be undertaken every three years. Along with this, an annual intensive site monitoring at critical dolphin hotspots is to be undertaken. A robust scientific monitoring of any population is the single most crucial aspect that is needed for any effective conservation action, and to ensure the long-term survival of a species. The river and marine ecosystem is the lifeline for the most marginal people in the country, apart from several threatened and endangered fauna. Dolphin acts as an umbrella species, whose conservation will result in the wellbeing of associated habitat and biodiversity, including humans. This effort is truly in line with our conservation philosophy of '*Vasudhaiva Kutumbikam*'.

The recent most estimation of the Ganges river dolphins 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. The Indus river dolphin meanwhile has a population of 6-8 dolphins in India (Kanwar et al., 2019), with majority of the population, of ~1816 individuals, residing in Pakistan (WWF-Pakistan). Dolphins (both Ganges river dolphin and Indus river dolphin) are impacted by anthropogenic and natural threats, which includes habitat loss, habitat degradation, reduction in flow, pollution, poaching, net entanglement, river navigation, unsustainable fishery practices and sand mining, to name some. Due to the decrease in flow and increased deaths of dolphins due to entanglement and poaching for oil, we have seen the species go locally extinct in parts of Yamuna, and rivers of Ken, Betwa, and more recently in Barak River. With less than 10% of the entire river dolphin range lying within protected areas, and threats mounting in terms of poaching, death due to entanglement, developmental challenges (river navigation, dams etc.), lack of infrastructure and trained manpower for rescue and rehabilitation, there is a need for long-term monitoring. Population monitoring of these species is challenging, due to logistic difficulties, as well as non-availability of standard methods. This problem is further exacerbated for Ganges and Indus river dolphins due to their very short surfacing time, making visual observations exceedingly challenging. However, to secure the future of dolphins in our country, it is of utmost importance to regularly monitor their population trends. Given that dolphins have very slow growth rate, with one calf being born every 2-3 years, any threats to the population will result in rapid decline, beyond a point of no-return, before recovery measures can be put into place. Therefore, it is of utmost importance to have a pulse on the dolphin numbers in the country, and regularly monitor critical dolphin hotspots, with a trained cadre of manpower, to ensure the well-being of not only dolphins, but also the rivers in our country and the associated livelihoods of people.

1 INTRODUCTION

River dolphins are indicator of a healthy river and act as an umbrella species of the river ecosystem. There are currently two species of the river dolphins inhabiting India, Ganges river dolphin (*Platanista gangetica*) and the Indus river dolphin *(Platanista minor*)(Braulik et al 2021). Ganges river dolphin is listed in Schedule I of the Indian Wildlife (Protection) Act 1972 in India, and was declared as the National Aquatic Animal of India and the State Aquatic Animal of Assam (India) in 2009. They are also accorded the highest protection priority for conservation, by being listed in Appendix I of CITES and Appendix II of CMS COP. There are currently around ~3500 individuals in the Ganga-Brahmaputra-Meghna-Karnaphuli-Sangu river systems (Sinha and Kannan, 2014). The Indus dolphins in India are only distributed in a small pocket of the Beas River in Punjab, while the majority of the population, amounting to ~1816 individuals, are distributed in Pakistan (WWF Pakistan, 2017).

River dolphins are characterized by a long rostrum, almost small dorsal fin, and side-swimming behaviour (Herald et al. 1969; Sinha & Sharma, 2003). Males are smaller than females in both the species (2.5m vs 2m; Kasuya, 1972). They give birth once every 2-3 years, and generally to only one calf. This puts the species at a high risk of extinction, as population recovery will be slow. They have rudimentary eyes, as an adaptation for turbid waters and rely largely on acoustic communication for not only movement but also foraging and other life history traits. This means they can only make out the difference between light and dark, and survival mainly dependent on their hearing. This makes the soundscape of the river very important for the survival of the dolphins. They have the longest inner ear canals of any extant cetacean, and hence can hear a wide frequency range (Thewissen & Nummela 2008; Southall et al., 2007).. They produce clicks, bursts, twitters, whistles (rare) and stratiform sounds (Mizue et al., 1971). Sound produced by dolphins have peak frequency of 61 kHz and a median of 65 ± 19 kHz, and Inter-click Interval between 10 to 100 milliseconds. (Bahl, R et al.,2007, Sugimatsu et al.,2011, Qureshi et. al. 2019). Preliminary results also suggest that dolphins behaviorally respond to high ship traffic, where they are known to exhibit vocalization changes in amplitude and frequency (Dey et al., 2019 & Qureshi et al., 2019). Ganges river dolphins surface for a very limited time, with an average of 1.26 (SD ± 0.23) seconds above water, and an average 107.3 (SD ± 46.8) seconds time under water, making it very difficult to observe (Wakid & Braulik, 2009). Given the very low surfacing time, traditional monitoring and abundance estimation methods are difficult to implement.

Hardly anything is known regarding their habitat preference in detail, or their breeding habitat, movement ranges and prey preference. Few studies have suggested that being a gape limited predator, they prefer fish of size classes 3-30cm (Sinha et al. 1993, Choudhary et al. 2006; Kelkar et al., 2010). From recent studies, it is understood that they prefer confluences, meanders and mid-channel islands (Sinha and Sharma, 2002; Qureshi et al., 2019). Apart from river morphology, flow is also deterministic of dolphin presence, as it influences the microhabitat and prey present in the area (Qureshi et al., 2019). However, there is a need to address these large knowledge gaps, without which apt conservation actions will fail.

1.1 Status of Ganges river dolphin

There are currently about ~3500 dolphins range-wide. India is home to more than 90% of the Ganges river dolphins existing in the world. For this species, there is currently around 40% range reduction from the historical distribution. The numbers of 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; Yeung et al., 2009; less than 2000 by Mazumder et al., 2014; Smith and Braulik, 2012). Having a pulse on the abundances and population trends are essential for effective conservation actions for the long-term survival of any species. Especially for dolphins, which inhabit the most threatened

habitat in the world, and have a slow growth rate, stemming any population decline in its early stages will be crucial for its survival. As mentioned before, monitoring population hotspots, which act as safe havens and sources will be the most critical aspect of conservation of this aquatic species. As part of the Project Dolphin, apart from range-wide enumeration, critical hotspots will be annually monitored. Based on existing data (Qureshi et al., 2018 & 2019; WII-GACMAC, 2018), hotspots and critical habitats have been identified across the dolphin range. The following section describes the population distribution and hotspots in Ganga, Brahmaputra and Indus of the river dolphins.

1.1.1 Ganga

1.1.1.1 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 1.1), this stretch was considered the upstream limit of their historical range (Sinha et al. 2000). The minimum population in the Uttar Pradesh part of Ganga is around 500 dolphins (extrapolated from encounter rates given in GACMC, 2018). The ~ 800 dolphins is a guestimate for dolphin population in Uttar Pradesh.

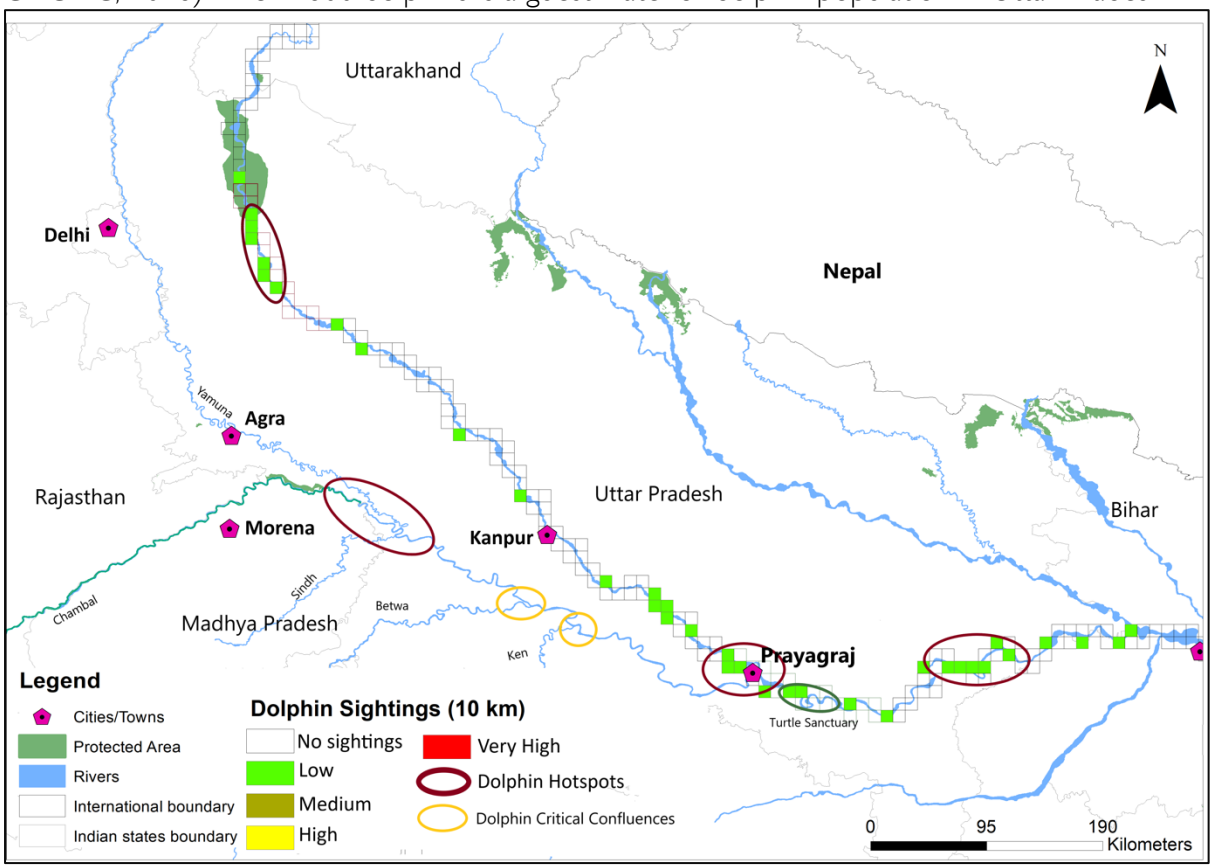


Figure 1.1:Dolphin hotspots in Uttar Pradesh based on population encounters at every 10km. The categories are classified by pooling population estimates across the entire population of Ganga and Brahmaputra, and dividing the quartiles into the categories depicted here

The Wildlife Institute of India, under the NMCG-WII Project "Biodiversity Conservation and Ganga Rejuvenation" conducted ecological assessment of the Ganga River from Bijnor to Ballia 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 to Narora, which is protected as Hastinapur WLS and Upper Ganga Ramsar Site, and (2) Prayagraj to Ballia, 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 (Figure 1.1), special attention is needed for especially those stretches where no protection infrastructure or mechanism exists currently. For example, Ballia – Buxar – Bhojpur, Amroha – Anupshahar, the confluence of Ganga and Yamuna at Allahabad, the confluence of Yamuna – Chambal, Yamuna – Ken and Yamuna – Betwa. Historically, dolphins occurred year-round in the Yamuna River at Delhi (Anderson 1878), this distribution continued downstream till the Chambal confluence. However, after 1967, dolphin sightings have become rare in the Yamuna River above the Chambal-Yamuna confluence (Sinha et al. 2000). A three-day survey in October 2012 covered 400 km between Pachhnada and Allahabad and encountered a total of 31 dolphins (ER of 0.075 per km) (Behera et al. 2014). Although there is a lack of extensive survey across the river, a clear and steady decline in the population of Ganges river dolphin in Yamuna can be observed. Another important tributary of the Ganga, the Ghaghara river, hosts an estimated 231 dolphins between Girijapuri and Mohawn in Uttar Pradesh (445 km) (Sanghi, 2014; Behera et al., 2014).

1.1.1.2 Madhya Pradesh:

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. This unique ecosystem is very important as it provides a stable habitat for breeding, and thus Chambal is one of the few tributaries of Ganga which still harbours a sizeable population. According to the most recent survey, total of 80 dolphins have been recorded in the Chambal Sanctuary (MP Forest dept 2021), Chambal also hosts the only demographically viable population of gharial.

1.1.1.3 Bihar:

Dolphin range in main stem Ganga of Bihar seems fairly stable with high population densities across the stretch, with an estimate of 1096 individuals (SE± 17) (Qureshi et al, 2018). 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. The stretch between Chausa and Maniharighat in Bihar seems to be the strongest hold for this species in the Ganges river basin.

While the Dolphin Sanctuary in Bihar itself serves as a good habitat, where dolphins thrive in the region, the stretch surrounding Katihar (near Maniharighat) seems to be another major hotspot. Similarly other stretches (Figure 1.2) 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.

A significant reduction in population has been observed in Koshi river and river Gandak (Narayani in Nepal) upstream of the barrages (Smith et al. 1994; Sinha et al. 2000; R. K. Sinha & Kannan, 2014). In a survey in 2010, 257 dolphins were recorded in the Gandak river (Choudhary, 2012). In the Ghaghara river, an estimated 125 dolphins were recorded in the river stretch in Bihar. The stretches between Chhatei and Ghagra-Ganga confluence holds high densities of dolphins and needs special attention (WTI, 2019). In an abundance estimation study carried out for 155 km of Koshi river in India a total of 132 (SE± 6) dolphins were sighted (Qureshi et al., 2018), and around 160 dolphins by another independent estimate (Choudhary et al., 2019a, Choudhary et al., 2019b).

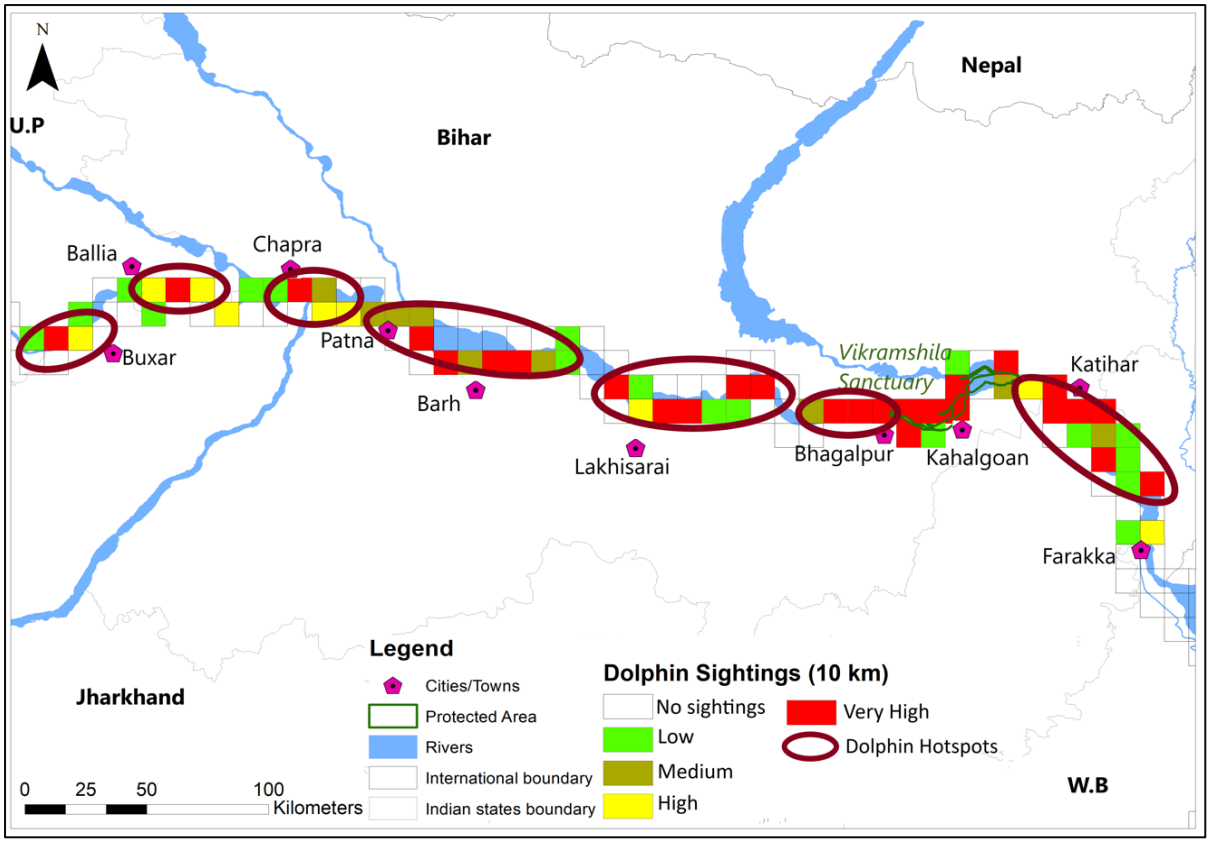


Figure 1.2:Dolphin hotspots in Bihar based on population encounters at every 10km. The categories are classified by pooling population estimates across the entire population of Ganga and Brahmaputra, and dividing the quartiles into the categories depicted here.

1.1.1.4 West Bengal:

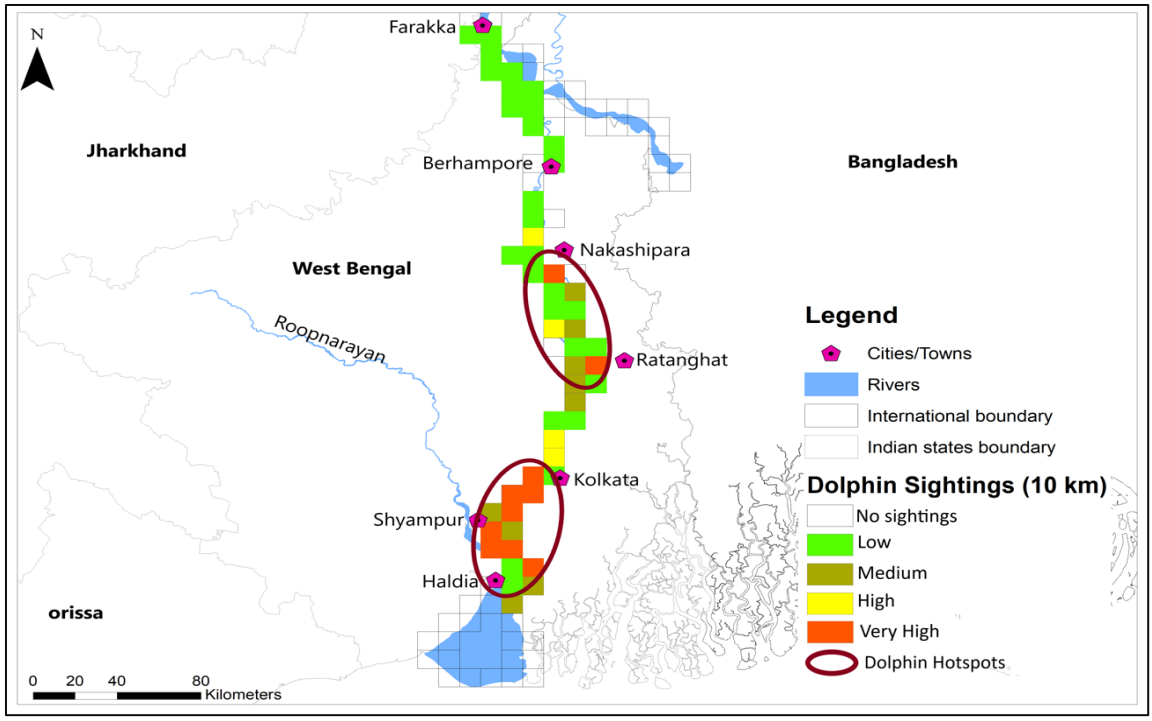


Figure 1.3:Dolphin hotspots in West Bengal based on population encounters at every 10km. The categories are classified by pooling population estimates across the entire population of Ganga and Brahmaputra, and dividing the quartiles into the categories depicted here

In West Bengal, the Farakka barrage located on the Ganges River, 400 km downstream of Patna, close to India–Bangladesh border acts as a population barrier (Sinha & Kannan, 2014). Although a sizeable population (~358 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. 2015). The stretch between Farakka feeder canal and Kakdwip in West Bengal sustains a population of about 358 (SE± 10) 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. 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 (Figure 1.3). While Roopnarayan hosts a population of at least 25 dolphins (Qureshi et al., 2018), Mahananda was known to have atleast 14 dolphins (Choudhary and Dey, 2019).

There is no known range description of the species from the Sundarbans, however historical records suggest that the species used estuarine habitats of the region (Anderson 1878). Wakid et al (2015) recorded a population of 92 Irrawaddy dolphins and 28 Indo-Pacific Humpback Dolphins, but no Gangetic dolphins in 776 km surveyed stretches of Indian Sundarbans, conducted in February-March, 2014. The habitat is also home to the critically endangered Ganges Shark, and endangered Irrawaddy dolphins, both of which are losing habitat rapidly and are on the verge of population collapse. This habitat is unique and requires special focus to restore biodiversity to its former status.

1.1.2 Brahmaputra

The Brahmaputra river system remains one of the major population strongholds of the Ganges river dolphin today, harbouring 30% of the world's population, with minimal barriers, so far, unlike the Ganges river system (Wakid, 2009). Although tributaries like Kulsi and Subansiri also harbour dolphin population, these populations experience a seasonal rise-and-fall which coincides with the flood cycle (Sinha & Kannan, 2014). The range of the dolphins in Brahmaputra is continuous from Assam-Arunachal border in the East to the Assam-Bangladesh border in the West, with certain points harbouring a good population of dolphins 877 (SE± 19) (Qureshi et al., 2018). Brahmaputra boasts of certain stretches where natural habitats still persist, for eg., Dibru Saikhowa National Park, Kaziranga National Park, and Orang National Park. These provide a safe haven for biodiversity in general. The dolphin hotspots in Brahmaputra are at Sivasagar, Kaziranga-Tezpur, Guwahati, and Goalpara-Dhubri, 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 (Figure 1.4).

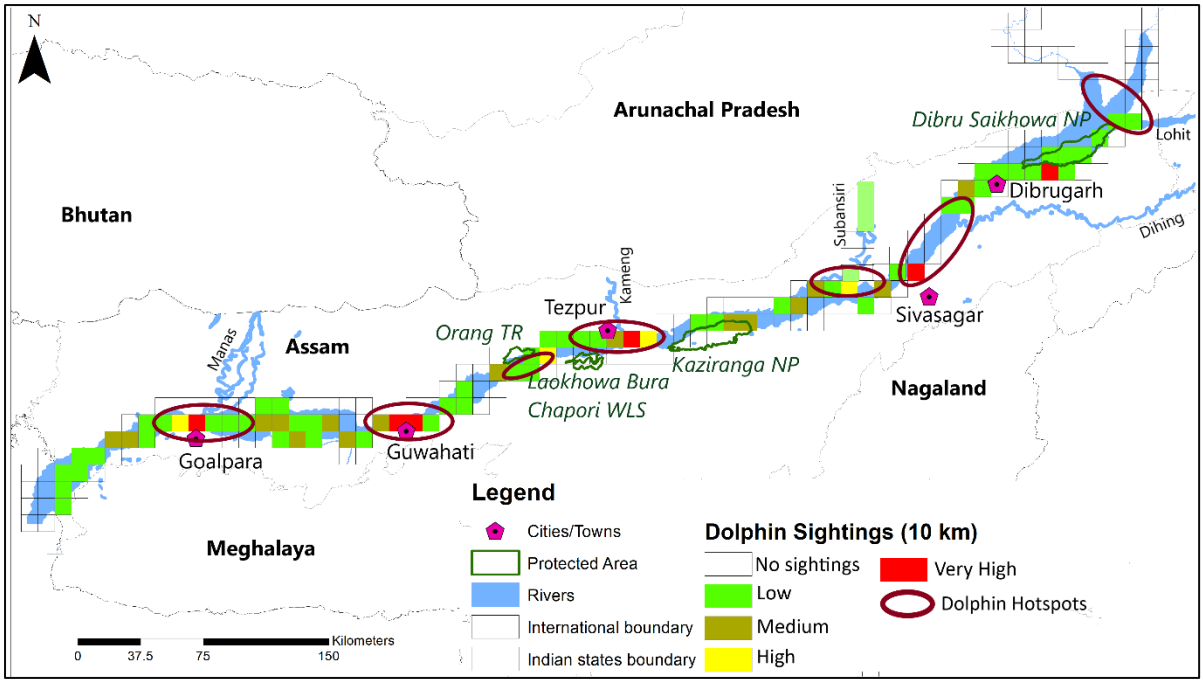


Figure 1.4:Dolphin hotspots in Brahmaputra, based on population encounters at every 10km. The categories are classified by pooling population estimates across the entire population of Ganga and Brahmaputra, and dividing the quartiles into the categories depicted here.

Two of the major populations in Brahmaputra river systems exist in the tributaries of Kulsi and Subansiri. A total of 32 dolphins (SE± 4) and 48 (SE ± 6) was the most recent estimate of these river respectively (Qureshi et al., 2020). Other smaller tributaries like Pohumara-Kaldia of Brahmaputra harbour a total of around 30 dolphins during summer season(Qureshi et al., 2020). The dolphin population in the tributaries were found to be stable. Especially during monsoon, which is a natural characteristic of Brahmaputra, these tributaries provide much needed refuge. Also, during lean months, it is essential to maintain their connection with the main river. Monsoon season dolphin occupancy was recorded in around 16 of the 31 surveyed tributaries of Brahmaputra (Qureshi et al., 2020). Dolphins have recently disappeared from Barak River (Singha, Pers comm, Chowdhury, 2019)

1.2 Status of Indus river dolphin

The Indus river dolphin is classified as endangered on the International Union for Conservation of Nature (IUCN) Red List of threatened species due to an 80% decline in its distribution range and a habitat severely fragmented by dams and depleted by water diversions (Braulik et al. 2015a). The Indus River dolphin was found in approximately 3400 km of Indus River and its tributaries, from the foothills of Himalayas to the limits of tidal zone in Pakistan. One such population was reported from Punjab (India) in 2007 between Beas city and Harike Barrage. While the population across its range is thought to be 1816 (WWF, Pakistan), in India, 6-8 individuals exist (Kanwar et al., 2019). Indus river dolphin is sharing common habitat with the reintroduced population of critically endangered Gharial since 2017. In Pakistan, their numbers declined dramatically after the construction of an irrigation system, and most dolphins are confined to a 1200 km stretch of the river and divided into isolated populations by six barrages.

2 MONITORING PLAN

Abundance of target species is one of the most fundamental information required for successful monitoring of its status and for intervention, if needed for its revival. However, population estimation methods for aquatic mammals largely suffer from the aquatic system's complex topography, currents, rippled water surface, reduced visibility of species and a non-uniform distribution of the species (Dawson et al. 2008, Richman et al. 2014). These render population estimation methods commonly adopted for terrestrial mammals unsuitable for aquatic mammals (Dawson et al., 2008). 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 involve visual as well as acoustic surveys or combination of both (Dawson et al, 2008; Richman et al 2014). Double observer based mark-recapture method corrects for observer bias and has been used for river dolphins and marine mammal surveys (Smith and Reeves, 2000, Qureshi et al 2018). There is substantial bias due to observer error and it is an absolute must to use double observer based surveys involving either double platform or boat in tandem method (Braulik et al 2012, Deori et al 2019), depending upon the navigability of medium or small size boats. While the visual-acoustic combination method is the most robust, it can only work in areas with good water depth, where medium size boats can navigate, and the technical know-how of analyzing acoustic data is developed. However, the correction factor developed for unavailability (by subject-experts) 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 effect on temporal trend of dolphin monitoring.

Overall, the survey method is divided into two monitoring schemes, range wide survey every three years ie tri-annual and annual surveys of critical hotspots. The activities for tri-annual survey are covered in 3 forms (Form 1, 2 & 3) with annexures. The annual monitoring of hotspots will have form 1, 2, 4, 5 and 6 with annexures. Data analysis will be done at Wildlife Institute of India in collaboration with State Forest Departments.

1. Form 1: Visual monitoring of Dolphin populations: Depending on the width and depth of the river, one of the following boat based methods will be used for dolphin visual monitoring:
    a. Form 1A: Double observer survey: This survey method will be used in large rivers, e.g. Brahmaputra and parts of Ganga where depth is adequate, and will involve a boat with two decks
    b. Form 1B: Boat in tandem survey: This protocol will be followed for wide rivers, with larger dolphin population. For example, parts of Ganga, and rivers like Kosi, Gandak, Subansiri, Kulsi, Chambal, amongst others.
    c. Form 1C: Single boat survey: This protocol will be followed in very narrow rivers, with low amount of water. For example, majority of the tributaries of Ganga
2. Form 2: Habitat and anthropogenic activity assessment
3. Form 3: Monitoring of associated biodiversity
4. Form 4: Monitoring of associated biodiversity at hotspots
5. Form 5: Fish abundance monitoring
6. Form 6: Water quality monitoring
7. Form 7: Carcass measurement and sample collection protocol

2.1 Tri-annual range-wide dolphin survey plan

For tri-annual range wide survey, each state will undertake the survey independently. This will be done in two parts parallelly: (1) Main stream Ganga or Brahmaputra and (2) Tributaries. The survey in the mainstream part of river should be carried out by a single team or by two teams at the most, to reduce bias and noise in data. Given the existing length of the rivers, the mainstream survey will take maximum of one month in each state. Tributaries will be surveyed by two to three teams depending on number of tributaries having dolphins (Table 2.1). The tributary team may have to do two to three tributaries per team. Table 2.1 gives broad details of survey plan and methods to be used in mainstream and tributaries of Ganga and Brahmaputra. On an average team will do 40 to 60 km of survey per day.

Steps involved in pre-planning:

- States need to apriori identify the staff who are to take part in the survey so that appropriate training is imparted, with researchers from Wildlife Institute of India, other Institutions and NGOs.
- State Forest Department should identify nodal officer for each state.
- Training workshop will be conducted during October of the year when range wide monitoring is to take place.
- The arrangements for survey will require hiring/procurement of boats and procurement of equipment, which should happen by October. See Appendix 2 and 4 for equipment list.
- Large size boat with double decks will be needed for double observer method, boat in tandem method needs two motor boats or motorized rafts and for single boat survey a motorized raft will be needed.
- The survey in Ganga and its tributaries, including Sundarbans, will takes place during Late October to Mid-December and whatever could not be surveyed during this time can be surveyed during February. Fog in December and January months will make survey difficult and after February, the water level will be too low in not only many tributaries, but also parts of mainstem Ganga. In Brahmaputra survey will be done during will be conducted from mid-January to end of February to avoid windy season in March.
- For all survey teams there will be one support vehicle for supply of essentials, dealing with medical emergencies and setting up of camps for overnight stay along the survey route. Each Participant will have to fill a form given in Appendix 5.
- Double observer method will need 10 people, boat in tandem 8 people and single boat 4 people other than boat staff. It is advisable that 2 extra people are trained per team, in case any replacement is needed during survey.
- All the intended participants of the survey will be trained for a 3 to 4 days in data collection, as per the protocols defined in data collection forms. It is essential that people get well versed with identifying dolphin surfacing, visual distance and angle estimation, identification of other aquatic fauna of conservation concern which can be seen from boat.

Table 2.1: Dolphin survey in Ganga and Brahmaputra, with details of method of survey and number of teams needed for survey

River	Stretch	Method	Number of Teams
Ganga-Uttar Pradesh	Bijnor to sangam Prayagraj	1B-Boat in Tandem	UP1
Ganga-Uttar Pradesh	Sangam Prayagraj to Chausa	1A-Double Observer	UP2

Ganga-Bihar	Chausa to Farrkka	1A-Double Observer	B1
Hooghly-West Bengal	Farrakka to Ganga Sagar	1A-Double Observer	WB1
Sundarbans- West Bengal	Sundarbans	1A-Double Observer	WB2
Brahmaputra-Assam	Assam-Arunachal Pradesh border to India-Bangladesh border	1A-Double Observer	A1
Tributaries			
Chambal Madhya Pradesh	Batesura to Pachhnada	1B-Boat in Tandem	MP1
Yamuna-Uttar Pradesh	Gauhani Kachar to Sangam Pryagraj	1C-Single Boat	UP3
Sharda-Uttar Pradesh	Pilibhit to Sharda-Ghagra confluence	1C-Single Boat	UP4
Girwa-Uttar Pradesh	Nepal border to Girija barrage	1B-Boat in Tandem	UP4
Ghagra-Uttar Pradesh	Girija barrage to Tola Bala Rai	1C-Single Boat	UP4
Ghagra-Bihar	Tola Bala Rai to	1C-Single Boat	B2
Gandak-Bihar	Valmiki nagar to Sadikpur-Patna	1B-Boat in Tandem	B2
Kosi-Bihar	Bahadurganj to Kursera	1B-Boat in Tandem	B3
Son-Bihar		1C-Single Boat	B3
Roopnarayan-West Bengal		1A-Double Observer	WB1
Subansiri-Assam	Chawoldhuwa to Khoga Ghat	1A-Double Observer	A2
Kulsi-Assam	Kukurmara to Nagarbera	1B-Boat in Tandem	A2

2.2 Intensive monitoring of Protected Areas and Critical hotspots of dolphins

States on the basis of maps provided (Figure 1.1 to Figure 1.4), should ideally work in all hotspots or will choose hotspots for annual monitoring due to logistic constraints. These hotspots are important for dolphins and conservation of aquatic fauna of conservation concern. For intensive monitoring Form 1A and 1B will be used for dolphin population estimation, Form 2 for habitat and anthropogenic activity, Form 4 for other aquatic species like gharial and otters, Form 5 for fish abundance and Form 6 for water quality monitoring. The training workshop will be carried out for Forest Department staff to carry out these activities.

Range-wide Monitoring protocols

3 FORM 1: VISUAL MONITORING OF DOLPHIN POPULATIONS

Before embarking on the actual survey, it is crucial that participants need to train on distance and angle estimation (see Annexure 1), and make themselves aware of the instruments to be used during survey (for details, see Annexure 2).

3.1 Form 1A: Double observer survey

A double observer survey for dolphin enumeration exercise is carried out in rivers suitable for navigation of bigger vessels. It works on the principle of a capture-recapture framework. This is a framework where two independent observer teams simultaneously count dolphins through a boat survey and the population is estimated by correcting for the number of dolphins missed by the other team. The procedure to conduct a double observer method of dolphin enumeration exercise is detailed below.

Figure 3.1: Image showing double observer method with two independent observer teams separated by a visual barrier

- Two independent observer teams are placed on two platforms of the same boat and separated by a visual barrier (Figure 3.1).
- Teams should synchronize their GPS units and, all watches being used to be synchronized with GPS. It is better to use GPS only for time recording to maintain uniformity.
- Boat speed of 8 to 10 km / hour should be maintained to avoid double counting of dolphins as average dolphin surfacing time is 107.3 (SD ± 46.8) seconds .
- Each observer team consists of - left observer that conducts observation from 0° to 89°, a right observer that conducts observations between 90° to 180° (observations beyond these angles are written with remarks) and a central data recorder can assist in conducting observations between 80-110°, if required.
- Dolphins surface for a few seconds above water (1.26 seconds SD ± 0.23), and the most common type of surfacing are given in Figure 3.3, for ease of identification. This should be carefully studied and should not be confused for eddy currents, waves or fish that surface, in order to ensure appropriate dolphin enumeration.
- As soon as a dolphin is sighted by the observer, the observer provides the data recorder with the following information: number of dolphins, age structure ('Calf' includes neonates and calves; 'Non-calf' refers to sub adults, 'Adults' and 'Unknown') radial angle and radial distance. (The procedure to determine the radial angle and distance are given in the Annexure 1).

- The recorder along with the above-mentioned information also records the GPS location, odometer reading, boat bearing and time of dolphin surfacing, the river channel type (Table 4.1; Figure 4.3) average boat speed, visibility conditions (Table 4.3) the distance to the left and right bank using a range finder and their habitat types (Table 4.2; Figure 4.4; Form 1A). All of the river channel and river bank habitat types have respective codes, (Table 4.1 & Table 4.2)so on encountering one river channel type, recorder has to put the respective code in the river channel type column.
- At the end of each survey day, the mark and recaptured or missed individuals are determined by matching information on GPS location, time of dolphin surfacing, angle and distance of dolphin sighting, odometer reading, boat bearing, and other recorded parameters.

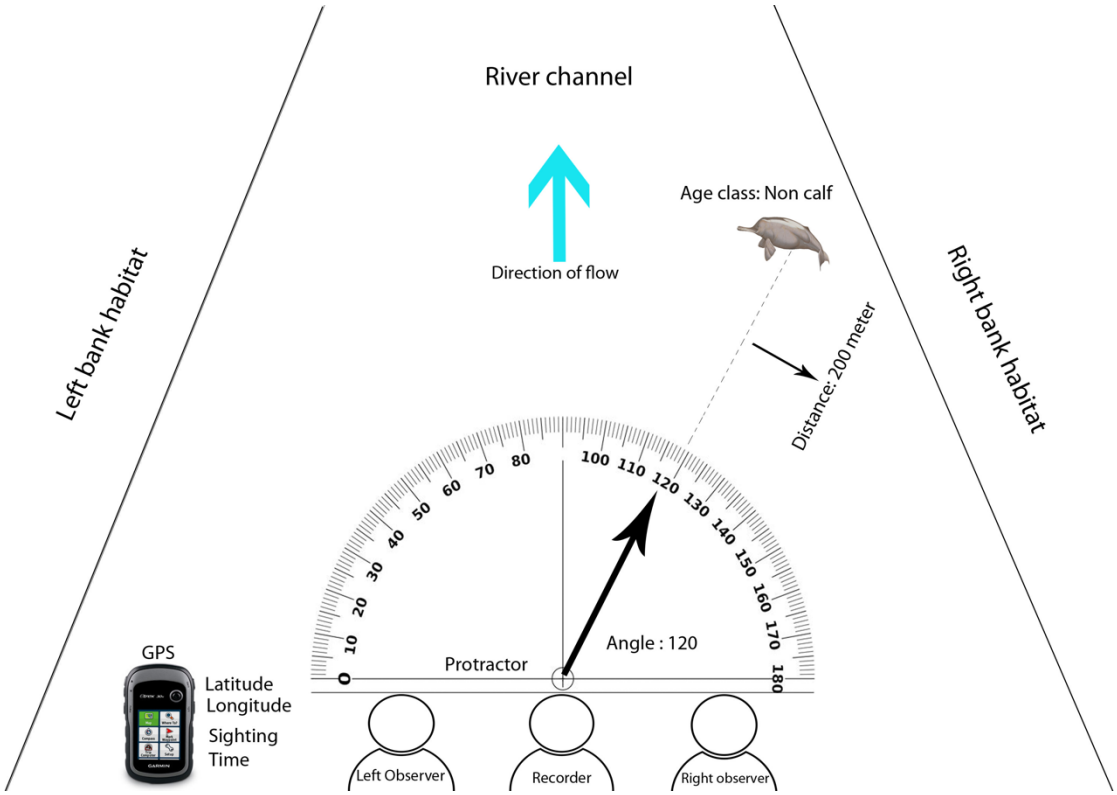


Figure 3.2: Recording dolphin sightings by each team

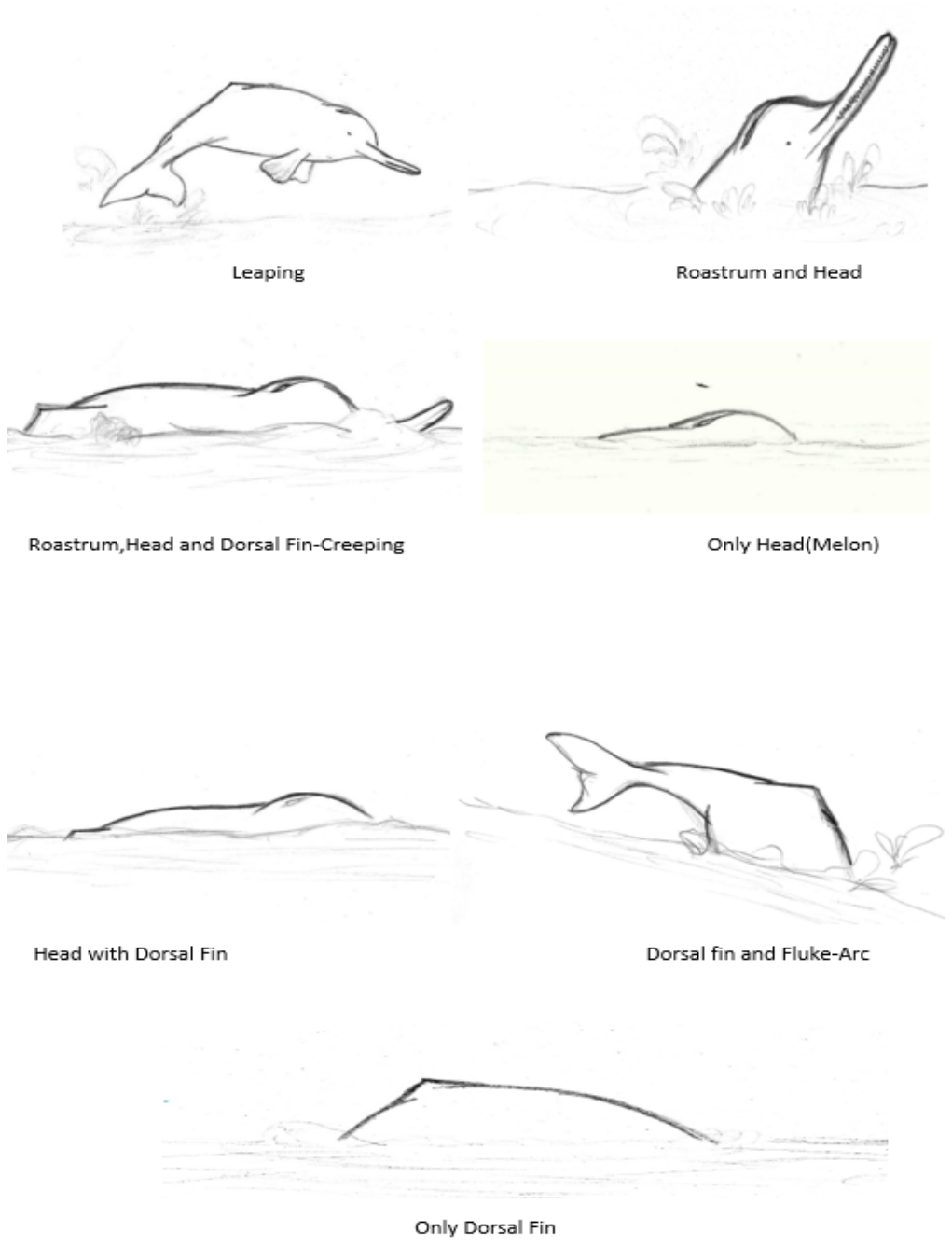


Figure 3.3: image showing different dolphin surfacing patterns (Image by: Rajat Rastogi)

FORM 1A: DOUBLE OBSERVER SURVEY DOLPHIN RECORDING DATA SHEET

Date	Observers		Avg. boat speed (km/h)	Distance travelled (km)
	L	R	Survey from-	Survey to-
Time start	Recorder		Start Lat.	End Lat.
Time end	Survey team: Lower deck / Upper deck		Start Long.	End Long.
Data sheet no.	GPS ID:	Track ID:	Remarks:	

Way pt.	Locations Lat. Long.	Observation time	Odometer	Sighting dist. (m)	Angle (°)	Calf	Non-Calf	Unknown	Observer	Boat Bearing	Boat speed (km/h)	River channel type	Wind*	Glare*	Rain/Fog*	Tide	Habitat type		Bank dist (m)		Resurfaing	Remarks
																	L	R	L	R		

*Wind (0: Water surface is glassy or had only small ripples, 1: Small waves but no whitecaps, 2: Larger waves with whitecaps) Glare (0: No glare, 1: slight glare (less than 10%), 2: Severe glare (more than 10%) Rain / Fog (0: No fog or rain,1: Fog or rain (not more than 10%), 2: obscuring more than 10%)

3.2 Form 1B: Boat in tandem survey

This method is a modified version of double observer method applicable for shallow wide rivers or rivers with sizeable dolphin population, where big motorized boats with double platforms is not feasible. In this method, instead of using a single big motorized boat, we will use two small motorized boats. The procedure is as follows:

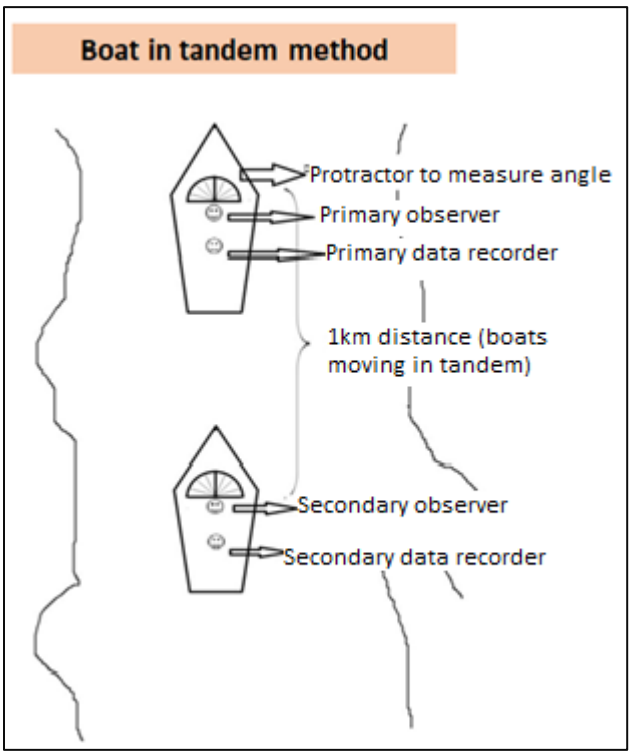


Figure 3.4: Boat in tandem method

- Two independent teams will travel in tandem with the second boat maintaining a distance of 1km (or 8 to 10 min) from the first boat, which is sufficient to ensure sighting independency between the two teams (Figure 3.4). The two boats will move at an average speed of 8-10km/hr in a downstream direction.
- In big shallow rivers (channel width is more than 600m), two observers covering the left and right part of the 180 degree viewing angle will be required. In narrow rivers, a single observer will be sufficient to cover the entire 180 degree viewing angle. Hence, the observer team will be comprised of two/one observer, and one data recorder in each boat. The first boat will be considered as primary observer team and second boat as a secondary team.
- Prior to starting the survey, both the observer teams will synchronize the timings on their GPS recorders which will be very crucial. The entire matching will be based on the positions of GPS locations of dolphins recorded throughout the survey.
- Dolphin surfaces only for a few seconds. The type of surfacing is given in Figure 3.3. This should be carefully studied and should not be confused for eddy currents, waves or fish that surface in order to ensure appropriate dolphin enumeration.
- As soon as a dolphin is sighted by the observer, the observer provides the data recorder with the following information: number of dolphins, age structure ('Calf' includes neonates and calves; 'Non-calf' refers to sub adults, 'Adults' and 'Unknown') radial angle and radial distance. (The procedure to determine the radial angle and distance are given in the Annexure 1).

- The recorder along with the above-mentioned information also records the GPS location, odometer reading, boat bearing and time of dolphin surfacing, the river channel type (Table 4.1), average boat speed, visibility conditions (Table 4.3), the distance to the left and right bank using a range finder and their habitat types (Form 1B). All of the river channel and river bank habitat types (Table 4.1 & Table 4.2) have respective codes, so on encountering one river channel type, recorder has to put the respective code in the river channel type column.
- At the end of each survey day, data from the primary and secondary observer teams should be verified.

FORM 1B: BOAT IN TANDEM SURVEY DOLPHIN RECORDING DATA SHEET

Date	Observers		Avg. boat speed	Distance travelled
	L	R	Survey from-	Survey to-
Time start	Recorder		Start Lat.	End Lat.
Time end	Survey team: Boat 1 (primary) / Boat 2 (secondary)		Start Long.	End Long.
Data sheet no.	GPS ID:	Track ID:	Remarks:	

Way pt.	Locations Lat. Long.	Observation time	Odometer	Sighting dist. (m)	Angle (°)	Calf	Non-Calf	Unknown	Observer	Boat Bearing	Boat speed (km/h)	River channel type	Wind*	Glare*	Rain/Fog*	Tide	Habitat type		Bank dist (m)		Resurfaing	Remarks
																	L	R	L	R		

*Wind (0: Water surface is glassy or had only small ripples, 1: Small waves but no whitecaps, 2: Larger waves with whitecaps) Glare (0: No glare, 1: slight glare (less than 10%), 2: Severe glare (more than 10%) Rain / Fog (0: No fog or rain,1: Fog or rain (not more than 10%), 2: obscuring more than 10%)

3.3 Form 1C: Single boat survey

Single boat dolphin observation will be used in those rivers which are small, shallow and dolphin population is sparsely distributed. As far as possible motorized small boat should be used for survey. Examples of such rivers are Sone, Mahananda, Punpun, Buri Gandak in Bihar and Sharda, Yamuna andGomti in Uttar Pradesh, having shallow water depth and also having less dolphin records from the past surveys. The methodology is similar to that of boat in tandem, except that there will be only one boat instead of two.

Figure 3.5: Single small boat with two dolphin Observers (Left & Right) and a data Recorder

- In single boat dolphin survey there has to be three people two dolphin observers (left & right) and one data recorder (Figure 3.5).
- Prior to starting the survey, all observer s will synchronize the timings on their GPS recorders and watches which will be very crucial.
- Dolphin surfaces only for a few seconds. The type of surfacing is given in Figure 3.3. This should be carefully studied and should not be confused for eddy currents, waves or fish that surface in order to ensure appropriate dolphin enumeration.
- As soon as a dolphin is sighted by the observer, the observer provides the data recorder with the following information: number of dolphins, age structure (Calf: Includes neonates and Calf; Non-Calf: Sub adult and Adults and Unknown) radial angle and radial distance. (The procedure to determine the radial angle and distance are given in the Annexure 1).
- The recorder along with the above-mentioned information also records the GPS location, odometer reading, boat bearing and time of dolphin surfacing, the river channel type (Table 4.1), average boat speed, visibility conditions (Table 4.3) the distance to the left and right bank using a range finder and their habitat types (Table 4.2; Form 1C). All of the river channel and river bank habitat types have respective codes (Table 4.1 & Table 4.2), so on encountering one river channel type, recorder has to put the respective code in the river channel type column.

FORM 1C: SINGLE BOAT SURVEY DOLPHIN RECORDING DATA SHEET

Date	Observers		Avg. boat speed	Distance travelled
	L	R	Survey from-	Survey to-
Time start	Recorder		Start Lat.	End Lat.
Time end			Start Long.	End Long.
Data sheet no.	GPS ID:	Track ID:	Remarks:	

Way pt.	Locations Lat. Long.	Observation time	Odometer	Sighting dist. (m)	Angle (°)	Calf	Non-Calf	Unknown	Observer	Boat Bearing	Boat speed (km/h)	River channel type	Wind*	Glare*	Rain/Fog*	Tide	Habitat type		Bank dist (m)		Resurfaing	Remarks
																	L	R	L	R		

*Wind (0: Water surface is glassy or had only small ripples, 1: Small waves but no whitecaps, 2: Larger waves with whitecaps) Glare (0: No glare, 1: slight glare (less than 10%), 2: Severe glare (more than 10%) Rain / Fog (0: No fog or rain,1: Fog or rain (not more than 10%), 2: obscuring more than 10%)

4 FORM 2: HABITAT AND ANTHROPOGENIC ASSESSMENT

Apart from the team that is visually monitoring the dolphins, a separate team (one observer and/or one recorder) will independently record habitat characteristics and anthropogenic activities along the same track in the entire river. In bigger rivers, where large motor boats can be used for survey, the habitat survey team can record from the same boat along with the dolphin survey (Figure 4.1). In case of smaller tributaries, where small boats will be used, for doing boat in tandem method, the survey team can decide from which boat the habitat survey can be done and in single boat it will be recorded by recorder (Figure 4.2).

Figure 4.1 Double observer survey boat with two observer teams and one habitat and anthropogenic activity recorder team

Figure 4.2: Observer and data recorder in single small boat

- For the habitat survey the observer should sit at a proper location on the boat from where visibility is better for both the banks of the river.
- The depth of river will be recorded with Hummingbird/Chartplotter in case of bigger boats where a double-observer method is employed, and a hand held depth sounder where boat in tandem or single boats are employed (Annexure 2). The screen of the instrument should be near the recorder so that the data can be read and recorded.
- Habitat characteristics and anthropogenic activities will be recorded for every 1 km segment and this will be done for the entire river stretch. The parameters to record are given in the datasheet.
- The latitude and longitude at the start and end of each segment will be recorded using GPS.
- Between the start and end of each 1 km, all the habitat characteristics along with anthropogenic activities need to be counted by the observer and recorded.
- Information like datasheet number, observer and recorder names, date of survey, weather condition (wind, glare, rain) of the particular day, start and end time of the survey (end time need to be noted down after the survey ends), total distance covered (after survey ends) and average boat speed during the survey (after survey ends) etc. should be filled accordingly in the datasheet.
- Recorder should note down the reach number (that will be the odometer of the GPS) on reaching each segment in the datasheet. Reach no. will start from 0 (start point) and end with total distance covered during survey (0, 1, 2, 3, 4… etc).
- Also, in order to keep the uniformity in the data collection, recorder has to check the odometer of the GPS constantly and repeat the procedures for next segments.

4.1 Habitat specific data to be recorded

- Habitat data consist of river channel type, river depth, river channel width, and river bank habitat.
- At the starting point of every new segment, the observer has to record the bank distance of both the banks from the boat with the help of the rangefinder.
- The major river channel type representing that particular 1 km segment has to be recorded
- The major habitat type of both the river banks for that particular segment need to be recorded and filled in the respective column of the datasheet (Form 2); Table 4.2) have respective codes, so on encountering one river channel type, recorder has to put the respective code in the river channel type column. Visibility conditions should also be recorded (Table 4.3)
- Depth at any three consecutive points (preferably at every 300 m of the 1 km) has to be recorded for that particular segment on the track. The depth data will be visible in the hummingbird or chart plotter screen, which needs to noted in respective column of data sheet. In case of small boat use hand held depth sounder for depth measurement.

Table 4.1: River channel type classification

Sl. no.	Channel type	Characteristics	Codes
1	Wide channel	channel width >600m	WC
2	Narrow	channel width <600m	NC
3	Meander	curves/bends formed by the river channel	M
4	Mid channel	presence of island in the middle of river channel	MCI
5	Confluence	Confluences occur where a tributary joins a larger river, where two rivers join to create a third or, where two separated channels of a river, having formed an island, rejoin downstream	CF
6	Braided channel	This type of channel forms when one channel gets divided into many smaller channels, by temporary islands called eyots. Braided channels are predominant in rivers with high sediment load, a steep profile and fluctuating discharge profile	BRC
7	Braiding confluence	Where two or more channels of the river separated by islands joins together forming confluence like area	BRCF
9	Stagnant pool	Somewhat circular inlet like narrow area near banks of river, which has very less or no water flow	SP

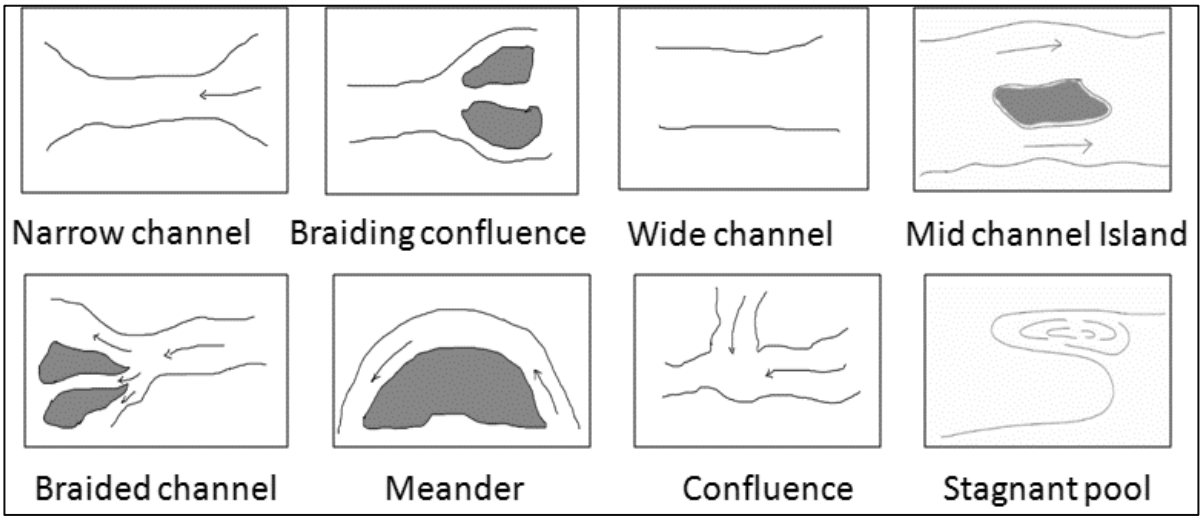


Figure 4.3: Channel types

Table 4.2: River bank habitats classification

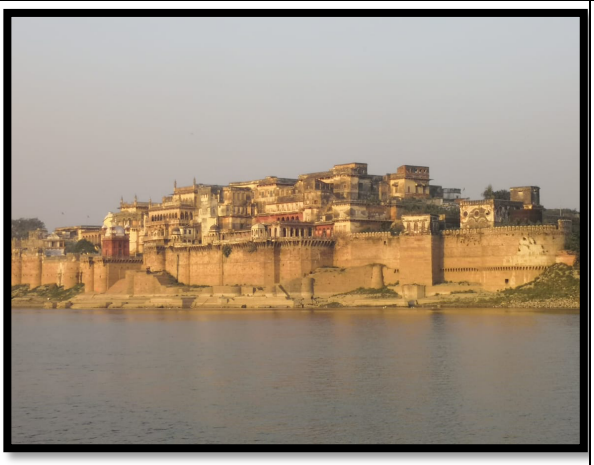
Sl. No.	Habitat type	Characteristics	Codes
1	Sandbanks	Ridge of sand along the shore, with no or very less vegetation	SB
2	Human habitation	Presence of human settlement along the river bank, majorly observed when passing town/city/villages	HH
3	Grassland	When the river bank vegetation is dominated by grasses	GL
4	Shrubland	Vegetation dominated by shrubs (multi-stemmed vegetation with no prominent trunk), often also including grasses, herbs, and geophytes	SL
5	Mature forest	Vegetation dominated by trees with or without interspersion of grasses/ shrubs	MF
6	Cropland	When the riverbank is predominantly used for agriculture purposes	CL

SANDBANKS

MATURE FOREST

SHRUBLAND

GRASSLAND



HUMAN HABITATION

AGRICULTURE

Figure 4.4: Example of different bank habitat types

Table 4.3: Visibility conditions

Visibility Conditions (Codes)	Scales
Rain/Fog (R/F)	0 = No rain/fog, 1 = fog/rain obscuring no more than 10% of the field of view or slight fog/rain partially obscuring no more than 50% of the field of view 2 = Severe fog/rain obscuring more than 10% of the field of view or slight fog/rain partially obscuring more than 50% of the field of view
Wind(W)	0 = water surface is glassy or had only small ripples, 1 = small waves but no white caps, 2 = larger waves with whitecaps
Glare(G)	0 = No glare, 1 = glare is very severe (view completely obscured) but covering <10% of the field or when glare is slight (view only partially obscured) and covers less than 50% of the field view, 2 = severe glare covering more than 10% of the field of view or slight glare covering more than 50% of the field of view

4.2 Anthropogenic activity data to be recorded

The anthropogenic data focuses on the use of river by humans, which includes presence of different types of boats, ships, irrigation pumps, different types of fishing activities and gears, presence of human settlement and agriculture near the banks. The following anthropogenic activities are recorded in the same 1 km segment as habitat data.

- Human activities need to be counted in a segment. For example, if you see a total of 5 country boats in 1 km segment, you need to count and fill in the respective columns of the datasheet (Form 2). Examples of human activities are given in Figure 4.5, Figure 4.6 and Figure 4.7.

Figure 4.5: Example of human activities (a) Tin Boat; (b) Roro Boat; (c) Sand Boat; (d) Country Fishing Boat/Trawler; (e) Ferry Boat/Vessel and (f) Ship

(a)

(b)

(c)

(d)

(e)

(f)

Figure 4.6: Example of human activities (a) Ferry Ghat/crossing; (b) Sand mining (boats); (c) Dredger; (d) Irrigation Pump and (e&f) drains

Figure 4.7: Example of fishing methods (a) Gill Net; (b) Fish Trap; (c) Hook Fishing; (d) Cast Net; (e) Jeng Fishing; (f) Lift Net; (g) Drag Net and (h)Mosquito Net

FORM 2: HABITAT AND ANTHROPOGENIC ACTIVITIES SAMPLING DATA SHEET

Data sheet no.	Data Recorder	Start Time	Start Lat	Long	Total Trip (km)
Date		End Time	End Lat	Long	Avg. Boat Speed (km/hr)

Reach no.	Way pt.	Bank distance		Bank habitat		Channel type	Weather / Visibility condition		
N	E	LB	RB	LB	RB		W (0/1/2/3)	G (0/1/2/3)	R (0/1/2/3)

Tin boat	RoRo boat/ Budbudi	Sand boat	Sand mining pump	Sand depositories	Ferry Ghat/ Ferry crossing	Ferry boat	Ships	Dredger	Irrigation pumps	Agriculture Y/N	Tea garden

Human habitation (In 10s)	Sewage outlets	Country fishing boat	Fishing camp	Oil bait	Gill net	Fish traps	Hook fishing	Cast net fishing	Jeng Fishing	Lift net	Drag net	Mosquito net

Temple ghat/Idol immersion	Bridges	Barrages	Pontoon	Depth 1 (m)	Depth 2 (m)	Depth 3 (m)	Remarks

5 FORM 3: MONITORING OF ASSOCIATED BIODIVERSITY

Information on the presence and usage of other riverine species that inhabit dolphin habitats will be gathered through the protocol outlined below.

- Encounters of other riverine species can be recorded during the dolphin enumeration exercise. This, however, should not be practiced by the dolphin observation team, but only by the habitat team without compromising on the habitat data.
- Other riverine species include gharials, muggers, otters, turtles, or birds. On sighting any of these riverine species, the observer records the GPS location, time of encounter, species encountered, age-sex class of the individual wherever determinable, activity and the counts of individuals in the datasheet (Form 3). Wherever feasible, it is recommended to back up the observation with a photograph either on mobile phone or a camera, especially when species identity is unclear. See data sheet footnote for age classification of gharial and mugger.
- Apart from direct animal encounters, sighting of nests, tracks and carcasses or any cases of active poaching can also be recorded in the data sheet.

FORM 3: DATA SHEET FOR OTHER RIVERINE SPECIES (mainly for gharials, muggers, otters turtles and birds)

Date	Time	Observer Name	Location		Species#	Image ID	Age-sex* (please write counts)					Activity (tick or counts)			Remarks
			N	E			Adult Male	Adult Female	Sub-adult	Young	Unknown	Basking	Foraging	Nesting	

*Age-sex classes for gharials: Adult males have a 'ghara' – a bulge on their snout that adult females lack
Size for gharials: young <1m, subadult 1-3m, adult>3m
Size for muggers: young <0.5m, subadult 0.5-1.5m, adult>1.5m
Size for otters: young<0.3m, subadult 0.3-1m, adult>1m
#For unknown turtle species specify: large ones >0.5m, small ones <0.5m


Adult male gharial


Adult female gharial

LIST OF OTHER RIVERINE SPECIES* TO RECORD

COMMON NAME	SCIENTIFIC NAME
Crocodilians	
Gharial	Gavialis gangeticus
Mugger Crocodile	Crocodylus palustris
Otters	
Smooth-Coated Otter	*Lutra perspicillata*
Small-Clawed Otter	*Aonyx cinereus*
Chelonians (Turtles, Terrapins And Tortoises)	
Indian Flapshell	Lissemys punctata sp.
Indian Roofed Turtle	Pangshura tecta
Assam Roofed Turtle	Pangshura sylhetensis
Indian Softshell Turtle	Nilssonia gangetica
Red Crowned Roofed Turtle	Batagur kachuga
Indian Tent Turtle	Pangshura tentoria
Indian Spotted Turtle	Geoclemys hamiltonii
Indian Pond Terrapin	Melanochelys trijuga
Brown Roof Turtle	Pangshura smithii
Indian Leaf Turtle	Cyclemys gemeli
Keeled Box Turtle	Cuora mouhoti
Malayan Box Turtle	Cuora amboinensis
Tricarinate Hill Turtle	Melanochelys tricarinata
Three Striped Roof Turtle	Batagur dhongoka
Crowned River Turtle	Hardella thurji
Peacock Soft Shelled Turtle	Nilssonia hurum
Black Soft Shelled Turtle	Nilssonia nigricans
Narrow-Headed Soft Shelled Turtle	Chitra indica
Elongated Tortoise	Indotestudo elongata
Birds	
Indian Skimmer	Rynchops albicollis
Black Bellied Tern	Sterna acuticauda
Greater Thicknee	Esacus recurvirostris
Swamp Grass-Babbler	Laticilla cinerascens
Baer's Pochard	*Aythya baeri*
Black Stork	Ciconia nigra
Spot Billed Pelican	*Pelecanus philippensis*
Oriental Darter	Anhinga melanogaster
Pallas Fish Eagle	Haliaeetus leucoryphus
Grey Headed Fish Eagle	Icthyophaga ichthyaetus
* the list does not include snakes, toads or frogs. Any encounters of these should be recorded	

Annual Intensive site monitoring protocols

6 DOLPHIN MONITORING AT INTENSIVE SITES FORM 1A/ FORM 1B

Dolphin monitoring at intensive sites will be done by following Form 1A or 1B protocols depending on the river depth. It is crucial to do annual monitoring of these source population for long term conservation.

7 FORM 4: ASSOCIATED SPECIES MONITORING AT INTENSIVE SITES

Information on the presence and usage of other riverine species that inhabit dolphin habitats will be gathered through specified surveys. While opportunistic encounters involve recording encounters of other species that are sighted during any of the boat surveys intended for dolphin observations, specified surveys are periodic surveys meant for recording species on river banks either by using country boats or by conducting foot transects. This is to be conducted twice a year in the intensive sites to be monitored as species usage differ seasonally. The protocol for the specified surveys is outlined below:

- Specified surveys for monitoring other riverine species can be conducted periodically in winter and summer. The sample length of these surveys are site-specific and needs to be decided based on the available logistics and the length of the river stretch of interest, but a minimum sampling unit of 50 km on each bank needs to be chosen for monitoring. For areas where the river stretch, including both banks does not exceed 50 km, the entire stretch needs to be surveyed.
- Boat-survey can be conducted for the chosen sample length. 25 km stretch can be Sampled per day it will take 4 days to complete entire stretch of 50 km on both banks,
- The monitoring for the entire chosen stretch needs to be repeated once in winter and summer. It is ideal to keep the sampling days of a single season continuous – i.e., designated 5 continuous days to survey the designated 50 km with 5km stretch each day on each bank. The survey will be done in alternate 5 km stretch that way 50 km will be covered.The same process will be repeated for other bank. It will take total 8 days to sample 50 km stretch of a river on both banks..
- During this survey, the two observers conduct one survey while travelling upstream and one while travelling downstream. While travelling upstream, Form 4A: 'other shoreline fauna' survey is to be undertaken and while returning downstream Form 4B: 'waterfowl' survey is to be conducted from boat.

7.1 Form 4A: Boat based other shoreline fauna

- observers scan the river bank (either through binoculars or naked eye) while travelling on a boat that is moving 10-15m away from the river bank at a speed of 5 km/h, and record presence or signs of gharials, muggers, otters, turtles and any other herpetofauna (snakes or frogs).
- Upon encountering any of the signs or direct observation, the GPS location, type of sign, activity of the animal, group size and habitat type is to be recorded in the data sheet (Form 4A).
- Signs can be recorded only if direct sighting of certain species is absent, for example where otters pug marks are visible but not the animals, one can record spraint (otter's excreta) or pugmarks. Multiple tracks can be differentiated based on whether the sign is new or old.
- Upon completion of the upstream survey, the observers pause for a period of 15-20 minutes before returning on the same path conducting a Form 4B 'waterfowl' survey; this period of stoppage minimizes the chances of missing the waterfowls that got disturbed while conducting the 'other shoreline' survey.

7.2 Form 4B: Waterfowl transect survey:

- Two member team is required for the downstream survey (one observer and one recorder)

- The observer faces the bow of the boat, and scans 180° on either side and record presence of 'waterfowls'..
- Upon encountering, the observer provides the recorder with information on species sighted, group size, distance to the bird (or the center of the group) using a handheld range finder and angle to the bird (or the center of the group) using a hand held compass in the data sheet (Form 4B).
- The recorder also writes down GPS location and the bearing of the boat using a hand held compass. Wherever feasible, it is recommended to back up the observation with a photograph either on mobile phone or a camera, especially when species identity is unclear.

7.3 Shoreline foot survey (Form 4A & Form 4B)

- For the foot transects, two or three observers conduct a foot survey on the designated river bank. Upon reaching the designated region, the observers walk along the bank 3to 5 km and conduct an 'other shoreline fauna' survey where they record presence of gharials, muggers, otters, turtles and any other herpetofauna that they may sight.
- While walking, forward scanning is required as chances of missing animals increase as approach distance decreases. Upon encountering, the observer records the GPS location, type of sign, activity of the animal, group size and habitat type in the data sheet (Form 4A). Signs can be recorded only if direct sighting of certain species is absent, for example where otters pug marks are visible but not the animals, one can record spraint (otter's excreta) or pugmarks.
- Multiple tracks can be differentiated based on whether the sign is new or old.
- Upon completion, the observers pause for a period of 15-20 minutes before returning on the same transect conducting a 'waterfowl' survey; this period of stoppage minimizes the chances of missing the waterfowls that got disturbed and pushed away while conducting the 'other shoreline' survey.
- In the waterfowl survey, a two member team is required (one observer and one recorder)
- The observer chooses a specific angle on the handheld compass to follow while returning and conducting a transect. The angle should be chosen in a way that the transect line drawn is more or less straight and largely runs parallel to the river.
- Once the transect bearing is chosen, the observer, while walking, scans 180° on either side and record presence of 'waterfowls';. Upon encountering, the observer provides the recorder with information on species sighted, group size, distance to the bird using a handheld range finder and angle to the bird using a hand held compass in the data sheet (Form 4B).
- The recorder along with this information records the GPS location, the bearing of the transect using a hand held compass. If the animal or sign is encountered by multiple observers, only one record is sufficient.
- Wherever feasible, it is recommended to back up the observation with a photograph either on mobile phone or a camera, especially when species identity is unclear.
- During any of the surveys, apart from direct animal encounters, sighting of carcasses or any cases of active poaching can also be recorded in the data sheet.

Form 4A: DATA SHEET FOR SPECIFIED-SURVEYS OF OTHER SHORELINE FAUNA

(mainly for gharials, muggers, otters, turtles any other herpetofauna and birds)

Data sheet no:	Date:	Type of survey (please tick one)	Foot / Boat-based	Observer Names:
Average speed (km/h):		Start Time:	End Time:	
Total trip (km):		Start Lat:	End Lat:	

Time	Way point	Location		Species#	Image ID	Direct Sighting								Sign		Remarks
						Age-sex* (please write counts)					Activity (tick or counts)					
		N	E			Adult Male	Adult Female	Sub-adult	Young	Unknown	Basking	Foraging	Nesting	Type of sign (Nest/track/ excreta) please specify	Age of sign (Old/New) please specify	

age-sex classes for gharials: Adult males have a 'ghara' – a bulge on their snout that adult females lackSize for gharials: young <1m, subadult 1-3m, adult>3m

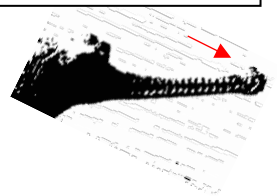
Size for muggers: young <0.5m, subadult 0.5-1.5m, adult>1.5m

Size for otters: young<0.3m, subadult 0.3-1m, adult>1m

#For unknown turtle species specify: large ones >0.5m, small ones <0.5m

Adult male gharial

Adult female gharial



From 4B: DATA SHEET FOR SPECIFIED-SURVEYS FOR TRANSECT SURVEY OF WATERFOWLS

Data sheet no:	Type of survey (please tick one)	Foot / Boat-based	Observer Names:
Date:	Start Time:	End Time:	
Total trip (km):	Start Lat:	End Lat:	

Time (hh:mm)	Way point	Location		Bearing of the boat or walk (°)	Species#	Image ID	Counts	Radial distance (m)	Animal bearing (°)	Remarks
		N	E							

8 FORM 5: FISH SAMPLING AND FISH LANDING SITE SURVEY

The prey of dolphin mainly includes surface dwellers Clupeid (shads) and Cyprinid fishes (small carps, barbs). Mid-column prey groups (barbs, catfishes, perchlets) are mostly associated with underwater habitats and riverine vegetation, whereas benthic groups include mud-dwelling catfishes, gobies, shrimps, and spiny eels. Fish sizes determined from analyzing dolphin stomach contents range from 3.5 to 20 cm. Fish sampling, hence, is necessary and will assist in understanding fish population and in evaluating habitats available for dolphins to occupy.

8.1 Form 5A: Fish monitoring protocol:

To sample fishes of the river (focusing mainly on dolphin prey base), natural fishing practices of the local fishermen should be observed and recorded. As each river stretch contains different fish species, which is well known to the experienced fishermen, different fishing nets (different mesh sizes, length, breadth, fishing duration and time of the day) are used, according to the river habitat and fish species availability. Some of the nets mainly used for fishing practices in different river habitats and for different fish catch by the fishermen are as follows:

Gill Nets

- 10mm, 12mm (Cheli Jaal) eg. Salmophasia boopis, Xenentodon cancila
- 24mm, 26mm, 30mm (Soya Jaal) eg. *Labeo bata, Cirrhinus reba*
- 32mm, 35mm (Naagin Jaal) eg. Eutropiichthys vacha, Clupisoma garua
- 60mm (Ilish Jaal/Chhadi Jaal) eg. *Tenualosa ilisha*
- 80mm, 100mm, 200mm (Faash Jaal/Raang Jaal) eg. *Sperata aor*, *Bagarius bagariu*s, Indian Major Carps

Cast Net

- 12mm (Khyapla Jaal) eg. Glossogobius giuris, Macrognathus pancalus, crustaceans
- 18mm, 20mm, 24mm (Sutli Jaal) eg. *Ailia coila, Mastacembelus armatus*
- 30mm, 60mm (Teuri Jaal) eg. *Chitala chitala*

The protocol for fish sampling is outlined below:

- Each gill net will be deployed perpendicular to the water flow for 15-60 minutes, following the natural procedure of fishing net deployment by local fishermen, for every 2 km of the river stretch, and cast nets will be used on both the river banks.
- Ten sampling trials for gill nets and 10 for cast net will be done in every 2 km segment. Data of every trial should be entered in a separate data sheet.
- The 2 km segment will be repeated after every 4 km, i.e., 10 sampling segments should be done in a 60 km stretch.
- At each sampling point, location information, net type and dimensions, effort, river characteristic, weather condition, bank vegetation and anthropogenic activities will be recorded (Form 5A).
- Local name of all fishes captured should be recorded. In case of unidentified fish, photograph should be taken for identification. Fishes should be counted species wise, weighed and measured.

8.2 Form 5B: Fish Landing Site Survey

Surveys are conducted at fish landing sites with the purpose of collecting data on total catch and species composition, associated effort, and other secondary data such as selling price, fishing gear used, fishing season and fish size (in weight units) of riverine fishes exclusively. The fish landing surveys can be conducted at regular fish markets also, to examine the characteristics of fishing activities and their effects on fish quality and distribution.

- The fish landing sites will get fishes from various sources (including private ponds, wetlands, streams, cultivated lands). Care should be taken to specifically get information on fish caught from rivers.

- Fish market survey will be done seasonally at the fish landing sites (at least for one week each season). Information about fish species, species wise quantity and market value per kg, types of fishing gear used to catch that species with gear specification (length X breadth, mesh size), time spent per day to catch that amount of that species will be recorded.

Form 5A: DATA SHEET FOR FISH SAMPLING AT INTENSIVE MONITORING SITES

Locality	Date	Collector's Name	Location		Weather condition (*Please tick*)			
			N	E	Sunny	Windy	Rainy	Foggy
					S			

Gill/Cast net dimension			Net casting	Trial No.	Channel type	Bank Width	
Mesh size	Length	Width	Start time	End time		Left	Right

Sl.no	Species			Individual Species count	Weight(g)	Fish Dimension (cm)				Size class	Depth(m)	Stream
	Fish Taxa	Local Name	Common Name			Total length	Std. length	Head length	Body depth			

Form 5B: FISH LANDING SITE SURVEY DATASHEET

Date	Location of fish market		Sl. No.	Name of the informant	Time of the day	Fish Species	Amount (please specify g or kg)	Economic exchange (Rs/kg)	Type of fishing gear	Gear specification (if possible)		Effort (hour/day)
	Lat	Long								L x B	Mesh size	

9 FORM 6 : WATER QUALITY MONITORING

Water quality monitoring is essential for determining the health and composition of streams, rivers, and reservoirs in real-time, as well as over weeks, months, and years. Measurements of pH, dissolved oxygen (DO), temperature, electrical conductivity, nitrate, turbidity and coliform are the essential parameters that provide comprehensive quality and usage suitability of water, including physical, chemical and biological characteristics that should be routinely monitored over time. The assessment of these essential water quality parameters can be done through handheld and mobile equipment.

The multiparameter handheld instrument can be used for water quality monitoring as it comes with real-time measurement, profiling, and unattended data logging. The choice of the sensor depends on the parameters, the required specifications and the operating condition. The presence of total coliform in the water can be estimated through portable coliform test kits that determine the microbial quality of water.

Before a site visit, organize necessary field supplies, calibrate applicable portable sensors and ensure that the required laboratory supplies are available (Annexure 3)

- Shore-based - One person holds the water quality meter on the shore, while another takes the sensors and wades out into the water body, preferable from the centre of the water body, wherever possible.
- Boat-based - While the boat moves forward, switch off the engine and allow the boat to drift forward and clear of possible contamination caused by the motor or propeller.
- Turn the water quality testing instrument on and place the sensors in the water to a depth of 0.2m (to reduce impact surface slicks).
- The reading should be taken at every 2 km for a 60 km river stretch.
- It is important to monitor these parameters for 24 hrs at 3 locations in the study area. At every 20 km stretch place the instrument with small country boat for a 24 hours recording.
- While taking the reading, record the site details (e.g., site code, site name, waterway, GPS coordinates), date and time of measurement, all measured values, any factors that may have affected the measurement (e.g., presence of an algal bloom, recent rainfall etc.).
- Download data from the water quality meter (always keep a copy of unmodified data files on a backed-up drive).

10 Form 7: Carcass measurements & Sample Collection

During the survey, or on any occasion, if you chance upon a dolphin mortality, it is important to note down the carcass condition, record measurements and collect tissue samples for lab analysis, along with following due procedure and protocol related to dealing with death of endangered species. If carcass is decomposed, take only tissue samples,

Things to carry to field

1. Datasheet
2. Permanent Marker & hard-leaded pencil (HB-2H)
3. 10m measuring tape
4. Disposable gloves
5. 10 ml vials
6. 70% Ethanol (50ml)
7. Bleach (50ml)
8. Scalpels (3 no)
9. Scalpel holder (1 no)
10. Cotton wipes or tissue paper
11. Zip lock
12. Table salt (50 g)
13. Ziplocks

Form 7: Carcass measurement and Sample collection

- Record geographic coordinates of the site where the dolphin was found, along with time and date
- The sex of the animal (See figure 10.1)
- In the remarks section, write the cause of death, if known
- First take all possible measurements, and then proceed to sample collection
- If the body is in advanced decomposition, then record this in the remarks section and proceed directly to sample collection

Carcass measurement:

- Use a 10m measuring tape.
- Body length: take measurement beside the animal (not going along it's back), from the tip of its beak to the middle notch of its tail.
- ● Girth: place the tape perpendicular to the dolphin on the ground, roll the dolphin onto the tape, feed the tape underneath its stomach, then roll the dolphin back to an upright position to measure just before the dorsal fin.
- Snout/rostrum length: Measure the length of the rostrum from the tip to the base

Sample collection protocol:

- Do not handle the carcass without gloves
- Do not use the same instruments (scalpel, sample container, alcohol) for different individual animals.
- Clean the scalpel by pouring bleach on the blade (NOT DIPPING BLADE into bleach vial), and then clean by pouring ethanol, before collecting any sample. Repeat procedure for each sample collection. (Ethanol does not remove DNA, only Bleach can disintegrate DNA).
- Use Method 1 generally, but incase of emergencies, where you chanced upon a sample collection opportunity, but do not have the necessary equipment, follow the procedure in Method 2.

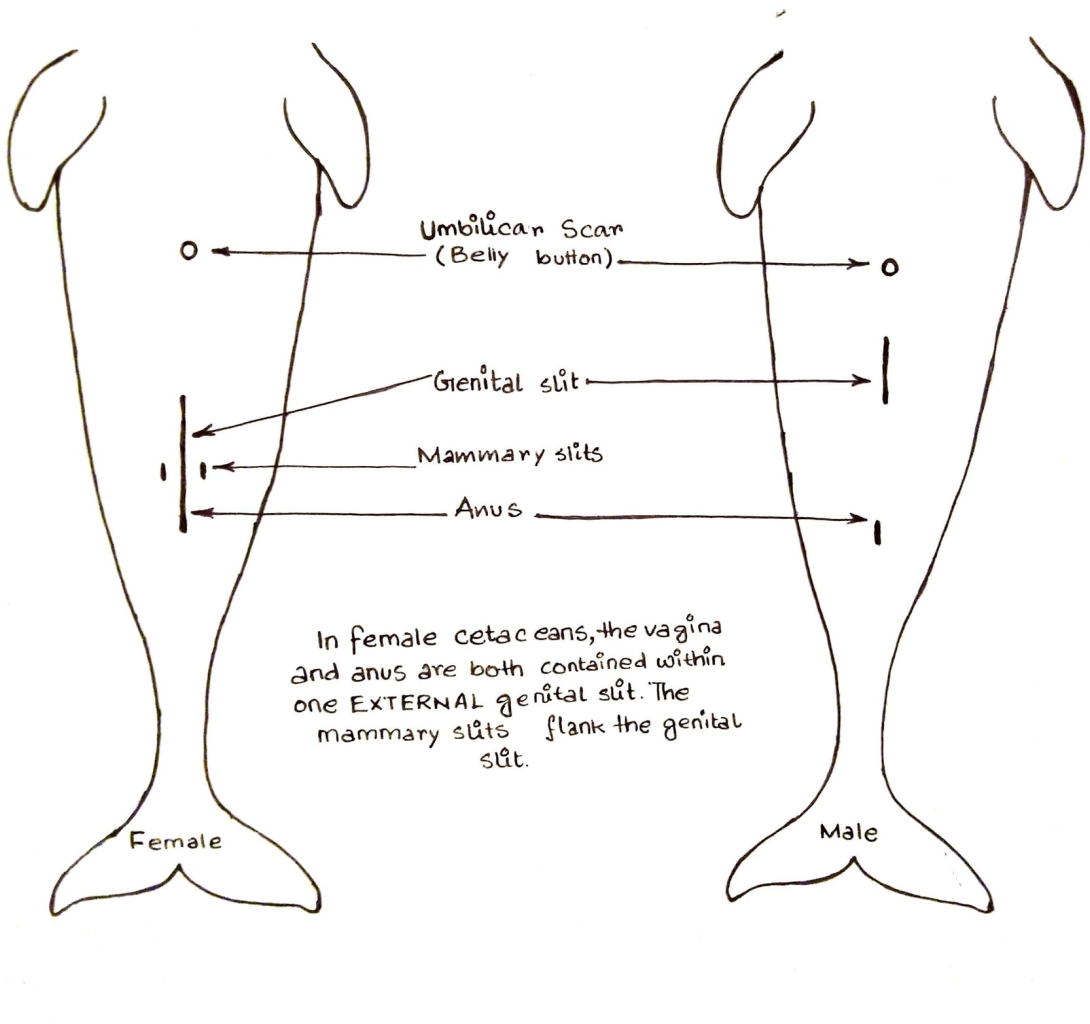


Figure 10.1: Differentiation of male and female dolphins

Method 1:

1. Fill the datasheet with as much information before collection of sample.
2. Wear gloves
3. Half-fill the container you are going to use with ethanol, wiping away spillage.
4. Clean whatever dissecting instrument (Scalpels are preferred) you have, firstly by pouring the bleach solution onto the instrument, and subsequently wipe away by pouring a small amount of ethanol.
5. Cut a 5cm x 10cm rectangle, and when cutting: go deeper, make sure you are cutting at right angles to the body and go all the way to the muscle (red in color).
6. Cut out the piece, cut skin part, blubber (white/creamish) and muscle part red in colour. Store each part of the cut tissue in different containers.
7. Try to collect a couple of samples (eg one muscle + one skin, or skin from two different spots on the carcass) but do not put more than one tissue-type in each container. Note the tissue type in the datasheet. For each sample type give a separate sample ID.
8. After the sample is in the container, top it up with ethanol ensuring that the tissue is covered by at least two volumes of the solution and secure the lid well. If there is any possibility of leakage, keep the containers upright.
9. Ensure that the label has not been removed by spilt ethanol. Dry and relabel if necessary, or insert a paper label with the field number and tissue type written in pencil into the container.

10. Store away from sunlight and excess heat. If possible refrigerate. Send to: Prof Qamar Qureshi, Wildlife Institute of India, Chandrabani, Dehradun – 248001, as soon as possible.

Method 2:

Preservation of food by dry salting or drying is an ancient technique. Like the other method above, salting works by dehydration. However, for the technique to work effectively the tissue must be in very thin slices.

1. When you chance upon a tissue sample in field without proper instruments to collect, then use the following protocol.
2. Obtain a container to collect the tissue sample in.
3. Fill half the container with table salt from an unopened packet of salt.
4. Sterilise a blade/knife by pouring alcohol or even house hold bleach. If either is not available, sterilize the cutting instrument by placing over fire.
5. Cut a 5cm x 10cm rectangle, and when cutting: go deeper, make sure you are cutting at right angles to the body and go all the way to the muscle (red in color).
6. Cut out the piece, cut skin part, blubber (white/creamish) and muscle part red in colour. Store each part of the cut tissue in different containers.
7. Try to collect a couple of samples (eg one muscle + one skin, or skin from two different spots on the carcass) but do not put more than one tissue-type in each container. For each sample give a separate sample ID
8. Seal the sample well.
9. Write down all possible details of the sample in a notebook or piece of paper, with a pencil
10. Put the sample in a plastic cover, with the data and seal properly.
11. Transfer to ethanol vials as soon as possible, by filling in the datasheet appropriately.
12. Store away from sunlight and excess heat. If possible refrigerate. Send to: Prof Qamar Qureshi, Wildlife Institute of India, Chandrabani, Dehradun – 248001, as soon as possible.

Form 7: CARCASS MEASUREMENT AND SAMPLE COLLECTION DATA SHEET

Locality	Date	Collector's Name	Location	
			N	E

Sex	Body lenth (m)	Body girth (m)	Rostrum lenth (m)

Sample ID	Tissue type	Remarks

Annexures

11 ANNEXURE 1: PROTOCOL FOR DISTANCE CALIBRATION AND ANGLE ESTIMATION

Since survey participants would need to ocular-ly estimate of distances on the river, as range finders (equipment for distance estimation) do not work on water - as water is not a reflective surface for EMR. Therefore, it is imperative to properly train participants on this method, to reduce errors during survey. Apart from distance estimation, survey participants need to also record angle on the river. While there are instruments to help in angle estimation, ocular estimation will help in reducing error rates. This will also help in aligning the protractor to be used by both observer teams.

11.1 Training on distance estimation

This task needs to be carried out by all the observers who participate in the dolphin enumeration exercise. It is useful to estimate distance from the observer to the surfaced dolphin in order to determine whether the dolphins observed by two different observers are the same or not. Each observer needs to calibrate oneself to determine distances visually as laser range finders that help determining distance to objects on land do not work on water. The procedure to train oneself to visually determine distances is outlined below.

- Prior to the start of the dolphin enumeration exercise, a day should be spent in training for dolphin observation, distance and angle estimation and other information collection for survey.
- Every observer independently performs a distance calibration exercise. The training data sheet should be maintained separately.
- After training every day calibration needs to be done for each observer and the observer records data in one's own sheet for the entire dolphin enumeration exercise (Table 11.1).
- The purpose behind this to visually estimate and determine one's accuracy in distance estimation by comparing one's visual distance estimations to objects at known distances.
- For this purpose, each observer, from the boat, chooses 10 points that are on water spread in a distance range of 400-500 m. These could be floating objects such as logs, markers, etc. or bank edges, boats, lift nets etc. These points, however, should not be objects on land, i.e., on islands or banks as visual distance estimation differs between land and water.
- Once the points are chosen, each observer visually estimates the distance to the point one by one and records, in one's datasheet, the distance estimated to the object (Figure 11.1)
- Following which, the observer determines the actual distance to the point using a hand held laser range finder to the object on the river. This procedure continues for all of the points chosen.
- With each point, upon examining one's estimation versus actual distance, attempt to maintain a consistent accuracy needs to be made. For example, the visual estimation is more or less always an x% over or under estimation of the actual distance, irrespective of what the value of x is – it can be as high as 50 or as low as 20. A bad example would be an observation where the variation in accuracy of each object is high – point 1 is x%, point 2 is 2x%, point 3 is 5x% etc.
- After completing the distance calibration exercise, one's accuracy needs to be determined by each observer.
- A similar distance calibration exercise needs to be carried out independently by each observer before the start of the actual survey every day. This data sheet needs to be maintained separately. This will be used later to match dolphins for the mark-recapture method of dolphin population determination. To elaborate, during a double observer method when two observers sight a dolphin at the same occasion, while matching the

dolphins later after the survey, the accuracy of the observers can be taken into account to determine if the distances obtained after correcting both the observers' accuracy yield distances similar enough to consider the sighted dolphin to be the same or consider it to be a different one.

- For the boat in tandem method, the accuracy of the observer helps in projecting the location of the dolphins to determine whether both the boats sighted the same individuals in a given segment.
    - This exercise is mandatory prior to dolphin enumeration exercise every day, however, not restricted only to the survey period. This exercise can be carried out at leisure to train oneself to estimate distances closer to the actual distances - this developed skill comes in handy many a times in the field.

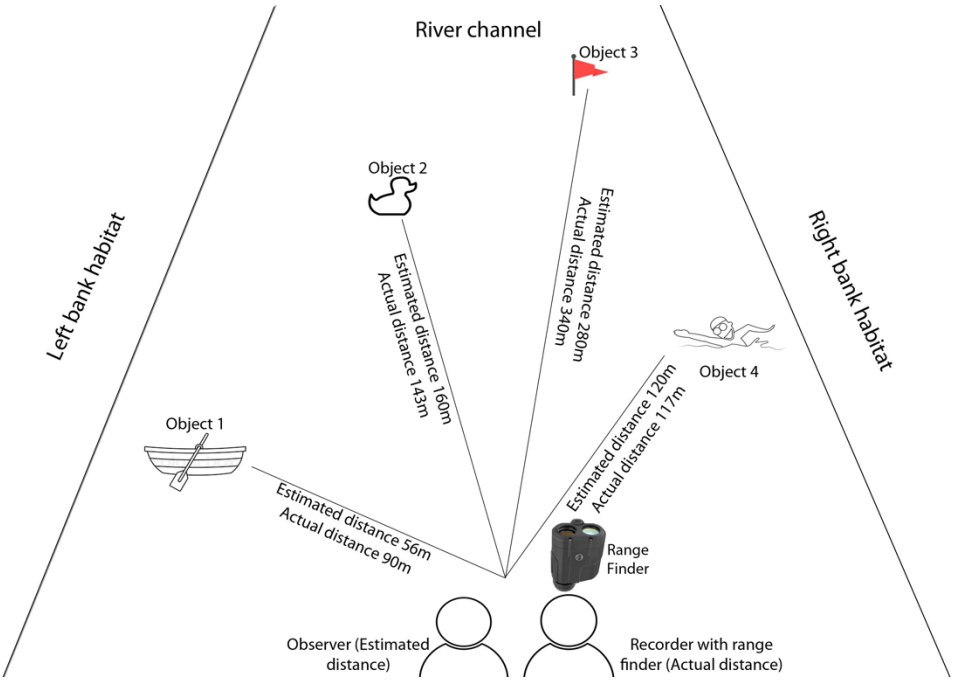


Figure 11.1: Distance calibration exercise

Table 11.1: Distance Calibration datasheet

Observer	Latitude	Longitude
Date	Training	Y/N
Data sheet no.	Survey	Y/N

Sl.No.	Object	Estimated Distance	Actual Distance	Difference

11.2 Angle estimation:

Angle of dolphin sighting is taken to match dolphin sighting between primary and secondary observers. In wider river like Brahmaputra and Ganga, two observers covering the 180 degree viewing angle in two halves, starting from 0 - 90 degree on the left side and 90- 180 degree on the right side will collect information, while in narrow river one observer will collect data for 180 degree. This will be done using a big protractor aligning its zero to the bow of the boat. This data is very crucial along with the distance estimation, as the angle of sighting the dolphin will further ensure that both the observer in a double observer method were accounting for the same dolphin given that it was recorded in the same time and GPS location. Following points should be taken into account prior to a survey:

- In double observer method, place both the protractor with its Ninety (90) marking pointing towards the bow of the boat.
- To train observer in angle estimation new trainee and experienced person will record the angle of minimum 10 markers on the river (which can be any floating object on the water surface) chosen a priori. Trainee should practice it till the difference between the experienced observer and trainee is zero or negligible (Table 11.2).
- To calibrate both the protractors in double observer large boat (one on each deck) will record the angle of minimum five markers on the river (which can be any floating object on the water surface) chosen a priori. If the two platforms were placed exactly on top of other, the angle recorded should be similar, however, if not, make sure both protractor have similar ninety by adjusting its orientation. If it is not possible, make sure the difference in angle estimation is properly recorded and this will be adjusted when dolphin sighting angles between two teams are compared (Table 11.3).

This procedure has to be repeated each day prior to survey, to ensure the proper alignment of the protractor. The difference in angle estimation will be incorporated in data analysis while matching the dolphin sightings.

Table 11.2: Angle estimation for training

Observer		Latitude		Longitude
Date		Training		Y/N
Data sheet no.		Survey		Y/N
Sl. No.	Object	Angle Experienced	Angle Trainee	Difference
Average				

Table 11.3: Angle calibration for double observer survey

Observer		Latitude		Longitude
Date		Training		Y/N
Data sheet no.		Survey		Y/N
Sl.No.	Object	Angle lower deck	Angle upper deck	Difference
Average				

12 ANNEXURE 2: INSTRUMENTS USED FOR DOLPHIN SURVEY

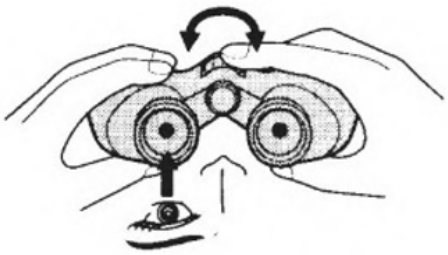
Several instruments will be needed for assessing dolphins and associated aquatic species and habitat. This annexure provides list and protocol of its use.

Table 12.1: Instrument details for use in survey

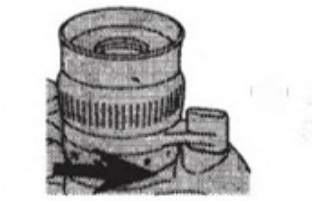
Sl. No.	Equipment	Unit	Purpose	Survey Type
1	Datasheet	Pages	Writing down the observations	All type of surveys
2	Life jacket	Team size	Life jacket for each team member for safety	All type of surveys
3	Polaroid spectacles	Team size	Sun glasses to protect eyes from glare and better observation	All type of surveys
4	Life buoy	1 or more	Safety for each team, numbers depends on boat size	All type of surveys
5	Protractor	2	Get large size wooden board of 1/2 to 1 m in size and paint a protractor	All type of surveys
6	GPS + 2AA batteries per GPS	3	For position and time recording	All type of surveys
7	Range finder + 1 CR2 battery per range finder	3	For taking bank distances (of both the river banks) from the survey boat and training team in visual distance estimation	All type of surveys
8	Binocular	1	For observing habitat characteristics and anthropogenic activities	All type of surveys
9	Humminbird + 12V Battery	1	For navigation, taking depth and plotting river surface	Double Observer
10	Chartplotter + 12V Battery	1	For navigation and depth measurement	Double Observer
11	Depth sounder + 9V Battery	2	Depth measurement	Boat in tandem and single boat
12	Compass	2	Measurement of bearing	All type of surveys
13	8mm pp rope	100 m	For securing range of things, tying instruments	All type of surveys
14	Hat	Team size	For safety	All type of surveys
15	YSI portable + 2 C-Cell Batteries	1	Water quality monitoring at intensive monitoring sites	Intensive site survey only
16	Field note book + stationeries	Team size	For recording field information	All type of surveys

12.1 Binoculars

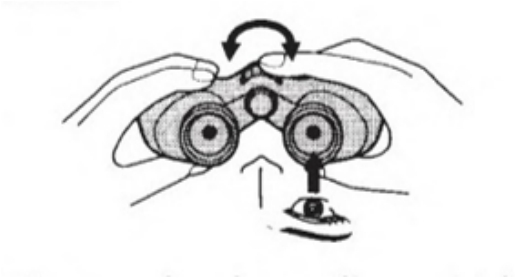
Optical devices used for observing the animals at far distance without disturbing their natural behaviour.



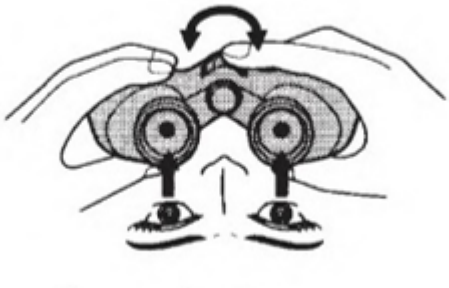
Rotate the focusing ring until obtaining a sharp image of object in left eye piece



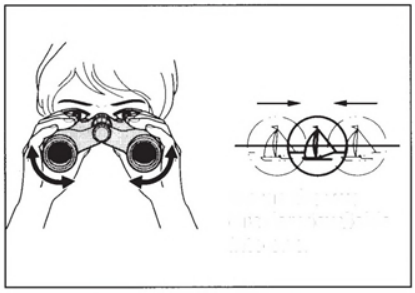
Set the zoomer level at right eye piece to maximum position



Rotate the focusing ring until obtaining a sharp image of object in right eye piece



Check focusing on both the eyes
Adjust the eye piece to the center until you can visualize or see through both the eyes



To see or view a different object, adjust the focus ring until you get the clear image

12.2 Chart plotter

An instrument used for navigations in water bodies (Marine and river system) which uses the integrated technology of GPS and SONAR with all the navigational information and sensors for accessing it.

GPS Satellite Signal Acquisition

When you turn ON the COMBO unit, the GPS receiver must collect satellite data and establish the current location. When the chartplotter acquires satellite signals, appears at the top of the Home screen. When the chartplotter loses satellite signals, indication disappears and a flashing question mark appears on the screen.

Creating a Mark or Waypoint

Select an option:

1. To create a mark at the cursor, select MARK/WPT.
2. To create a waypoint at the cursor, hold MARK/WPT.
3. To create a mark at your boat position, with the cursor invisible and no menu shown, select MARK/WPT.
4. To create a waypoint at your boat position, with the cursor invisible and no menu shown, select MARK/WPT Position.

Navigating to a Waypoint

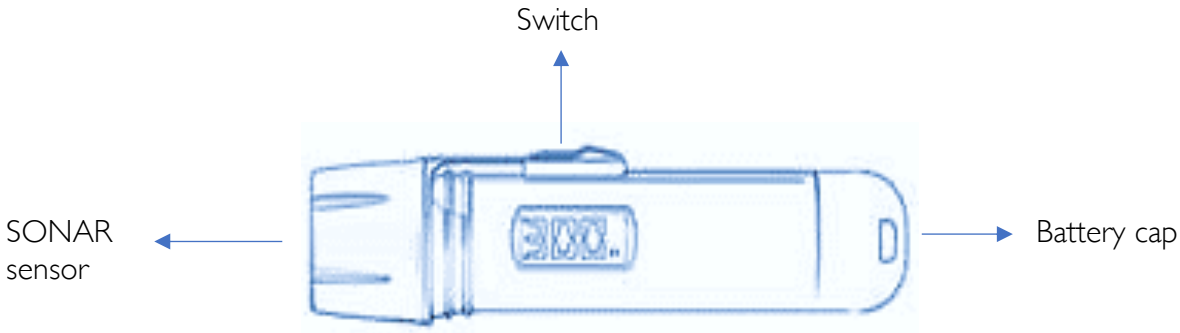
1. Pan the waypoint map to find the waypoint.
2. Place the center of the cursor on the center of the waypoint symbol. The waypoint name appears on the screen.
3. Select the waypoint.
4. Select Navigate To > Go To.

Measuring Distance on the Waypoint Map

1. You can measure the distance between two locations.
2. From the waypoint map, begin panning .
3. Select SELECT > Measure Distance.
4. The distance and other data appear on the screen.

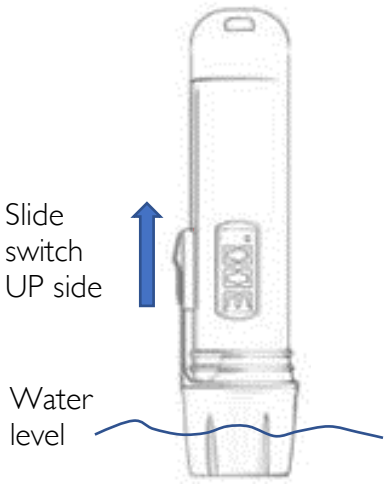
12.3 Depth sounder

Device used for measuring under water depth using SONAR. It measure pin point depth from the surface of water to bottom at with the SONAR is pointed towards.



Switching the Readings from English to Metric

1. Turn the unit on by sliding the switch towards the battery compartment and releasing.
2. Slide the switch towards the battery compartment and hold for **5 seconds**.
3. The current units of measure will blink, release the switch.
4. Pull and release the switch to change between the settings (FT/F, M/C)
5. The unit will automatically exit the units of measure setting and return to the last mode (depth or temp) if the switch is not moved for 10 seconds.



To measure water depth

1. Place the sonar sensor side of the device into the water. Make sure to **hold the device perpendicular to the water surface**.
2. **Slide the switch** towards the battery cap and release.
3. The current water depth will be indicated on the display:
   a. The depth will continue to **update 4 times per second** while the device is left in water that is between 2.5 and 300 ft deep (.8 and 61 m).
   b. If the device is unable to obtain an accurate depth reading or if it is removed from the water "- - -" will be displayed.
4. The device will **turn off automatically in 15 seconds** after being removed from the water.

To measure temperature

1. Activate the Depth Reading Mode.
2. While in Depth Reading Mode, slide the switch towards the battery compartment and release.
3. The display will show the current temperature.
4. To obtain air temperature readings, hold the device in your hand and activate the Thermometer Mode as per the above instructions.
5. To obtain water temperature readings, place the Temperature Sensor into the water and activate the Thermometer Mode.
6. The unit will automatically turn OFF after 1 minute of displaying the temperature

12.4 GPS device

Turning the Device ON or OFF

Hold .

Satellite Signals

- After the device is turned on, it begins acquiring satellite signals. The device may need a clear view of the sky to acquire satellite signals. When the GPS bars on the backlight page are solid, your device has acquired satellite signals. The time and date are set automatically based on the GPS position.
- For adjusting the screen:
- While the device is on, press .
- Move the Thumb Stick left and right to adjust the brightness level
- Note: The backlight brightness may be limited when the remaining capacity in the batteries is low.
- Extensive use of screen backlighting can significantly reduce battery life.

Waypoints

Waypoints are locations you record and store in the device.

Creating a waypoint

1. You can save your current location as a waypoint.
2. Select Mark Waypoint.
3. Select an option:
    a. To save the waypoint without changes, select Done.
    b. To make changes to the waypoint, select an attribute, make changes to the attribute, and select Done.

Increasing the accuracy of a waypoint Location

Waypoint averaging allows you to increase the accuracy of a waypoint location by collecting multiple samples of the waypoint location.

Select Waypoint Averaging.

1. Select a **waypoint**.
2. Move to the **location**.
3. Select **Start.**
4. When the Sample Confidence status bar reaches 100%, select Save.

Tracks: A track is a recording of your path. The track log contains information about points along the recorded path, including time, location, and elevation for each point.

Recording Track Logs

1. Select Setup > Tracks > Track Log.
2. Select Record, Do Not Show or Record, Show on Map.
3. If you select **Record, Show on Map**, a line on the map indicates your track.
4. Select Record Method.
5. Select an option:
    a. To record tracks at a variable rate that creates an optimum representation of your tracks, select **Auto**.
    b. To record tracks at a specified distance, select **Distance**.
    c. To record tracks at a specified time, select **Time**.
6. Select Recording Interval.
7. Complete an action:
    a. Select an option to record tracks more or less often.

8. Note: Using the Most often interval provides the most track detail, but fills up the device memory quicker. Use this setting only if you require a very precise track record.
    a. Enter a time or distance, and select Done.
9. As you move with the device turned on, a track log is created.

Navigating to a Destination

1. You can navigate to a destination using the map.
2. Select **Where To**?.
3. Select a **category**.
4. Select a destination.
5. Select **Go**. (The map page opens with your route marked with a magenta line.)
6. Navigate using the map.

Connecting to a Computer

1. Connect the **USB cable** to a **USB port** on your computer.
2. Pull up the weather cap from the mini-USB port.
3. Plug the small end of the USB cable into the mini-USB port.

12.5 Life jacket and Life buoy

Used for safety on board. All members of the team should wear life jacket for safety purpose.

Its mandatory to wear life jacket on board while doing survey on water bodies (river, reservoir or pools) in consideration of safety purpose of all crew members.

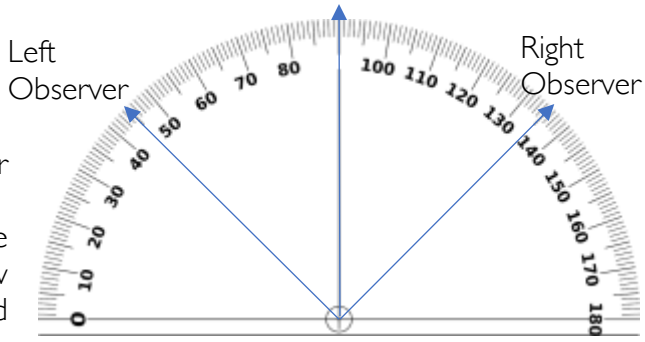
1. Life jacket floats person on water during any casualties or danger and doesn't let the person drown. Individual shouldn't panic and don't fight with water current.
2. Use leg and hand strokes along with water current by moving towards the corner or toward the bank diagonally.

Life buoy – another safety device used in the boat during survey. Used in the rescue purpose during any casualties – Eg, while rescuing any person drowning in water. Can carry maximum load of person (varies from material to brands). Very handy device while rescuing.

12.6 Protractor

A tool used to measure the angle of a dolphin sighting from boat during the survey. Provides an radial angle of animal sighted on water from recorder point of view (current GPS location).

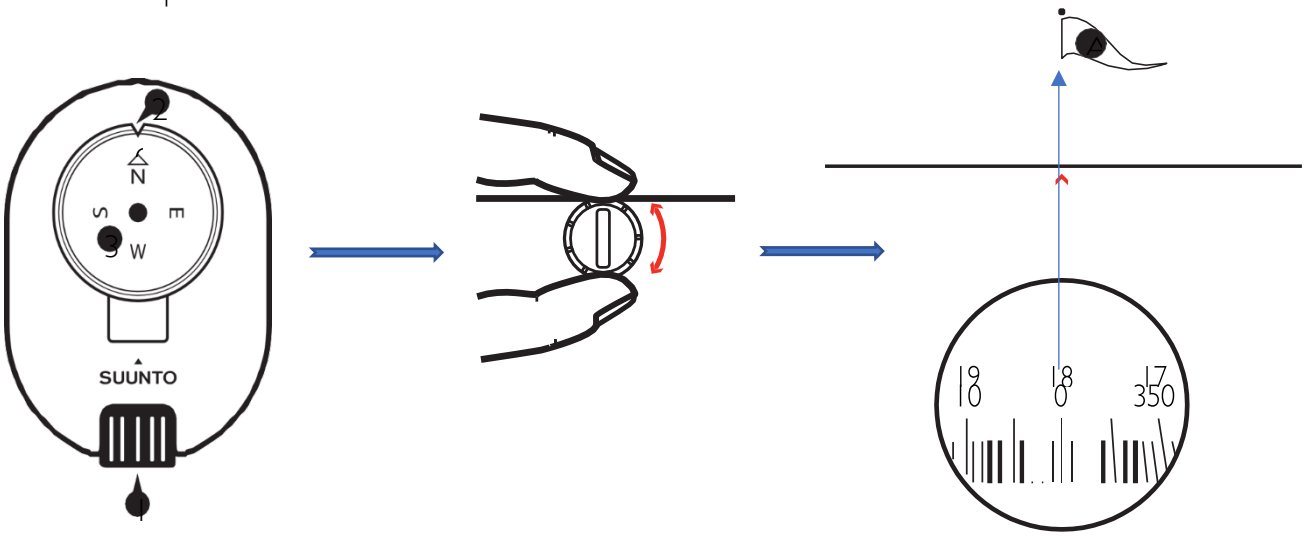
0 to 90^0 angle view is observed by the left observer and 90 to 180° angle view is observed by right observer combined covers a view of 180° view.



12.7 Magnetic compass

A compass is tool that shows the geographical cardinal directions that is used for navigation and works on the principle of magnetometer.

1. Optics
2. Bearing index
3. Compass card



Adjust focus

1. Close one eye and look through optics.
2. Turn optics knob until numbers are clear.

(NOTE: For best viewing, the oval-shaped aperture should be aligned with the sighting)

Sight a bearing

1. Keep both eyes open and look through optics towards target object.
2. An optical illusion makes the object and sighting line appear to overlap, allowing an accurate reading.
3. Read value from sighting line

12.8 Range Finder

Optical devices used for measuring the distance of a stationary object using laser technology.

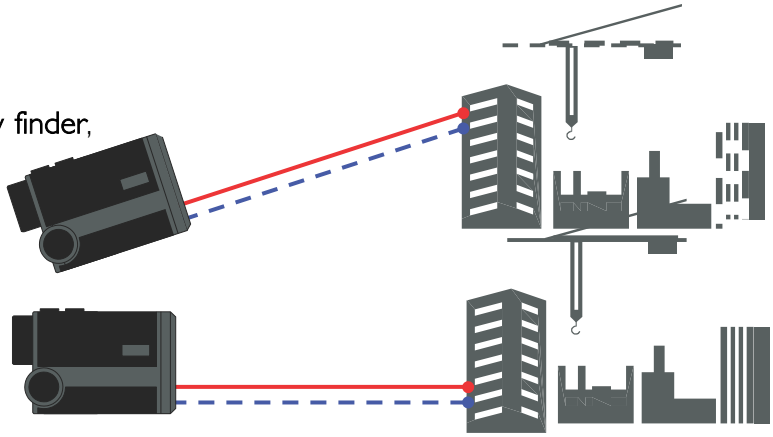
1. Twist-up eye cup
2. Dioptre adjustment
3. Laser objective
4. Objective lens
5. "ON" button
6. "MODE" button

Focusing

1. Look through the laser range finder at a **stationary object** in the distance.
2. Adjust the **dioptre focus** ring until the field of view becomes **sharp**.
3. Adjust the dioptre setting to get a clear image for your eyesight.
4. When turned on the range finder will start in the same mode it was in when last used.
5. To cycle through the modes simply press the **MODE**
6. button until you come to the setting you desire.
7. Simply press the **ON button** to laze the target you are aiming at.
8. The **signal strength** is displayed beneath the aim point. A minimum of **6 bars** is needed to operate, **10 bars** is the maximum strength.
9. The Laser Range Finder will **automatically turn off** when not used for **15 seconds**.
10. **Standard mode** measures the straight-line distance to the target you are aiming at.
11. When there is nothing displayed to the left of the distance you are in **standard mode**.
12. If you hold the **ON button** while in standard mode the range finder will **continuously scan** so you can move around and get **constant updates of the distance.**

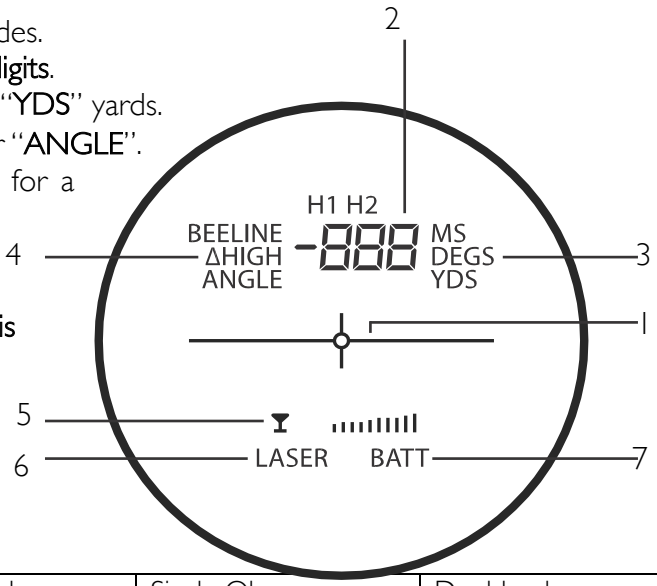
Measuring distance

LASER
DISTANCE MEASURED
Point at stationary object through **view finder**, focus and press the **power** button.



Interpreting the screen

1. Aim point with horizontal and vertical guides.
2. Distance measurement displayed with **3 digits**.
3. Units - "**MS**" metres, "**DEGS**" degrees or "**YDS**" yards.
4. Modes - "**BEELINE**", "**HIGH**", "**ΔHIGH**" or "**ANGLE**".
5. Laser quality - 6 bars or more required for a reading.
6. "**LASER**" flashes when the laser is in operation.
7. "**BATT**" displays when the battery **power is low**.



12.9 Check list of instruments needed:

Equipment /items	Accessories	Boat in tandem		Single Observer		Double observer	
	Per instrument	Units	Tick ✓	Units	Tick ✓	Units	Tick ✓
GPS	Two AA batteries; GPS connecting cable	2+1 spare		1+1 spare		3+1 spare	
Magnetic compass	Proper casing cover	2+1 spare		1+1 spare		2+1 spare	
Range finder	One CR2 battery	4		2		5	
Protractor	Wooden needles	2		1		2	
Binoculars	Proper sleeve and casing	4		2		4 + 1 spare	
Camera	Charger, charging cable, extra SD memory card	2		1		2	
Data sheet	50 pgs booklet	2 set		1 set		2 set	
Field notes		6		3		6 + 2 spare	
Depth sounder	9-volt battery	2		1		1	
Chart plotter	12 Volt battery, Battery charger, Connecting cable wires, Sonar transducer, GPS device	1 (if needed)		1 (if needed)		1 (Mandatory)	
Humminbird SONAR device	12 Volt battery, Battery charger, Connecting cable wires, Sonar transducer	1 (if needed)		1 (if needed)		1 (Mandatory)	

Safety and mandatory items							
Equipment /items	Accessories	Boat in tandem		Single Observer		Double observer	
	Per instrument	Units	Tick ✓	Units	Tick ✓	Units	Tick ✓
Round Hat	UV protected	6		3+1 spare		8	
Polaroid sun glass	UV protected	6		3+1 spare		8	
Medical kit	With all necessary medicine and First aid kit	1 set		1 set		1 set	
Tent	With extra pegs and tarpaulin	5		3		5 + 2 spare	
Generator	Engine oil, extension cord	1 (if needed)		1 (if needed)		1 (Mandatory)	
Dry bag	10-30 ltrs	4		2		4	
Life Jacket	Whistle	8+2 spare		5 + 2 spare		10 + 2 spare	
Life buoy	With reflector tag	2		1		2	
8mm PP rope		50-100mt		50-100mt		50-100mt	
Stationary items	Extra pen, and one of essential writing kit	1 set		1 set		1 set	
Insultation tape		1 box		1 box		1 box	
Duct tape		2		2		2	
Water purifier or storage facility	One unit purifier or five 20ltr storage can	1 unit or 120 ltrs cans		1 unit or 120 ltrs cans		1 unit or 200 ltrs cans	
Personalized medicine	-	-		-		-	

Equipment /items	Accessories	Boat in tandem		Single Observer		Double observer	
	Per instrument	Units	Tick ✓	Units	Tick ✓	Units	Tick ✓
Seasonal Field cloths	Jackets for winter; UV protected full sleeve shirts for Summer	All crew members		All crew members		All crew members	
Cable tie	Cable cutter	1 pack		1 pack		1 pack	
Common mechanical tool box	Plier, large screw driver, wire cutter and hammer	1 set		1 set		1 set	
Smart watch	Will digital clock and stopwatch	6		3		6+2 spare	
Bamboo	10 to 15 ft height	As required for boat		As required for boat		As required for boat	
Tarpaulin sheet	24 x18 ft in dimension	2		2		2+1	
Foam sheet	6x4 ft in dimension	1		1		1	
12Volt- 10A AC to DC converter	With sufficient clip and wire instrument	1		1		2	
Power bank	20000mAh	2		2		4	

***Note:** Battery for the instruments mentioned in the table is for per instrument or device only. Additional batteries needed for survey should be estimated individual depending on the numbers of survey days along with number of instruments used.

13 ANNEXURE 3: WATER QUALITY ASSESSMENT

Equipment Handling

- The manufacturer's directions for transport, cleaning, decontamination, storage and operation shall be followed to ensure safe and reliable equipment operation. When cleaning or calibrating a multi-probe, ensure access to a temperature stable and protected location.
- Inspect the equipment for any damage or any functional changes to the deployment site at the field (i.e., high flow, turbid water). Clean the deployment tube of any debris or sediment that may be caught inside. Transport it to a stable location for complete calibration and cleaning.

Calibration

Calibration must be undertaken as per the instrument manufacturer's instructions to ensure the instruments' data accuracy, safety, and long-term functionality. Some general issues to consider are that:

- Adequate supplies of calibration standards should be available. Make sure the standards have not expired. Calibration standards are intended as single-use solutions. Always pour an aliquot into a separate container for use and discard when done. Never reuse aliquots or immerse probes into original standard containers.
- The calibration should be conducted using standards in the range of values expected to be encountered in the field. This is particularly important when calibrating electrical conductivity for use in fresh, tidal or marine waters
- If manufacturer's procedures do not refer to temperature calibration, manual temperature readings taken using a thermometer should be compared to the instrument temperature readings
- The calibration must be performed and recorded before the start of a field trip and should be checked after each field trip
- It is advisable to re-check calibration daily during an extended period of field use. These in-field checks should be recorded in a notebook and later transcribed into the calibration logbook for the instrument
- Variability in performance shown by calibration checks should be reported with the data and provided to the instrument servicing agent.
- After completing the survey, clean the sensors with distilled water and store it properly as per the manufacturer manual.

14 ANNEXURE 4: PARTICIPANTS PERSONAL AND MEDICAL DETAILS

Participant's Personal and Medical Details					
Name		Age		Date	
Gender (Male/Female/Other					
Elements	Information			Remarks	
Official Address/ Phone Number/Email					
Personnel Address/ Phone Number/ Email					
Emergengy contact Official Name/Phone number					
Emergengy contact Personnel Name/Phone number					
Blood Group					
Allergies					
Morbidity (eg BP/sugar etc)					
Medications you take regularly					
Medications you take Occasionaly					
Covid Vaccination taken					
Do you have health insurance					
Details of health insurance					
Do yo have group insurance					
Details of group insurance					
Are you carrying enough medication you take regularly, for survey					
Are you carrying enough medication you take ocassionally, for survey					
Do you know swimming					

Have you been told and trained for emergency response during survey		

Signature with Name

I _____read the Participant's personal and medical form. Details provided by me are correct and I am responsible for any treatment given on its basis or people contacted for emergency needs.

Participant's Name and Signature:
Place and Date:

I_____ trained for emergency response, use of life jacket, lifebuoy use and dealing with emergency procedure. I am aware of my health condition and provided information on page 1, carrying my medicine with me. I will abide by wearing life jacket all time during survey and will assist my team mates during emergency.

Participant's Signature and Signature	Team leader's Signature	State Coordinator's
Name	Name	Name
Date and Place	Date and Place	Date and Place

15 REFERENCE

- Anderson, J. (1878). Anatomical and zoological researches comprising an account of zoological results of two expeditions of western Yunnan in 1868 and 1875; and a monograph of two cetacean genera, *Platanista* and *Orcella*. B. Quatrich, London, vol. 2.
- Bashir, T., Khan, A., Behera S.K. & Gautam, P. (2012). Factors determining occupancy of Ganges River dolphin (*Platanista gangetica gangetica*) during differing river discharges in the upper Ganges, India. *Mammalia,* 76(4): 417-426.
- Bahl, R., Sugimatsu, H., Kojima, J., Ura, T., Behera, S., Inoue, T., & Fukuchi, T,. 2007. Beam pattern estimation of clicks of a free-ranging Ganges river dolphin. OCEANS 2007. doi:10.1109/oceans.2007.4449286
- Behera, S.K., Sagar, V. & Nawab, A. (2008). Environmental flow requirements vis- à -vis habitat use pattern of freshwater dolphins. Proceedings of the 11th International River Symposium, Brisbane, Australia, 4 pp
- Behera, S.K., Singh, H., Sagar, V. & De, R. (2014). Current status of Ganges river dolphin *Platanista gangetica gangetica* in the rivers of Uttar Pradesh, India. In: Rivers for life. Proceedings of the International Symposium on river biodiversity: Ganges–Brahmaputra– Meghna river systems, IUCN, Patna, India, pp 139–149.
- Braulik G, Bhatti Z, Ehsan T, Hussain B, Khan A, et al. (2012) Robust abundance estimate for endangered river dolphin subspecies in South Asia. *Endanger Species Res* 17: 201–215
- Braulik, G. T., Noureen, U., Arshad, M., & Reeves, R. R. (2015a). Review of status, threats, and conservation management options for the endangered Indus River blind dolphin. *Biological Conservation*, 192, 30-41.
- Braulik, G.T., I. Archer, F., Khan, U., Imran, M., Sinha, R.K., Jefferson, T.A., Donovan, C. and Graves, J.A., 2021. Taxonomic revision of the South Asian River dolphins (Platanista): Indus and Ganges River dolphins are separate species. *Marine Mammal Science*
- Choudhary, S.K., Smith, B.D., Dey, S., Dey, S., & Prakash, S. (2006). Conservation and biomonitoring in the Vikramshila Gangetic Dolphin Sanctuary, Bihar, India. *Oryx*, 40(2), 189–197. https://doi.org/10.1017/S0030605306000664
- Choudhary, S., Dey, S., Dey, S., Sagar, V., Nair, T., & Kelkar, N. (2012). River dolphin distribution in regulated river systems: implications for dry-season flow regimes in the Gangetic basin. Aquatic Conservation: Marine and Freshwater Ecosystems, 22(1), 11-25.
- Chowdhury, M.R., Mitra, S., Sen, S. (2016). On the Behaviour, abundance, habitat use and potential threats of the Gangetic Dolphin *Platanista gangetica* in southern West Bengal, India. *Journal of Threatened Taxa.* 8(9), 9131-9137. DOI: 10.11609/jott.1752.8.9.9131-9137.
- Choudhary, S.K. & Dey, S. (2019). Final Report on Status of Ganges River dolphins in the five Rivers Parman, Bakra, Kankai, Mechi and Mahananda within Araria Forest Division, Bihar (May, 2019). Submitted to Araria Forest Division, Bihar. T. M. Bhagalpur University, Bhagalpur, Bihar, India, 55 pp.
- Choudhary, S.K., Dey, S. & Nair, T. (2019a). Final Report on 'Status of Ganges River dolphins in Kosi River, Saharsa District, Bihar, Submitted to Saharsa Forest Division, Bihar by T. M. Bhagalpur University, Bhagalpur, Bihar, India, 40 pp.
- Choudhary, S.K., Dey, S. & Nair, T. (2019b): Final Report on 'Status of Ganges River dolphins in Kosi River in Supaul District, Bihar (2019), Submitted to Supaul Forest Division, Bihar. T. M. Bhagalpur University, Bhagalpur, Bihar, India, 29 pp.
- Choudhury, N.B., Mazumder, M.K., Chakravarty, H., Choudhury, A.S., Boro, F. and Choudhury, I.B., 2019. The endangered Ganges river dolphin heads towards local extinction in the Barak river system of Assam, India: A plea for conservation. *Mammalian Biology*, *95*(1), pp.102-111.
- Dawson, S., Wade, P., Slooten, E. And Barlow, J. (2008), Design and field methods for sighting surveys of cetaceans in coastal and riverine habitats. Mammal Review, 38: 19-49. https://doi.org/10.1111/j.1365-2907.2008.00119.x
- Deori, S., Anumitra, P., Wakid, A., Alom, S., Prasad, N., & Qureshi, Q. (2018). PINGERS: can be the eyes of blind Ganges dolphins (*Platanista gangetica gangetica*, Roxburgh 1801). J. Sci, 11(4), 169-178.

- Dey, M., Krishnaswamy, J., Morisaka, T. & Kelkar, N. (2019). Interacting effects of vessel noise and shallow river depth elevate metabolic stress in Ganges river dolphins. Sci Rep 9, 15426. https://doi.org/10.1038/s41598-019-51664-1
- Herald, E. S., Brownell, R. L., Frye, F. L., Morris, E. J., Evans, W. E., & Scott, A. B. (1969). Blind river dolphin: first side-swimming cetacean. *Science*, 166(3911), 1408-1410.
- IUCN, 2006. IUCN Red List (species search page).
- Jones, S. (1982). The present status of the Gangetic susu, *Platanista gangetica* (Roxburgh), with comments on the Indus susu, P. minor (Owen). FAO Advisory Committee on Marine Resources Research, Working Party on Marine Mammals. FAO Fish. Ser., 4(5), 97-115.
- Kasuya, T., (1972).Some informations on the growth of the Ganges dolphin with a comment on the Indus dolphin. Scientific Reports of the Whales Research Institute, 24, 87-108.
- Kanwar et al. (2019). Status of Indus River Dolphin in India. Technical report by WWF-India and Department of Forests and Wildlife Preservation, Punjab.
- Kelkar, N., Krishnaswamy, J., Choudhary S., & Sutaria, D. (2010). Coexistence of fisheries with river dolphin conservation. *Conservation Biology,* 24(4): 1130-1140.
- Mazumder, M.K., Boro, F., Barbhuiya, B. & Singha, U. (2014). A study of the winter congregation sites of the Gangetic River Dolphin in southern Assam, India, with reference to conservation. *Global Ecology and Conservation*, 2, 359-366. DOI: 10.1016/j.gecco.2014.09.004.
- Mitra, S., Sultan, S., Sen, S. (2015). Occurrence records of Ganges River Dolphin (*Platanista gangetica*) in Southern West Bengal and impact of anthropogenic interferences in its habitat. *Journal of Pharmacy and Biological Science*s, 10(3): 76-83.
- Mohan, R. S. L., S. C. Dey, S. P. Bairagi and S. Roy (1997): On a survey of the Ganges River Dolphin, *Platanista gangetica* of the Brahmaputra river, Assam. *J Bombay Nat Hist Soc*, 94(3): 483 - 495.
- Qureshi, Q., Kolipakam, V., Hussain, S.A., Wakid, A., Raza, R., Roy, S., Singh, V., Phukan, A., Warudkar, A., Prasad, N.L., Rastogi, R., Goyal, N., Sharma, S., Jacob, M., Choudhary, G., Gaikwad, A. & Dey, S. (2018). Development of conservation action plan for river dolphin. Wildlife Institute of India Report, Dehradun, India.
- Qureshi Q, Kolipakam V, Wakid A, Ray S & Hussain SAH (2019) Development of Conservation Action Plan for Ganges River Dolphins – Part II. Wildlife Institute of India, Dehradun. Report. Pg.120
- Qureshi Q, Kolipakam V, Wakid A, Ray S & Hussain SAH (2020) Development of Conservation Action Plan for Ganges River Dolphins – Part III.Wildlife Institute of India, Dehradun. Report. (Unpub)
- Richman, N. I., Gibbons, J. M., Turvey, S. T., Akamatsu, T., Ahmed, B., Mahabub, E.,& Jones, J. P. (2014). To see or not to see: investigating detectability of Ganges River dolphins using a combined visual-acoustic survey. *PLoS One*, 9(5), e96811.
- Sanghi, R. (2014). Our National River Ganga. Springer International Publishing Switzerland 2014. XVI, 415 pp. https://doi.org/10.1007/978-3-319-00530-0
- Sinha RK, Das NK, Singh NK, Sharma G, Ahsan SN (1993). Gut contents of Gangetic dolphin *Platanista gangetica*. *Investigations on Cetacea* 24: 317–321.
- Sinha, R.K. (2000). Status of the Ganges River dolphin (*Platanista gangetica*) in the vicinity of Farakka Barrage, India. In: R.R.Reeves, B.D. Smith, & T. Kasuya (Eds.), *Biology and conservation of freshwater cetaceans in Asia*, Vol. 23, pp. 42–48. Occasional paper of the IUCN Species Survival Commission. IUCN.
- Sinha RK and Sharma GP (2003) Current status of the Ganges River dolphin, *Platanista gangetica* in the rivers Kosi and Son, Bihar, India. J Bombay Nat Hist Soc 100: 27–37.
- Sinha, R. K., & Kannan, K. (2014). Ganges River dolphin: An overview of biology, ecology, and conservation status in India. *Ambio*, 43, 1029– 1046. https://doi.org/10.1007/s13280-014-0534-7
- Smith, B.D. & Braulik, G.T. (2012). *Platanista gangetica*. In: IUCN 2013. IUCN Red List of Threatened Species. Version 2013.2. www.iucnredlist.org. Downloaded on 02 August 2020.Smith, B.D., and Reeves, R.R. (2000). Survey methods for population assessment of Asian river dolphins. In R.R. Reeves, B.D. Smith and T. Kasuya (eds.), Biology and Conservation of Freshwater

Cetaceans in Asia. IUCN Species Survival Commission Occasional Paper No. 23. IUCN, Gland, Switzerland.
- Smith, D., Sinha, R.K. & Regmi, U. (1994). Status of Ganges River Dolphins (*Platanista gangetica*) in the Karnali, Mahakali, Narayani and Sapta Kosi Rivers of Nepal and India in 1993. Marine mammal science, 10(3), 368-375.
- Southall, B. L., Bowles, A. E., Ellison, W. T., Finneran, J. J., Gentry, R. L., Greene,C. R., Kastak,D., et al. (2007). Marine mammal noise exposure Impacts of dredging on marine mammals noise exposure criteria, initial scientific recommendations. *Aquatic Mammals*, 411–414.
- Thewissen JGM, Nummela S (2008). Sensory Evolution on the Threshold: Adaptations in Secondarily Aquatic Vertebrates. University of California Press, San Diego, California, USA.
- Wakid, A. (2009). Status and distribution of the endangered Gangetic dolphin (*Platanista gangetica gangetica*) in the Brahmaputra River within India in 2005. *Current Science*, 97(8), 1143-1151.
- Wakid, A. & Braulik, G. (2009). Protection of endangered Ganges river dolphin in Brahmaputra River. Final Technical Report submitted to the IUCN-Sir Peter Scott Fund, 44 pp.
- WII-GACMC (2018). Macro fauna of the Ganga River: Status and conservation of select species. Ganga Aqualife Conservation Monitoring Center, Wildlife Institute of India, Dehradun, Uttarakhand, India, pp. 151. ISBN: 81-85496-31-5.
- WTI. (2019). Status of the Ganges River Dolphin in the Gandak and Ghaghara Rivers in Bihar, Final Technical Report submitted to the Chief Wildlife Warden, Bihar, Wildlife Trust of India, Delhi.
- Yeung, L. W. Y., Yamashita, N., Taniyasu, S., Lam, P. K. S., Sinha, R. K., Borole, D. V., & Kannan, K. (2009). A survey of perfluorinated compounds in surface water and biota including dolphins from the Ganges River and in other waterbodies in India. Chemosphere, 76(1), 55–62. doi:10.1016/j.chemosphere.2009.02.055

In Collaboration with Forest Departments of

Uttar Pradesh

Bihar

West Bengal

Assam

Madhya Pradesh

Rajasthan

Punjab

भारतीय वन्यजीव संस्थान
Wildlife Institute of India