Progress Report

(Development of Conservation plan for Gangetic River Dolphin - ESRP)
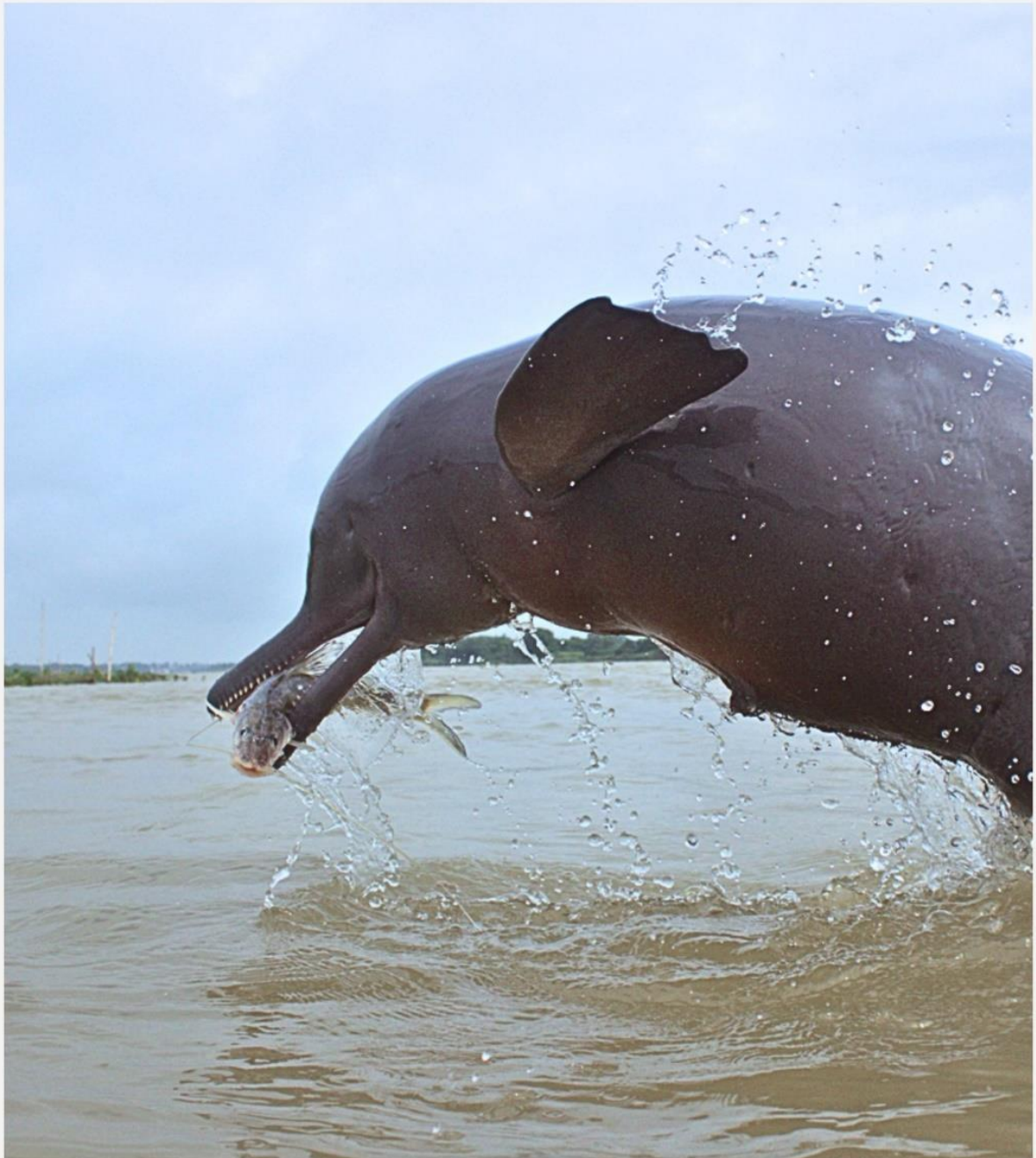
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Submitted by The Wildlife Institute of India

Summary

Intensive site studies are crucial for understanding the ecology of the Ganges river dolphin, helping to assess critical habitats, monitor population trends, observe behavior, and develop conservation strategies tailored to different regions. These studies also engage local communities in conservation efforts, highlighting the importance of preserving the species and its habitat. In this season, intensive sites in Uttar Pradesh, Bihar, West Bengal and Assam were targeted. The activities carried out during the session were

1. Repeated Ganges River dolphin population survey
2. Point count estimation method
3. Associated fauna survey
4. Fish sampling and fish market surveys
5. Plankton sampling
6. Vegetation survey
7. Efficacy of Pingers on Ganges River dolphins
8. Pinger- fish experiment
9. Experiment on depth preference of Ganges River dolphins
10. Community based surveys

In Uttar Pradesh Prayagraj Sangam to Bhadohi Semradhnath ghat (90km) in Ganga River, in Bihar Barh to Munger (109km) in Ganag River, in west Bengal 32km of Roopnarayan river (Ghatal to Manpur) and from Farakka to Diamond Harbour for community based surveys, in Assam Guwahati, Goalpara in Brahmaputra River and Kulsi tributary was selected for the intensive studies. The surveys are still undergoing in all the states and analysis of the collected data are in process.

In Uttar Pradesh, there were a few recorded instances of poaching involving turtles, snakes, and birds. In Assam, a unique fishing technique was identified where fish were corralled using mosquito nets in a larger river section. However, this method also posed a threat to dolphins, as they could get trapped and die in the process.

Introduction

The Ganges River Dolphin is an Endangered species of River Dolphin in the world. The species has been recognized as the National Aquatic Animal of India and the State Aquatic

Animal of Assam. Under the Wildlife Protection Act, 1972 the species has been protected as a Schedule-I Species in India.

It is an obligatory freshwater mammal found in the Ganges-Brahmaputra-Meghna and Karnaphuli River System of India-Nepal and Bangladesh. India holds about 90% of the global population of the species. The species is being badly affected by the population reduction due to severe anthropogenic pressures. To prevent its population decline by addressing the identified threats, the Wildlife Institute of India with support from the Ministry of Environment, Forest and Climate Change of the Government of India launched a long-term project 'Development of conservation action plan for River Dolphins', shortly called as CAMPA-Dolphin Project for 2016-25 under which several important research and conservation activities are undergoing in the Ganges River Dolphin inhabited rivers of India including the Brahmaputra river system.

The aim of this study was to conduct intensive investigations in the hotspots of the Ganges river dolphin in India. Intensive site studies will play a crucial role in comprehensively understanding the ecology of the Ganges river dolphin. These studies are essential for several reasons. Firstly, they help in assessing specific habitats critical for the species, including water quality, depth, flow rates, and the presence of suitable prey species, which is vital for effective habitat conservation and management. Secondly, by focusing on hotspots where the dolphin population is concentrated, we will be able to monitor population trends, assess threats, and implement conservation measures more effectively. Thirdly, intensive studies will provide a unique opportunity to observe the behavior of Ganges river dolphins in their natural habitat, including feeding behavior, social interactions, and breeding patterns, all of which are crucial for understanding the species' ecology. Additionally, studying the interaction of anthropogenic activities with Ganges river dolphins and their habitat helps in assessing threats such as pollution, habitat destruction, and bycatch in fisheries. The data collected from intensive site studies is also essential for developing conservation plans and management strategies tailored to the specific needs of the Ganges river dolphin population in different regions. Furthermore, since the habitat of Ganges river dolphins is intertwined with human societies, intensive studies can help in engaging local communities in conservation efforts by raising awareness about the importance of preserving the species and its habitat. This survey utilized the hotspots identified in the Ganga and Brahmaputra river systems

during the Rangewide survey of Ganges river dolphins to select study sites in Uttar Pradesh, Bihar, West Bengal, and Assam (Figure 1).
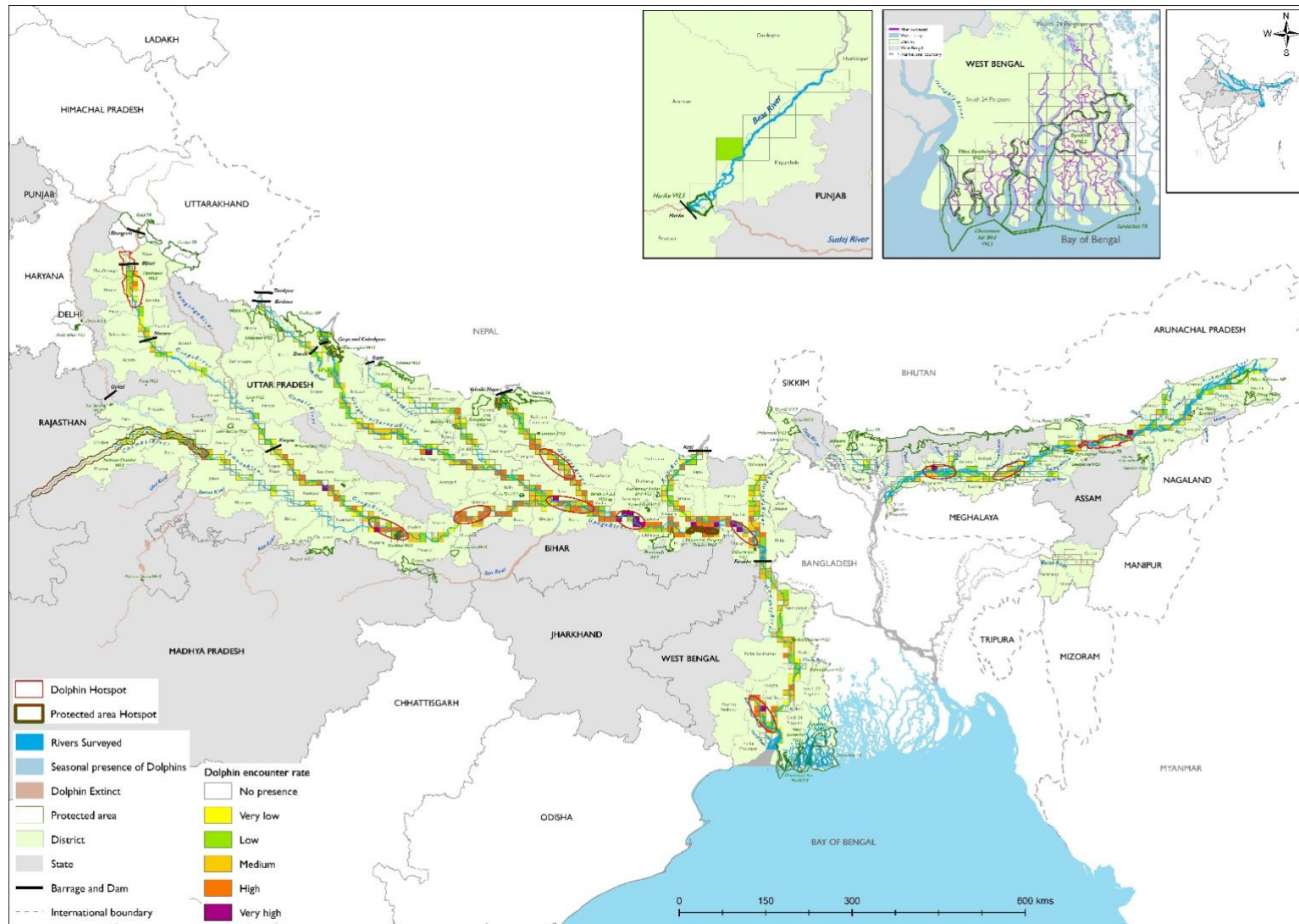
Figure 1 Pan India map showing hotspots of Ganges river dolphins in India

Study Area

Uttar Pradesh

The study area chosen for intensive investigation in Uttar Pradesh encompasses a 90-kilometer stretch of Ganga extending from Sangam, Prayagraj, to Semradnath in Bhadohi (Figure 2). This area also incorporates a 30-kilometer segment of the newly formed Kachhua Wildlife Sanctuary. This study stretch lies in 3 districts of Uttar Pradesh Prayagraj, Mirzapur and Bhadohi. Situated along the sacred Ganges River, this stretch not only serves as a lifeline for millions of people but also hosts a diverse array of aquatic species, including endangered Ganges river dolphin and also serves as a vital habitat for other diverse array of flora and fauna, like endangered Indian Skimmer and various species of threatened turtles .The study area's strategic location along the Ganges River provides a unique opportunity to assess the status of the river dolphin population and implement targeted conservation measures. The inclusion of the 30-kilometer segment of the Kachhua Wildlife Sanctuary within the study area further enhances its significance for wildlife conservation. Moreover, the study area's proximity to human settlements and industrial activities underscores the importance of integrating conservation efforts with sustainable development practices. Overall, the selected study area provides a valuable opportunity to advance our understanding of Ganges River dolphin conservation and contribute to the long-term protection of this emblematic species and its habitat.
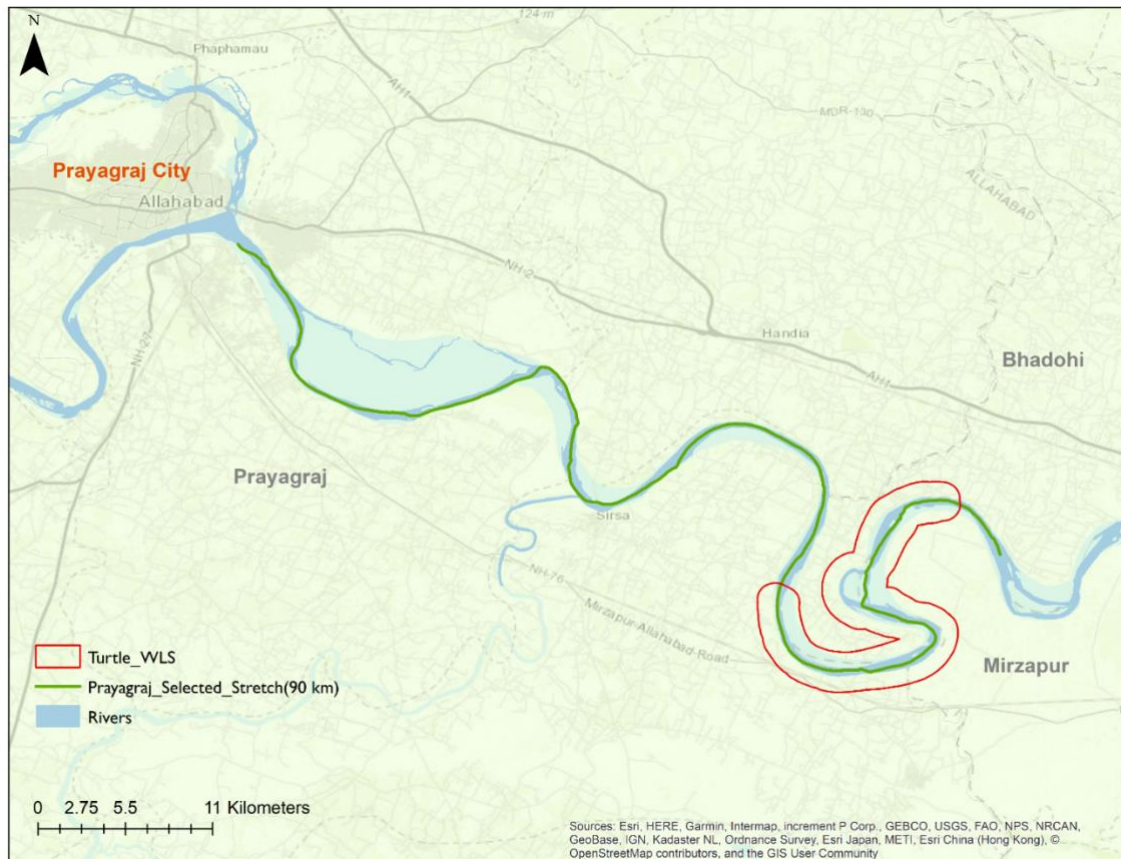
Figure 2 Map showing the study area of Uttar Pradesh intensive site (from Sam]ngam Prayagraj to Semradnath ghat, Badohi)

Bihar

The study site in Bihar runs from Barh to Munger covering a distance of 109.5 km (Figure 3). The major left-bank tributary of Ganga, Gandak, is situated 60 km upstream of the study area, and Burhi Gandak is 5 km downstream of Munger. The ecological significance of this stretch is further enhanced by the presence of the Vikramshila Gangetic Dolphin Sanctuary, located approximately 40 km downstream of the study area.

The Ganga River stretch is an important dolphin hotspot (WII,2021-22, unpublished report). The anthropogenic activities such as agriculture and dredging pose significant activities recorded in the area. Umanath Temple in Barh and Simaria Ghat are both crucial religious sites home to high dolphin populations. Simaria trade route, another ancient site with high dolphin numbers, is currently undergoing bridge construction work. The study area terminates with the Munger bridges, the river stretch supports three major water abstraction plans. Industrial activities in the stretch include Barh NTPC and Barauni NTPC plants present in close proximity to the river. The river banks are agriculturally highly

active, producing crops such as Cucurbitaceae family crops, mustards, wheat, and cattle fodder.

The stretch is home to a diverse range of associated species, including the vulnerable smooth-coated otter, endangered Greater Adjutant, and critically endangered Gharial, *Pangshura*, and *Nilssonia* species.
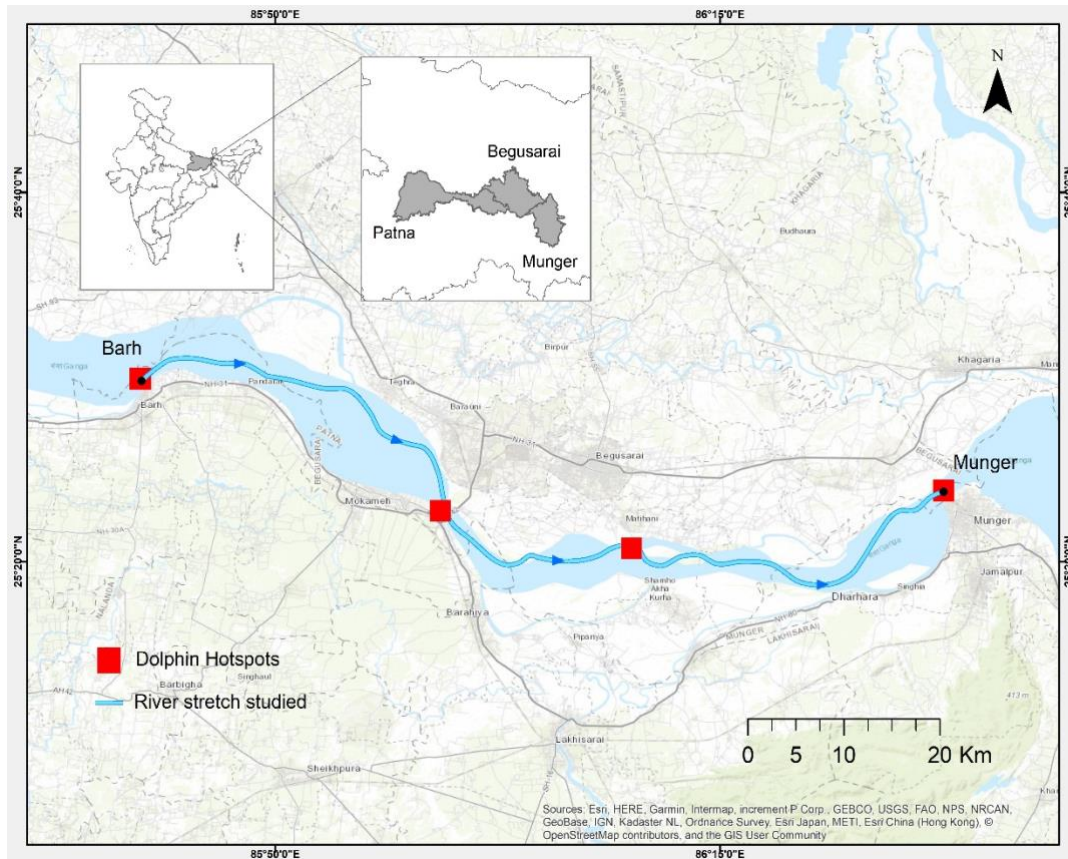
Figure 3 Map showing the study Area of Bihar from Barh to Munger

West Bengal

The intensive surveys in West Bengal was conducted in the Roopnarayan river which acts as a major tributary of Bhagirathi-Hooghly River and river flow is determined by tidal wave action. We have surveyed only 32 km in our intensive site from Ghatal to Mankur (Figure 4). Average depth is 2.9m and sandmining occurs predominantly with tractors near Bakshi ferry ghat. In this riverscape the river stretches to 225.85 km (121.949 nautical miles) with wider channels, shipping ports and extensive ship and motor vessel traffic. On the other hand, Roopnarayan River, with its network of sub-tributaries, (like Dwarakeswar, Silabati, Kangsabati and Damodar Rivers), is the most important tributary of the river Bhagirathi-Hooghly. The river begins as Dhaleswari (Dhalkisor) in the Chhota

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Nagpur plateau foothills northeast of the town of Purulia, West Bengal. Dwarakeswar River, near the town of Ghatal, is joined by the Shilabati River, where it takes the name Roopnarayan, flows over 78km to join the Hooghly River at Gadiara in East Midnapore district, West Bengal.

Figure 4 Map showing the intensive site of West Bengal (Roopnarayan river: Ghatal to Mankur)

Community based study sites

Over a span of two months, a comprehensive semi-structured questionnaire was used to conduct detailed fishermen interviews in Katwa, Purba Bardhaman, and Berhampore,

Murshidabad district in West Bengal. Currently, interviews with fishermen are ongoing in Bakshi, Howrah district. Additionally, stakeholder meetings and awareness workshops were conducted in Diamond Harbour, Katwa. Farakka, Kolaghat, Kalna, Berhampur, and the Padma river (Figure 5).
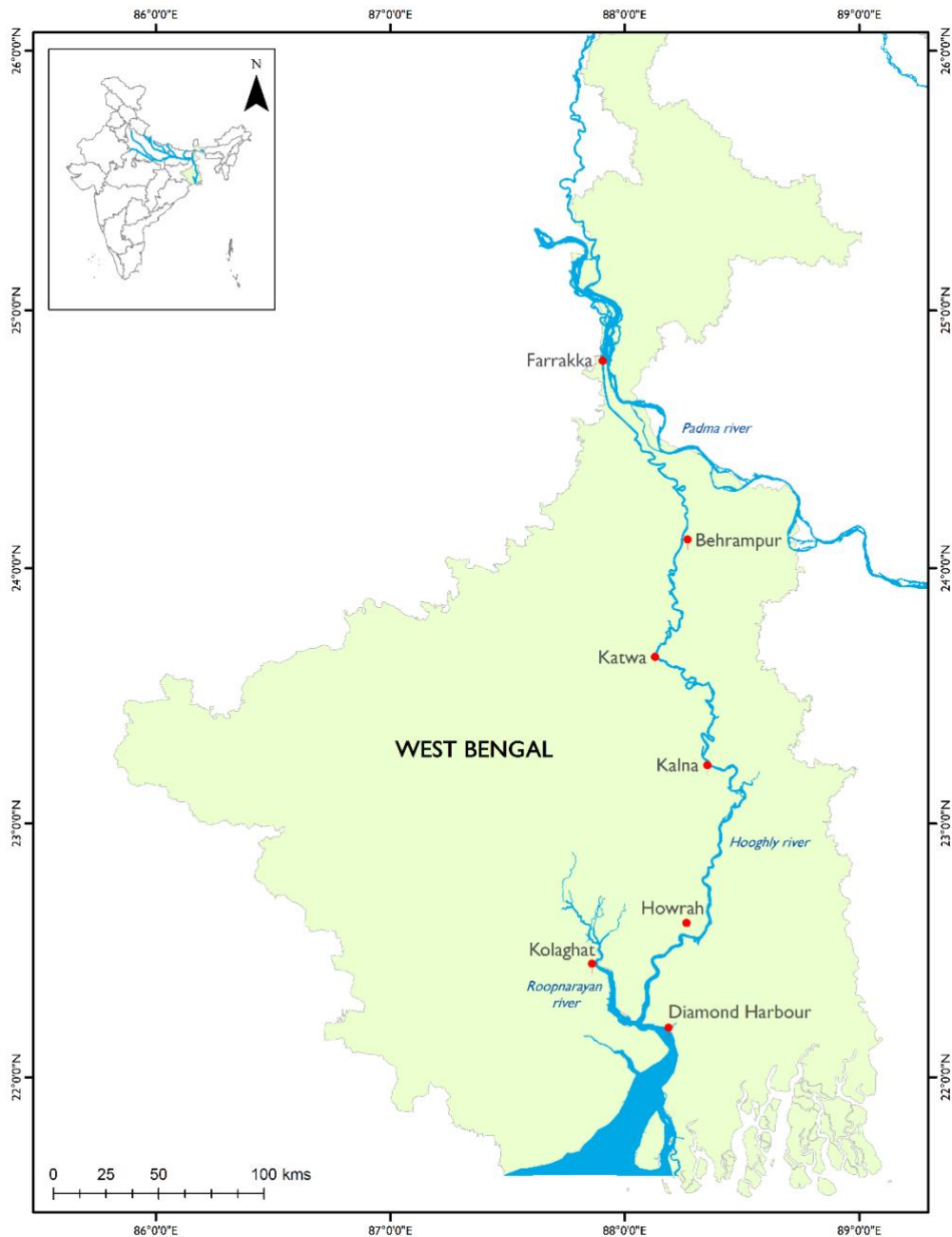

Figure 5 Map showing intensive sites of community based studies in West Bengal

Assam

Surveys were conducted along a 30 km stretch from Kirakata to Sarighat Bridge in Guahati area of Brahmaputra River (Figure 6). Dolphin population surveys with boat and point count was done here. Fish samples were also collected from this area.

Pinger -Dolphin experiment in Kulsi River

The study focused on the Kulsi River, a unique tributary of the Brahmaputra known for its population of Ganges river dolphins. This river is relatively narrow, with an average width of around 70 meters. The study area near Nagarbera, located near the confluence of the Brahmaputra and Kulsi Rivers, was selected for the experiment. Here, the river narrowed to 60 meters, and the area supported a significant population of Ganges River dolphins (Figure 6).

Pinger-Fish experiment in Brahmaputra River

The study area for the Pinger Fish experiment was selected in Guwahati and Goalpara, where there was a high level of commercial fishing activity in the Brahmaputra River. In Guwahati, two experiment setups were conducted near Kuruva Island, while in Goalpara, one experiment setup was conducted near the Pancharatna Bridge. Each setup involved two teams conducting the experiment, with each team positioned 500 meters apart from the other (Figure 6).

Depth Utilization in Brahmaputra River

The research site chosen for studying depth utilization was Guwahati, renowned for its sizable population of Ganges River dolphins and its ideal water depths for examining dolphin activity at various depths. Three experimental setups, each consisting of 4 to 5 pods, were deployed for a duration of 5 days each (Figure 6).
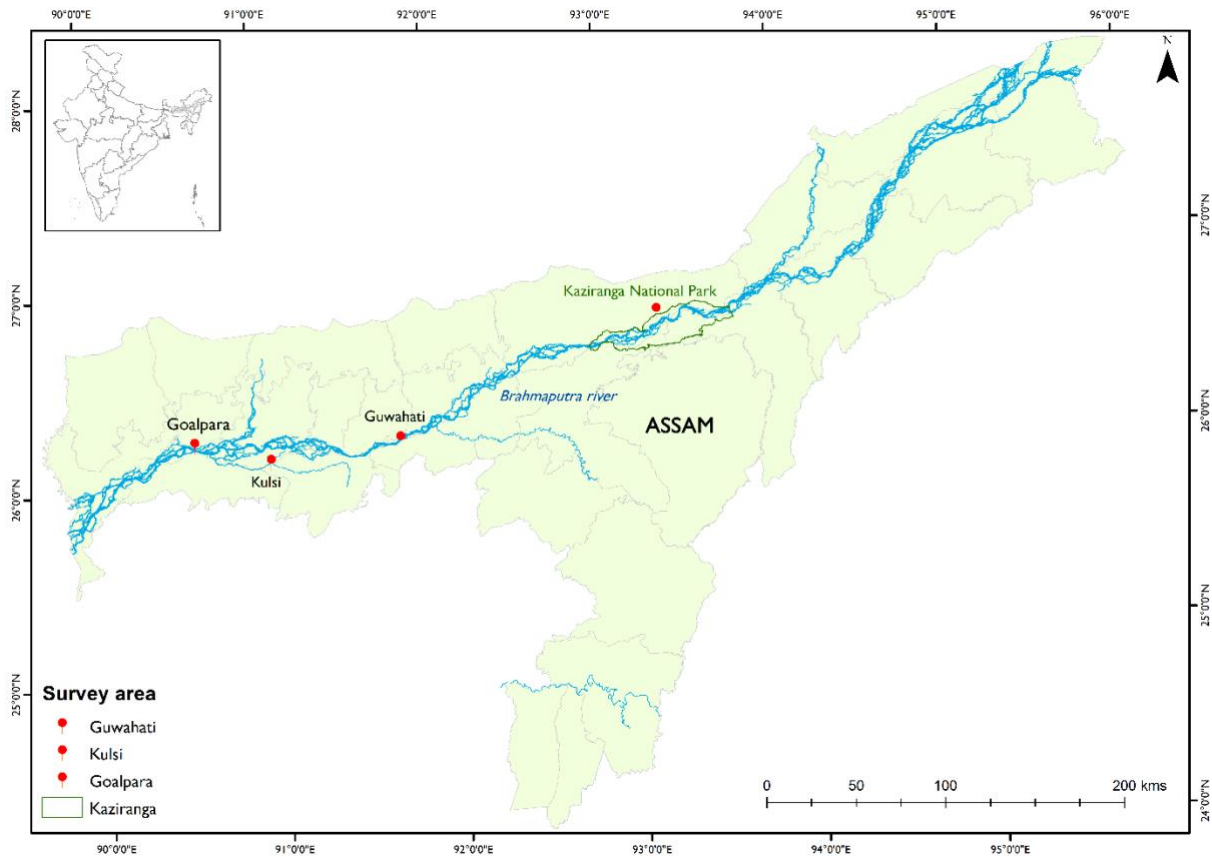
Figure 6 Map showing intensive sites of Assam in Brahmaputra River

Methodology

Dolphin Population Monitoring

The Independent Double Observer method was employed, adhering to a standardized protocol for Ganges River dolphins (Qureshi et al 2021). Surveys were repeated a minimum of two times.

Point count estimation of Dolphin population

Our study aimed to better understand dolphins' presence and abundance. To do this, we used Acoustic technology and direct observation. We placed FPODs, which continuously log dolphin clicks. It was placed every 2 kilometres along a 10-kilometre stretch of River.

We also set up cameras on the shore facing the water. These cameras were there to catch any boats or ships passing near our PODs, as this kind of human activity can affect the dolphins and their environment.

Alongside the cameras and PODs, we had a person stationed on the nearest bank, carefully watching the area around the PODs. This observer noted when dolphins surfaced and their dive pattern.

Lastly, we had a boat equipped with a towed FPOD. The boat team, consisting of researchers on different platforms, conducted surveys across the study area three times to ensure we gathered as much information as possible.

By combining these different methods, we aimed to get a complete picture of the dolphin population in the area, how they behave in different habitats diurnally, and how human activities might influence their acoustic characteristics and distribution.

Associated Fauna survey
Turtle, Gharial and Mugger survey
A 60 km survey was conducted, moving downstream at 10 km/day on either bank in a non-motorized country fishing boat, from 10.00 am to 3.00 pm in winter and from 7.00 am to 10.00 am and 3.00 pm to 6.00 pm in summers. Environmental and weather conditions like water-air temperature, cloud, wind conditions, fog, number of floating or stationary wooden logs, sandbars, small islands, and anthropogenic activities were recorded to assess their effect on Turtle detection. Repeat for 4 – 5 consecutive days at each site for studying temporal variation.

Another two 2 km foot-transects of defined width on selected habitat types was conducted using stratified sampling method for sign survey and Nests during noon, between the timings of boat-based surveys.

Avian Survey
Bank line surveys were conducted using a small boat moving along one of the banks, with an observer and a recorder sitting on the boat recording the different species and their numbers in the river as well as on the bank. The boat (Speed boat) covered a length of up to 10 km at one bank and repeated the survey from the other bank while returning, again covering a 10 km stretch such that both banks were covered.

Sign surveys for aquatic- associated mammals
Method includes searching for signs of animal activity (like footprints, Dens, spraints etc) for 3 km long strip of 10 m wide, after at an interval of 3 Km on both the banks of the river. The location to the sites where signs would be recorded using Garmin GPS, And Take a photograph of signs, ensuring they are clear and include recognizable features for later analysis. And it is necessary to include a ruler placed alongside the sign for scale. During the survey information about the species, sign types or direct sighting, number

and age of the signs, habitat type and level of human disturbances (within 5 m radius) was recorded.

Fish sampling

The 'Intensive study site' was selected based on dolphin distribution along the stretch. The sampling was carried out in each 60 km stretch, divided into 10 km segments. Each 10-kilometer segment was subdivided into 2.5 km, with 3 sampling points selected within each 2.5 km segment.

Experimental fishing using different sets of fishing nets (cast, gill, and drift nets) was carried out by researchers as well as by utilizing local expertise in each sampling segment of 2.5 km. Different types of gear, including cast nets, gill nets, and drag nets were used for collecting fish samples. This approach allowed for sampling a range of fish sizes and minimized bias due to specific gears (Kelkar et al., 2010; Choudhary et al., 2006).

When deploying a gill net, it was important to select a specific habitat and avoid setting the net near obstacles such as sunken stumps or logs that could entangle and rip the nets. The deployment process required only 1 or 2 people. The gill nets of various mesh sizes (13x13 mm, 25x25 mm, 50x50 mm, and 70x70 mm) were deployed for a minimum of 2 hours each at each of the three sampling sites. The captured fish species were kept in a bucket or tub, and photographs were taken in a photography tank or off-site plate with a 30 cm scale placed below the specimen. The researcher had to fill out the datasheet for the fishes, and identified and live fishes were released back into the river.

The cast net was thrown onto the surface of the water in an area likely to have the targeted fish. When choosing a location for a cast net, smooth sediment at the bottom was preferred to avoid tearing the net on underwater obstructions. Cast nets (13x13mm, 25x25mm, 30x30mm) were deployed at least 30 times each for 1-2 minutes at all three sites for standardization. The captured fish species were kept in a bucket or tub, and photographs were taken in a photography tank, off-site plate, or in a tray with a 30 cm scale. The researcher filled out the datasheet for the fishes, and identified and live fishes were released back into the river after morphometric measurements. For the identification of species, standard reference books (Talwar and Jhingran,1991; Jayram, 1999; 2010) and Eschemeyer's catalogue (Van der Laan et al 2014) were used.

Fish market and landing sites survey

A questionnaire survey was conducted at the fish landing sites (Montana, et al., 2011) to assess the present scenario of the commercial fisheries of the river. Fish markets and

landing centers associated with the river stream were monitored to look for the presence of any species which were not available during the experimental fishing. Fish species, their size, and weight along with the price were recorded. The average length and weight were recorded from a minimum of 10 fishes. The data collected were uses to estimate the economy generated from the fish resource collected from Ganges dolphin habitats and the catch effort and the fish species diversity.

Plankton sampling

The study area was divided into segments of 10 km, with each 10 km segment further divided into two sub-segments of 5 km. At every 2.5 km, vertical sampling across depth gradients was executed, and at every 5 km, surface sampling (horizontal towing) was done. The sampling devices, Van Dorn sampler, and the plankton net, were cleaned and in good working condition. At each specific sampling site, the depth of the water column was measured using a depth sounder, and according to the study objectives, different depths were marked using a scaled line.

Horizontal tow sampling was conducted using a plankton net with a mesh size of 60 μm. The net was tied to the boat's rear end and towed against the water flow. It was dropped on the surface of the water and allowed to sink to a depth of 50 cm from the surface. The net was then towed for 5 minutes, allowing water to filter out simultaneously. After towing, the net was raised, and the filtered water in the collection cup was transferred to sampling vials. To preserve the sample, 4% formaldehyde was added.

The vials were appropriately marked, containing the following information: the date and time of collection, site ID, depth of sampling (mainly for vertical sampling), and flow rate (using a flow meter). Other important water parameters, such as temperature, dissolved oxygen, turbidity, pH, and nutrient content (nitrate), were noted using the YSI on the assigned datasheet.

Vegetation survey

Habitat segregation
In a 60 km (approx.) stretch of the river was selected as the 'Intensive site' for study, based on the presence of dolphins. A 500 m buffer around the study stretch was mapped, and possible habitat types were identified and stratified prior to fieldwork using ArcGIS. This included both river (water part) and bankline (terrestrial part) areas. The stretch was further divided into 10 km segments for the convenience of the study.

Aquatic vegetation sampling

A team of two members, consisting of one observer and one recorder, collected data using boat-based quadrat sampling. The team was equipped with a datasheet designed for vegetation sampling, a handheld GPS, and a camera. Pools and stagnant water areas for sampling were identified prior to field data collection from the prepared maps. These locations were confirmed in the field and sampled for aquatic vegetation. Any new locations with the presence of aquatic vegetation were added and sampled if identified in the field. The sampling was conducted in 0.5m x 0.5m quadrats, considered as one sampling unit. Plant species were identified inside the quadrat, counted, and the percentage of vegetation coverage was recorded through visual estimation. The recorder filled in the datasheet provided with the necessary information.

Terrestrial vegetation sampling

The study of riparian vegetation was conducted in three stages: till the high water mark, beyond the high water mark, and on islands. In the field, vegetation sampling covered all different types of bank habitats identified prior to the survey. The field data was collected by a team comprising one observer and one recorder, equipped with a datasheet designed for vegetation sampling, a handheld GPS, and a camera.

Riparian vegetation sampling was done in circular plots, considered as a sampling unit. Each sampling unit had three circular plots at one location for trees (5m radius), shrubs (2m radius), and herbs (1m radius).

Till the highwater mark the vegetation sampling was conducted every 1.5 km on one sampling unit consisting of three circular plots for trees, shrubs, and herbs.

Beyond the high water mark the vegetation sampling was conducted every 3 km on a transect of 100 m length perpendicular to the river bank to understand the change of vegetation with distance from the water. Three units were sampled in the transect (at 0m, 50m, and 100m). Each sampling unit consisted of three circular plots for trees, shrubs, and herbs.

In the islands, circular sampling units were laid on these landforms to understand the vegetation structure. Depending on the area of the islands calculated from Land Use Land Cover (LULC) maps, circular plots were decided to cover all vegetation types present on the island. Plots were laid at different distances from the water. Each sampling unit

consisted of three circular plots of different radii to be sampled for herbs, shrubs, and trees separately.

Data collected included the presence/absence of vegetation, tree/shrub/herb density categorized as absent (0%), low (<= 25%), medium (<= 50%), high (<= 75%), or dense (<= 100%) inside the sampling unit, GPS location of the plot, identification of different plant species inside the plot, counting of individuals of species for trees, visual quantification of the percentage of coverage by each plant species identified for herbs and shrubs inside the plot, calculation of canopy cover of trees inside the plot using https://canopeoapp.com, noting of invasive species, taking good quality photographs of unidentified species for further identification with the help of experts, and collection of plant samples if required for identification.

Efficacy of Pinger on Dolphins

The accidental entanglement in fishing gear and manmade capture of Ganges River dolphin is one of the major threats impacting the species in the river ecosystem.

Ganges river dolphin is partially blind and their eyes are devoid of crystalline lenses and thus cannot resolve images (Herald et al., 1969). They use bio sonar clicks as their primary sense receptor. They continuously produce these high-frequency sound termed 'clicks' and the returning echoes to understand its surrounding environment and capture prey in the river water (Herald et al., 1969). The presence of nets is hard to echolocate using 'clicks', especially those of smaller mesh sizes, leading them to get entangled and consequently drown. Considering the impact of net entanglement, it is imperative to minimize the bycatch of the dolphins in the net. We propose here the possibilities of using acoustic deterrents to prevent/minimize the net bycatch of the Ganges River dolphins.

Pingers were acoustic deterrents widely used in the fishing industry to alert dolphins to the presence of fishing nets. The Dolphin Pingers used for experimental trials to deter the Ganges River dolphin had a frequency of 70 KHz. The main use of Pingers was to help dolphins echolocate the nets, which they otherwise could not identify. The detection range of Pingers in CPOD was within 300 to 350 meters. The 100% detection range was within 150 meters, so it was better to keep the Pinger within a 100-meter radius from the CPOD in the fishing net. Criteria for selecting the area included ensuring a good number of dolphins were present or surfacing, the area had commercial fishing activities. For long

nets (more than 100 meters), one Pinger was placed at every 100 meters, while for smaller nets (less than 100 meters), one Pinger was placed in the middle of the net.

The FPOD (Passive Acoustic Monitoring devices) was positioned 100 meters away from the center of the net to prevent loud sonic pings from masking the clicks of the Ganges River dolphins (Figure 7). It remained active 24 hours a day until the completion of the experiment. Spatial and temporal controls were used to address different objectives. Two control FPODs were placed 400 meters away (one upstream and one downstream) from the Pingered net, where the effect of Pingers was nearly negligible, referred to as non-Pingered FPODs. These two FPODs were active 24 hours a day until the completion of the experiment.

The experiment began with a **'pre-treatment'** phase for 8 days, during which the FPOD and net were in their respective positions, but the Pingers were inactive. This was followed by a **'treatment'** phase for 20 days, during which the Pingers were active. Subsequently, the Pingers were removed, and the FPODs were monitored for dolphin presence in the **'post-treatment'** phase for 8 days.

A visual observation team, consisting of one observer and one recorder, was stationed on the bank at the site of the fishing net deployment and recorded dolphin surfacing from morning till evening. The team was unaware of the experimental phase, i.e., whether the fishing nets contained Pingers or not. For each dolphin surfacing sighting, the observer provided the recorder with the time, angle of surfacing, estimated distance to the dolphin, and age class (calf, non-calf, or unknown).

The total duration of the experiment was 36 days (from 17th December 2023 to 25th January 2024), with approximately 960 hours of acoustic data collection.
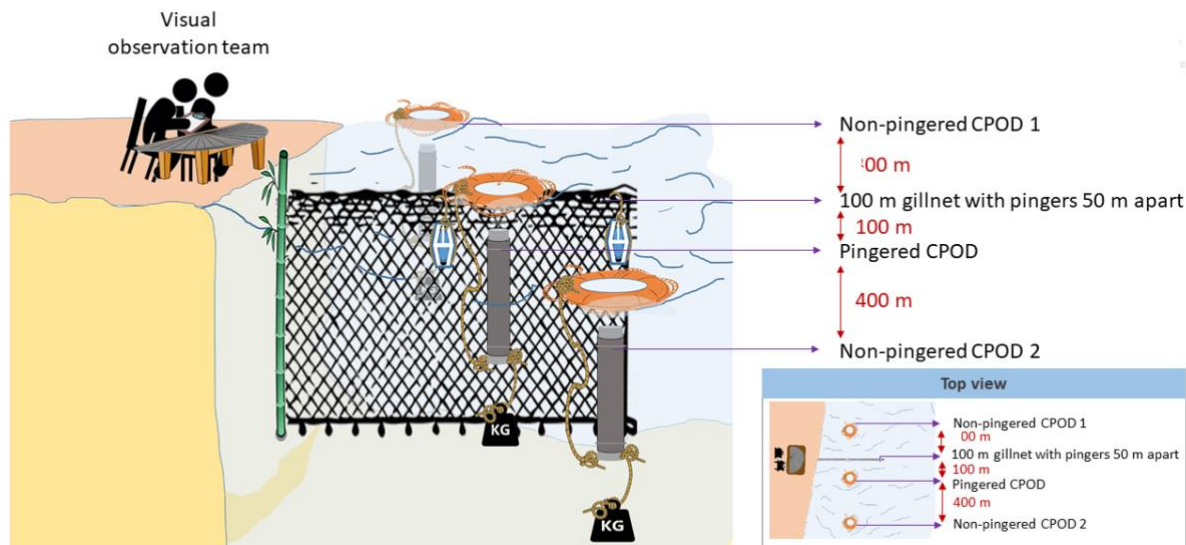
Figure 7 Experimental set up to estimate the efficacy of Pingers on Ganges River dolphins

Pinger- Fish experiment

Usually, commercial fishermen fish in groups, so the type of fisherman chosen for an area depended on their fishing practices. The time of the experiment matched the time of fishing by the fishermen, and the nets used were the same as those used by the fishermen. Two sets of experiments were conducted in selected areas with similar habitat types, namely **the Treatment and Control groups**. Depending on the number of fishermen in an area, 4-6 fishing nets or a minimum of 30% of the nets were selected randomly. All selected nets had Pingers, but only the person in charge of the experiment knew if they were active or inactive. The area where the Pingers were active became the Treatment set, while the area where the Pingers were inactive became the Control set. This setup of active and inactive Pingers alternated every other day. The Control set of nets was spaced at least 500 meters away from the last active Pinger nets in the study area to avoid the Pingers' effects on the Control nets. The experiment could be conducted either upstream or downstream of the river, depending on the availability of active fishers.

The fish catch of each day was recorded, including fish species, fishing net mesh size, length of the net, and other parameters in the datasheet provided. Similar experiments needed to be carried out in two or three setups with different groups of fishermen.

Experiment on depth preference of Ganges river dolphins

The riverine habitat of the Ganges River dolphin in India is experiencing low water depth across its ranges, particularly exacerbated during the lean season, leading to dolphin strandings and increased mortality. Visual records show dolphins have been observed in water depths of up to 2 meters. This experiment aims to investigate whether Ganges River dolphins will utilize different depths if sufficient water depth is available.

For this experiment, FPODs were used to record dolphin acoustic activity at varying depths (Figure 8). The Pods were placed at different water depths in selected sites known for a significant presence of Ganges River dolphins. The distance between each FPOD was maintained at approximately 450 meters to prevent overlapping of click trains in different PODs, considering that dolphin clicks can travel over long distances. Each set consisted of 5 days, and up to 4-5 FPODs were deployed based on depth availability. The topmost column of water for the FPOD was set at 2 meters, as recording beyond this depth would be affected by surface noise, while the bottom depth was set at 1 meter from the bottom.

A total of approximately 700 hours of data was collected at varying depths, ranging from 2 meters to 23 meters in the FPODs' depth profile.
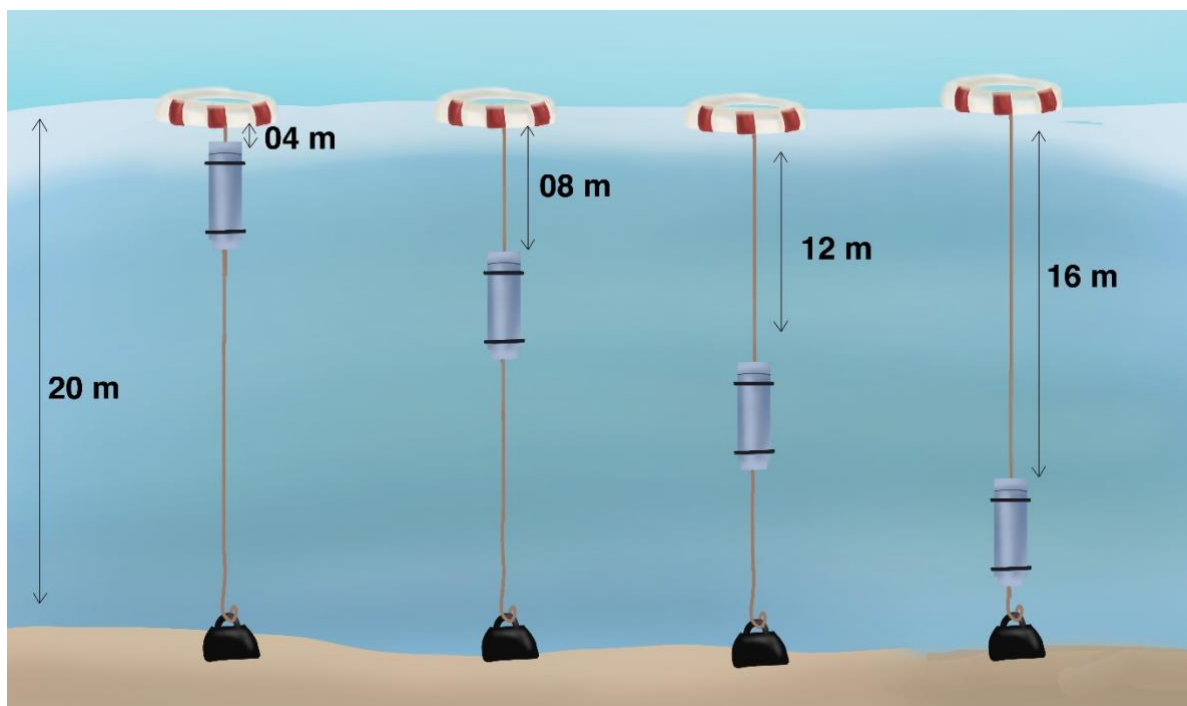

Figure 8 Experimental set up for determining depth ranges used by Ganges River dolphins

Community based survey

Sociological research designed for Ganges River Dolphin conservation is strengthened by multi-stakeholder partaking. With the aim of planning a long-term conservation success, Community-based participatory research (CBPR) is being followed. Beside understanding anthropogenic threats to the species survival, River Dolphin conservation research envisions answering a wide array of questions such as socioeconomic structure and community ethos of the primary stakeholder (fisher folk), social perception for River Dolphin and its habitat and possible involvement of Government and Non-Government agencies. To accomplish the said aim, a sequential research design is to be followed in all of the human settlements around river dolphin habitats (Appendix 21).

Site selection of River Dolphin Social Survey

The river stretch was selected based on Ganges River Dolphin abundance or dolphin hot spots. Human settlements along both banks of the selected river were identified. The local community and administration were interacted with to enlist nearby fishing villages. Fishing villages were validated with the existing dolphin hot spots. Village names, GPS coordinates, and necessary photo documentation were noted.

River Dolphin Social Survey

i.Sampling: Purposive sampling (Marshall, 1996) is followed for participant selection (target community: Fishers). After initial identification of the participant, river dolphin identification cue card is used. If the participant is able to identify the Ganges River Dolphin without assistance, interview is commenced further.

ii. Design: Two-fold study design is prepared for this survey. In the first stage, personal interviews and group discussions are conducted. In second stage, mass awareness and outreach activities are organized.

iii. Steps

- Intimation and permission from local administration & police station about the survey
- Manage all raw data in digital as well as print mode for further analysis

Ethical guidelines

i. Obtaining informed consent: Before commencing the interview, participants were briefed about the project. The interview proceeded only if the participant

agreed after understanding the purpose. If the participant was unwilling or uncomfortable, the interview was not conducted.

ii. Confidentiality: Participants were informed about the academic nature of the survey. They were not required to provide their name if they were unwilling to share it.

iii. Respect and Empathy: Composure was maintained while interacting with members of the stakeholder community. Non-judgemental behavior was demonstrated throughout the interviews, and the use of provocative language and gestures was avoided.

Conservation Education and Interactive Games for school students
Awareness based educational program serve multiple roles - beside imparting knowledge about endangered species, it creates preparedness for reporting wildlife crimes. This approach train pupils to become responsible towards wildlife leading to a sustainable conservation goal.

i. S**ampling:** Purposive sampling (Marshall, 1996) was followed for study area selection (target community: School students). Based on social survey report and dolphin hot spots, educational institutes are shortlisted for events.

ii. **Design:** Schools are selected in particular study area, Dolphin Sensitive Habitats/hot spots are given priority. All activities are conducted in native language of the audience. Interactive games designed on the basis of river dolphin features may be played with the students for active participation and better understanding.

iii. **Steps**

- Brief Introduction about the workshop was given.
- An awareness talk was delivered, with printed or audio-visual teaching aids. Student were involved for interactive games and were asked to relate those with Ganges River dolphin characteristics.
- After the session, feedback questionnaire was collected from participants. This questionnaire will assess participants' awareness on river dolphin as well.
- Prizes were distributed as a token of appreciation to participants.

Stakeholder Awareness & Training Program
Stakeholder Awareness & Training Program was conducted to identify other line agencies linked to River Dolphin conservation, in addition to the primary stakeholders from fishing communities. Departments such as the Forest department, Fisheries, Hydro-electric projects, Oil sector, Inland Water Transport, Irrigation, etc., which were directly associated with the river, were identified. Moreover, departments undertaking Elementary and Higher Education, Veterinary and Animal Husbandry, Border Security Forces, etc., which were somehow related to issues of long-term River Dolphin conservation management, were shortlisted.

a. **Design:** The design phase involved conducting interviews with department officials to list the ongoing beneficiary schemes and policies designed for target communities. Data on district units and the current status of scheme distribution were gathered from reports or officials. At a later stage, a field survey was conducted to understand the community perspective on such policies and the status of scheme availability. Advocacy programs were designed to impart wildlife conservation messages and propose inter-departmental participation for the same cause. Based on the targeted audience, outreach materials such as brochures and awareness leaflets on Ganges River dolphin, Wildlife Protection Act, state fishery rules, etc., were used.

Outreach activities of vulnerable villages
a. Identification of vulnerable villages: All data available on River Dolphin abundance, frequency of fishing activities in the river, cases of dolphin net entanglement, oil bait fishing, dolphin oil availability in the community, reported incidences of poaching and any information about dolphin meat consumption were enlisted. The data was then classified on the basis of River Dolphin survival threats caused directly by human, such as hunting and poaching for oil. The study area with the most severe condition were categorised as 'Vulnerable Village'.

b. Sampling: Snowball Sampling (Morgan, 2008) was followed to reach all of the Fisher households in the study site. Visit door-to-door for the awareness message dissemination.

c. Design: Sequential methodology in each study site was designed for vulnerable villages; including outreach events at schools, entire village and individual

households. Meetings were organized with Gram Panchayat, Block offices and fishermen cooperative groups for imparting the necessity for Ganges River Dolphin conservation. Also the local authority were encouraged to be responsive about dolphin poaching incidences to the Forest Department.

Results

Uttar Pradesh

Dolphin Population Monitoring

As of now two Dolphin Population Estimation surveys (31/12/23 to 01/01/24) and (28/01/24 to 29/01/24) have been conducted, both the surveys were done from Prayagraj (Sangam) to Semradnath Ghat (Bhadhoi) including the 30 km long segment of Turtle Wildlife Sanctuary.

We will be shortly doing the last repeat of Dolphin Population Estimation exercise in the first week of April. **147 and 119 dolphin count** were estimated in first and second survey respectively (Table 1).

Table 1 Least count of Ganges river dolphin from Prayagraj (Sangam) to Semradnath Ghat (Bhadhoi)

Survey	Primary Team Count		Secondary team Count		Total
I st Survey (31/12/23 to 01/01/24)	Matched	Unique	Matched	Unique	147
	114	18	114	15	
II nd Survey (28/01/24 to 29/01/24)	97	9	97	13	119

Training of Forest Department Personals during 2nd Dolphin Population Estimation Exercise

During the 2nd Dolphin Population Estimation Exercise we invited the UP-Forest department to join us on field for training for two days, so a total of 5 Forest personal (2 from Phulpur, 1 from Karchana and 2 from Meja Range) came to participate including Deputy Ranger from Phulpur Range (Figure 9).

Figure 9 Hands on training on Ganges River dolphin monitoring and equipment handling to Uttar Pradesh forest department

Point count estimation of Dolphin population

We have completed the Acoustic Monitoring in 9 segments (90 km) of the stretch from Sangam to Semradnath ghat with deployment of underwater acoustic monitoring device (FPOD) at every 2km (Figure 10).
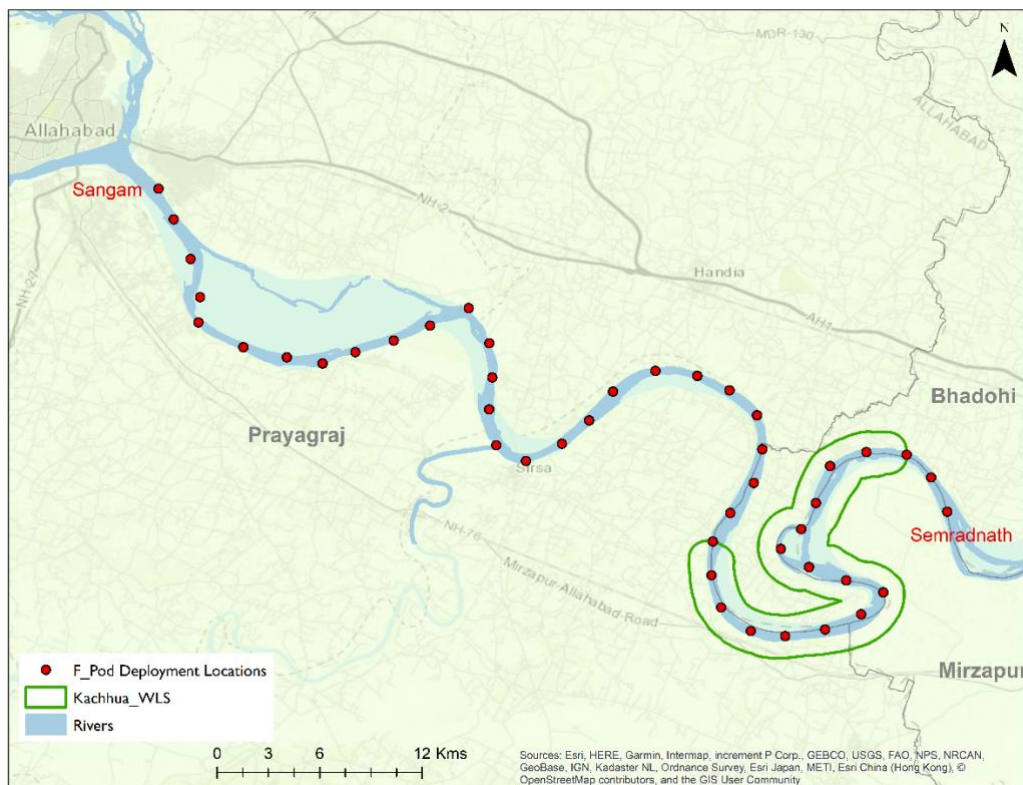
Figure 10 Map showing location of F- pods during Point count estimation of Ganges River dolphins population

Along with this we have also conducted visual monitoring of dolphins on the places of F-pod Deployment for 1 to 2 days in each segment (approximately 230 hours in total, Appendix). All the 5 pods were simultaneously observed in parallel hours of the day.

- 2 days visual monitoring: Seg 1 to Seg 6
- 1 day visual monitoring: Seg 7, 8 & 9

Associated fauna Survey

For evaluating the associated biodiversity of the Ganga river system, dedicated surveys were done in 3 different fashions:

• **Bank line boat surveys** (9 Segments completed): Total length=178km

• **Sign surveys** (9 Segments completed): Total Trails = 34, Length Covered= 98 km

• **Associated fauna observation on boat during dolphin estimation exercise (**two full length ABT surveys have been completed)

Figure 11 Map showing sighting locations of India skimmers and other important associated biodiversity related activities in the study site

In Addition to these Bird Point transect were done in selected stretch of the 25 kms from Sirsa to Kothari to evaluate the terrestrial birds that inhabits ganga riparian habitat (**94 Point Transects**)

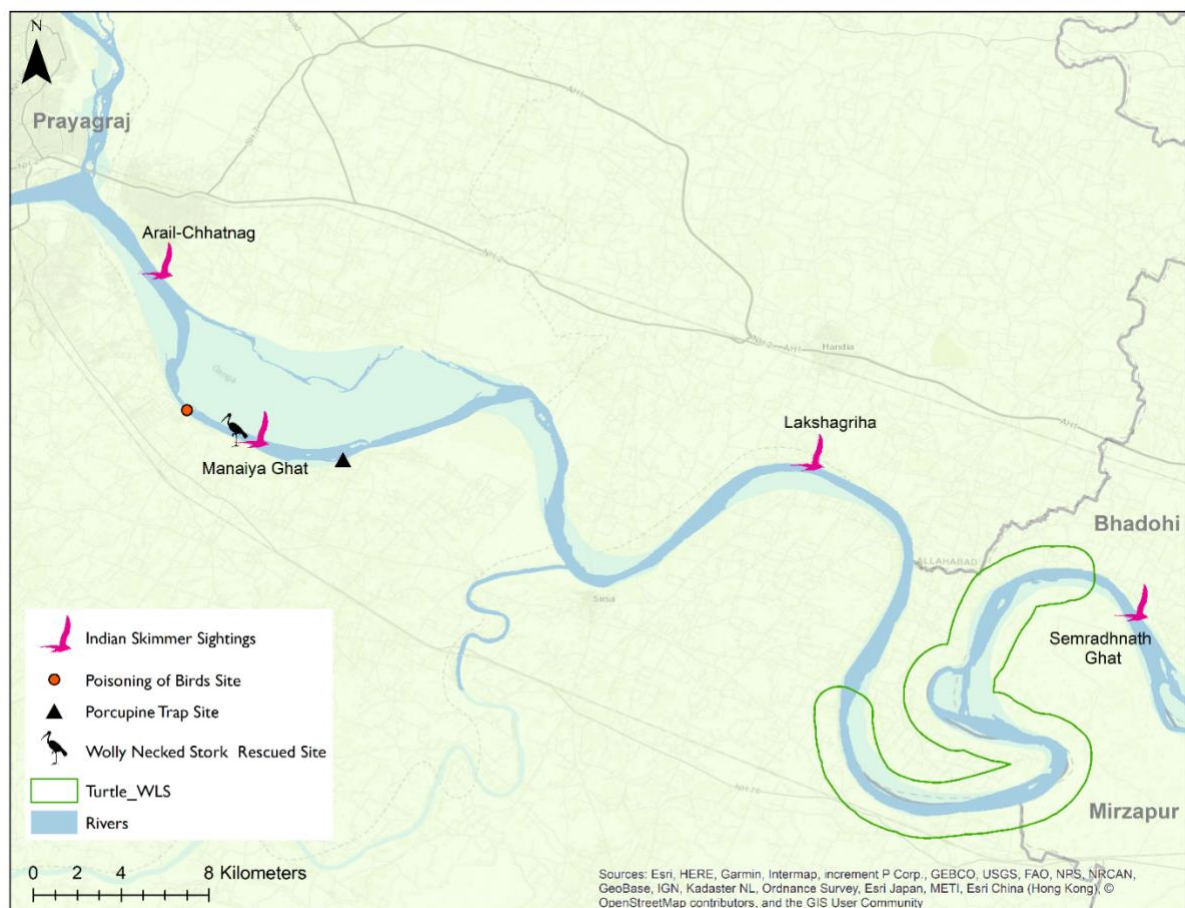Many different bird species both migratory and non-migratory were seen using the various habitats offered by river Ganga. But most substantial observation was the Endangered Indian Skimmer (*Rynchops albicollis*) (Figure 11, Table 2).

Table 2 Details of Indian skimmer sightings throughout the survey

S.No.	Date	Count	Location	Latitude	Longitude
1	01/01/24	1	Semradhnath Ghat	N 25.253863°	E 082.315454°
2	06/01/24	4	Arail-Chhatnag	N 25.393585°	E 081.915943°
3	16/01/24	7	Manaiya Ghat	N 25.324683°	E 081.955253°
4	28/01/24	5	Manaiya Ghat	N 25.324683°	E 081.955253°
5	28/01/24	30	Lakshagriha	N 25.315314°	E 82.182527°

Apart from the Avifaunal diversity, Mammalian species observed during the survey only includes the Nilgai (*Boselaphus tragocamelus*) as well as the Indian Golden Jackal (*Canis aureus indicus*) only (Appendix 2), while the herpetofauna diversity only includes the dead specimens of Snakes; Checkered Keelback (*Fowlea piscator*) and Indian Rat Snake (*Ptyas mucosa*) (Appendix 3). Dead specimens as well as the trail marks of Turtles; Indian Softshell turtle (Nilssonia gangetica) observed during the survey.

Major Threats to the Biodiversity observed during the survey

Along with the good biodiversity observed in the main river channel, some disturbing and alarming scenes which include poisoning of birds, Mass poaching of turtles as well as Porcupines were also observed by the researchers during the survey.

1)   **Poisoning of Water birds in the main river channel**: While conducting our boat based survey on 29th of December 2023 we encountered 2dead birds namely; a Little Egret and Indian Pond Heron and one almost dead Great Egret on a shallow Mid channel Sand Island near Lawayan Kalan Village (N 25.3393°, E 081.926867°) all three of them seemed to have been poisoned in some way, as in our earlier surveys we have encountered similar accounts from different parts of River Ganga (Appendix 4). Apart from that, one struggling Woolly-necked Stork (*Ciconia episcopus*) was also encountered

on our way while laying one transect on the nearby island (N 25.331211°, E 081.946297°) which was later rescued and shifted to the Forest rescue camp in Prayagraj.

2)   Poaching of Turtles seen on the sandbanks: On 5th of December during our transect walk we encountered 8 different Carpaces of dead Softshell turtles (Probably *Nilssonia sp*.) of all age classes, on the highly disturbed sand banks (from N25.4082°, E081.89991° to N25.40821°, E081.89996°) at Arail-Mavaiya ghats (Appendix 5). Which seemed to be a result of mass poaching at the site, as one of the sites even had a burnt skeleton of these turtles, other parts such as scattered remains of few plastrons, head and other parts were also seen there. We also got some turtle trails made on loose sand before encountering the Poaching scene, thus the site has potentially good number of turtles and an alarming rate of poaching as well.

3)   **Poaching of Porcupines and other denning animals**: Similar accounts of Poaching of some denning animals were also seen on the bank near Kabra, Manaiya Upaerhar villages (N 25.31910°, E 081.99072°) while our team was doing a sign survey along the bank (Appendix 7). While conducting the survey we encountered two huge animal dens on one of the old degraded cliff banks in the region, while no signs of porcupines were recorded on the loose sand outside the burrow, sign of other rodents were seen, all were trampled by fresh human foot prints, which suggested a recent visit to the site by someone, apart from that three snare animal traps were seen deployed at the entrances of the two dens. Which suggest high level of poaching of these denning animals. Upon asking the local villagers, information on the poaching of Indian crested porcupine was collected which seemed to be poached and eaten regularly by the locals here

Fish Sampling

Field Sampling was started from 4th segment and we have completed till 9th segment (i.e. 60 km, Figure). Shortly we will be starting the 30km segment in the upper stretch.
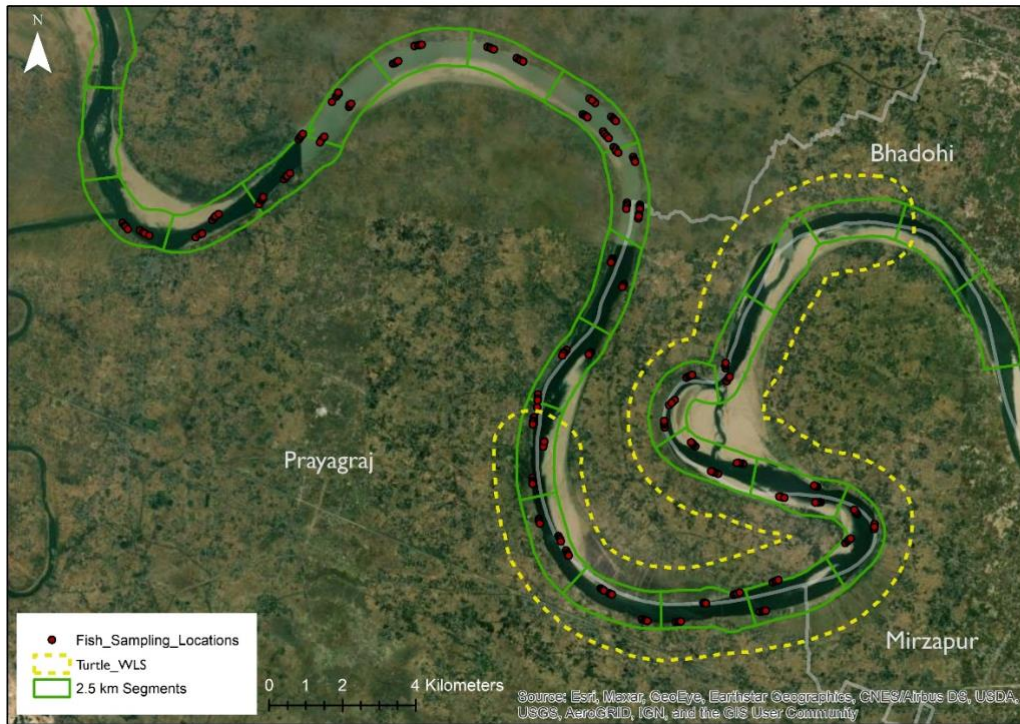
Figure 12 Map showing fish sampling locations in Uttar Pradesh intensive site

Fish Market or Landing site survey

As of now we have tried to covered mostly all small and big markets around the stretch, out of which on three sites fishes of rivers were recorded (2 sites with Ganga fishes and 1 site with Yamuna fishes, Figure 13). Other markets mostly consist fishes of Ponds. Total

18 fish species were identified out of which Common carp was invasive (Appendix 8). During fish sampling 36 fishes were identified (Appendix 9).
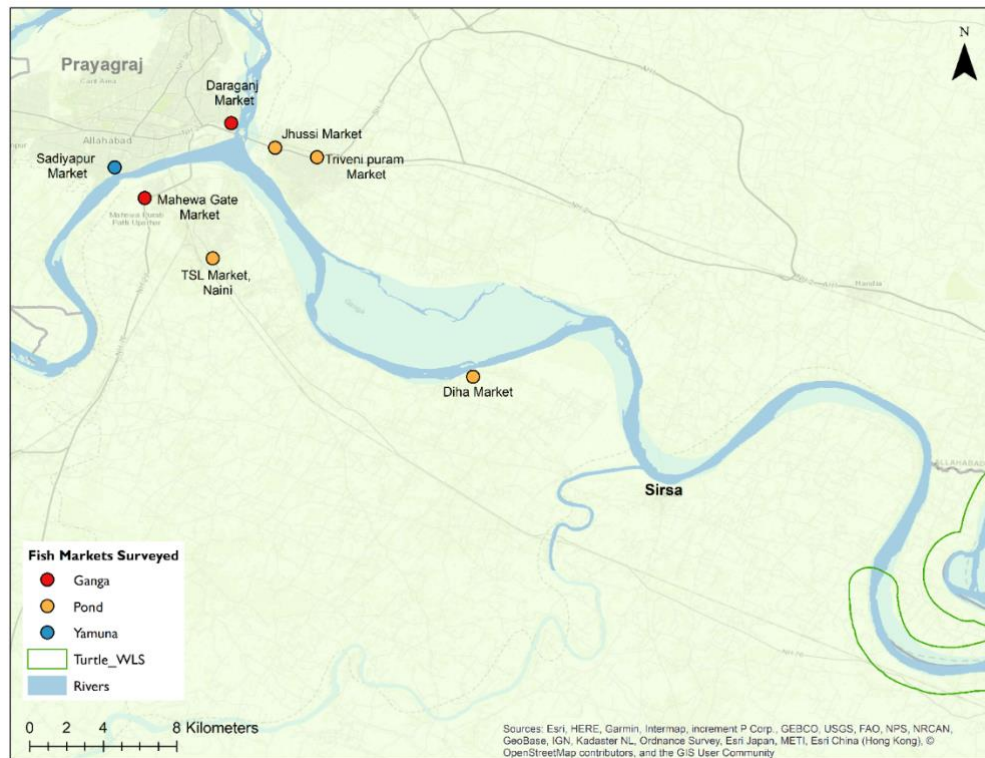
Figure 13 Map showing the fish markets surveyed in the Intensive site of Uttar Pradesh

Plankton Sampling

- **Plankton Sampling by dragging at every 2.5km grid:** Sampling was started from 4th Segment and completed till 9th segment (60 km). We will be starting sampling in the 1st 30km segment shortly.

- **Plankton Sampling at Sand mining locations:** There was only one major sand mining area is present in the stretch. Completed plankton sampling near the location (Upstream of the point, near the point and downstream of the point).

- **Temporal Plankton sampling:** It was done four times in a day
  - 1st sample: 10:30 am to 12:30 pm
  - 2nd sample: 3:30 pm to 5:30 pm
  - 3rd sample: 6:00 pm to 8:00 pm
  - 4th sample: 5:00 am to 7:00 am

This has been completed in 60 km starting from 4th seg till 9th seg.

Vegetation sampling

Riparian vegetation sampling was conducted in nine segments totaling 90 kilometers, along with a sign survey transect (trail walk). Currently, 178 circular plots have been completed for herbs, shrubs, and trees (Appendix 10). However, there are still some species that have yet to be identified.

Bihar

Point count for estimating Ganges dolphin Population

A two-stage FPOD deployment experiment was conducted in the Ganges River near Barh, Bihar, to investigate dolphin relative abundance. Each stage involved deploying two sets of four FPODs at designated locations spaced 2 kilometres apart, covering a total river stretch of 16 kilometres.

The first set of FPODs was deployed for five consecutive days, achieving the targeted 72 hours of continuous data collection according to the pre-established protocol. Additionally, visual observations were conducted at each FPOD location for a total of 4 hours across two dedicated observation days.48-hour camera trap data was also collected for the first FPOD.

Visual observation of Dolphins at each point of FPod Deployment during point count exercise was conducted between 12-5 PM. A total of 194 sightings were recorded across 8 points among which 119 were adults, 54 sub-adults and 9 were calves. 12 sightings could not be attributed to a specific age class hence were recorded as unknown. Dolphins were predominantly recorded during movement (56.54%). While they were observed during foraging (14.14%) and resting phase (22.51%), sightings during socialisation were rare (6.81%) (Fig.9). Similar pattern is observed from hourly observation records of different behavioural types (Fig. 10). Socialisation of Dolphins were recorded between 4-5 PM only. Records of movement dominated each hour of observation while reaching its peak at 3PM. Foraging and Resting reached their peak towards 4 PM and just after 4PM respectively. Calves were observed during movement only. Adult age group was prevalent in displaying foraging behaviour.

 Preliminary analysis of F-Pod data shows that detection of Dolphins across eight sites of deployment was highest during early morning at 6 AM and towards evening between 6-7 PM. Detection of Dolphins was lowest between 1-2 PM during afternoon. Visual

observation conducted at the sites of deployment in the time interval between 12-5 PM shows maximum sighting of Dolphin between 4-5 PM.

Associated fauna survey

a.   Boat surveys (Shoreline) for associated fauna: In February boat-based surveys for associated fauna was conducted in 39.07 km stretch between Barh to Teghra (Figure 14). Around 60 km stretch is still remaining which will be covered in the upcoming field session.
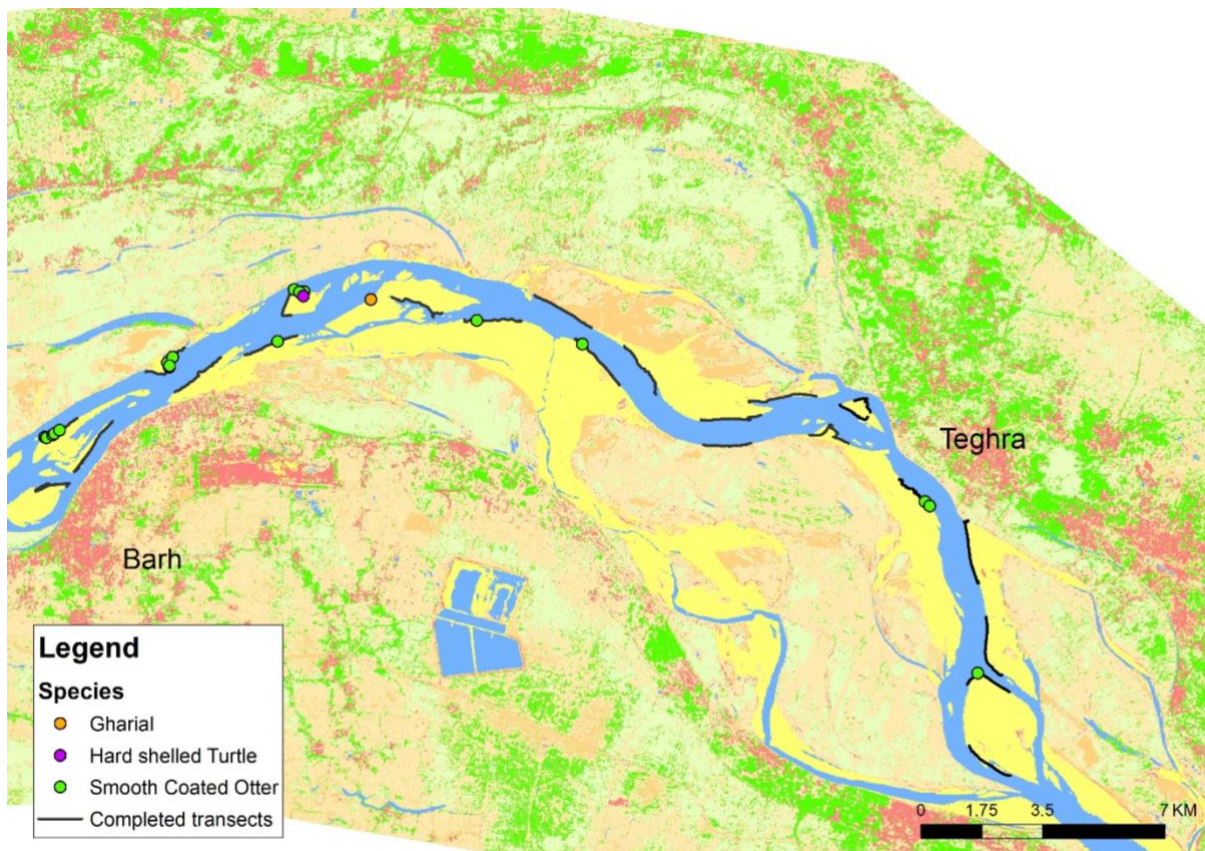
Figure 14 Map showing sightings of Associated fauna in the intensive sites of Bihar

b.   Sign Survey: Six transects were completed in this month with effort of 12.17 kms. In last two months a total of 22 transects were completed covering 43.68 km. 36 more transects are remaining which will be covered by first 2 weeks of March.

Table 3 Average encounter rates of signs of species recorded in the intensive site of Bihar

Species	Average Encounter rate of signs	Presence detected in % of transects

Gharial	0.02	4.5
Golden Jackal	14.2	90.9
Hard shell Turtle	0.02	4.54
Nilgai	4.03	68.18
Smooth Coated Otter	0.72	36.36
Wild Boar	2.56	40.9

Plankton Sampling

We have completed 70 kms of phytoplankton sampling from Barh to Chakour Ghat. During sampling we have collected the water sample by dragging the plankton net in every 5 kms for 3 minutes at the boat speed of (3 to 5) km/hr and preserved the samples approx. (2003ml) in a 250 ml air tight vial by adding (8 to 10) ml of 5% (V/V) formalin (Appendix 12). Also, during the sampling, we have recorded the turbidity of water with the help of Secchi Disk in every sampling point (Appendix 14) .

Dolphin Depth Preference Experiment

Based on river depth profiling in 2 km segment in Barh, we have deployed four F-Pods in four different depths with their hydrophones placed in depth (2, 3, 5, and 6m) respectively under the water for 5 days (16th to 21 February, 2024) with a minimum inter-FPOD distance of 600 meters established to minimize data overlap. All four depths were categorised as low, medium, deep and very deep respectively for analysis purposes (Figure 15). The analysis is ongoing.
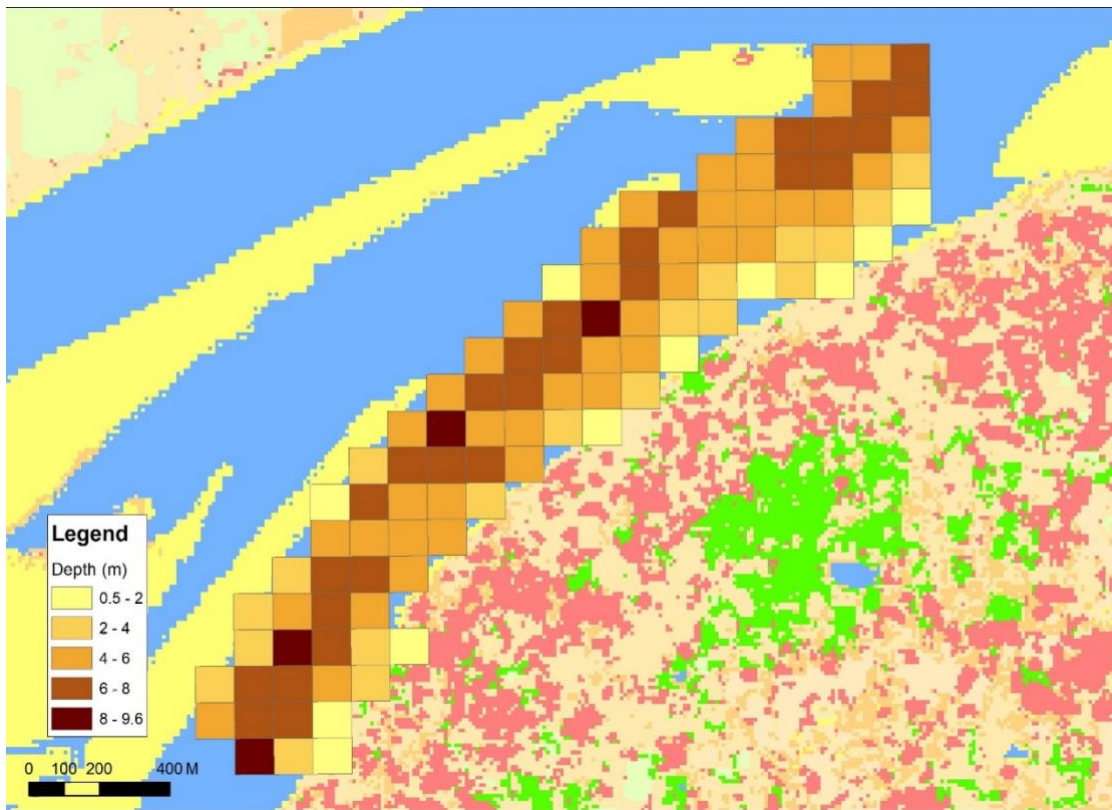
Figure 15 Map showing depth profile of river stretch in the intensive site of Bihar.

West Bengal

Point count for estimating Ganges dolphin Population

Our study aimed to better understand dolphins' presence and abundance. To do this, we used Acoustic technology and direct observation. We placed FPODs, which continuously log dolphin clicks. It was placed every 2 kilometres along a 10-kilometre stretch of River (Figure 16).

We also set up cameras on the shore facing the water. These cameras were there to catch any boats or ships passing near our PODs, as this kind of human activity can affect the dolphins and their environment.

Alongside the cameras and PODs, we had a person stationed on the nearest bank, carefully watching the area around the PODs. This observer noted when dolphins surfaced and their dive pattern.

Lastly, we had a boat equipped with a towed FPOD. The boat team, consisting of researchers on different platforms, conducted surveys across the study area three times to ensure we gathered as much information as possible.

By combining these different methods, we aimed to get a complete picture of the dolphin population in the area, how they behave in different habitats diurnally, and how human activities might influence their acoustic characteristics and distribution.

Figure 16 Point count locations alongwith the FPODS deployment in the intensive site of West Bengal

Associated Fauna Survey

a.   **Boat surveys (Shoreline) for associated fauna:** Boat-based bank assessment, spanning 3 segments and 59.52 km, uncovered 44 species, featuring 3 mammals (Indian Grey Mongoose, Flying Fox, Northern Plains Langur), 1 herpetofauna (Water Monitor), and 40 bird species. No threatened species were reported during these comprehensive assessments.

b.   **Sign survey for aquatic- associated mammals:** The foot transect-based sign survey encompassed 6 transects covering 18.2 km (Figure 17), identifying 52 species, including 6 herpetofauna (Water Monitor, Bengal Monitor, Rat Snake, Skittering Frog, Cricket Frog and an unidentified Agamid), 5 mammals (Bengal Fox, Jackal, Jungle Cat, Mongoose), and 42 bird species. None of the mammals were sighted directly. All assumptions are based on their passive signs.

Figure 17 Sign survey transects in the intensive site of West bengal

Fish sampling and Market survey
The fish sampling study identified 42 fish species using cast and gill nets, with *Salmostoma bacaila, Puntius sophore*, and *Apocryptes bato* being the most abundant. Notably, no invasive species were detected among the total catch. The sampling efforts totalled approximately 107 hours, 1508 cast net throws and 418 gill net deployments.

Market survey conducted across 14 local markets from Ghatal to Bakshi documented 67 fish species, categorized into fisheries, marine, river, pond, and river/marine types. Among these, 6 were non-native, while 57 were native species.

Plankton sampling
Plankton sampling was carried out over 32 km in the Roonarayan area and 20 km in the Katwa area. Analysis is underway, and specific findings have yet to be reported.

Vegetation sampling
Riparian vegetation sampling involved the assessment of 17 points/sites (Figure 18) along both Rupnarayan and Mundeswari rivers. It revealed a rich biodiversity with 79 riparian vegetation species, including 21 trees, 8 shrubs, and 50 herbs. The study

recorded 58 herb species, 22 tree species, and 6 shrub species, focusing on distinguishing between endemic, native, invasive, and non-native categories.
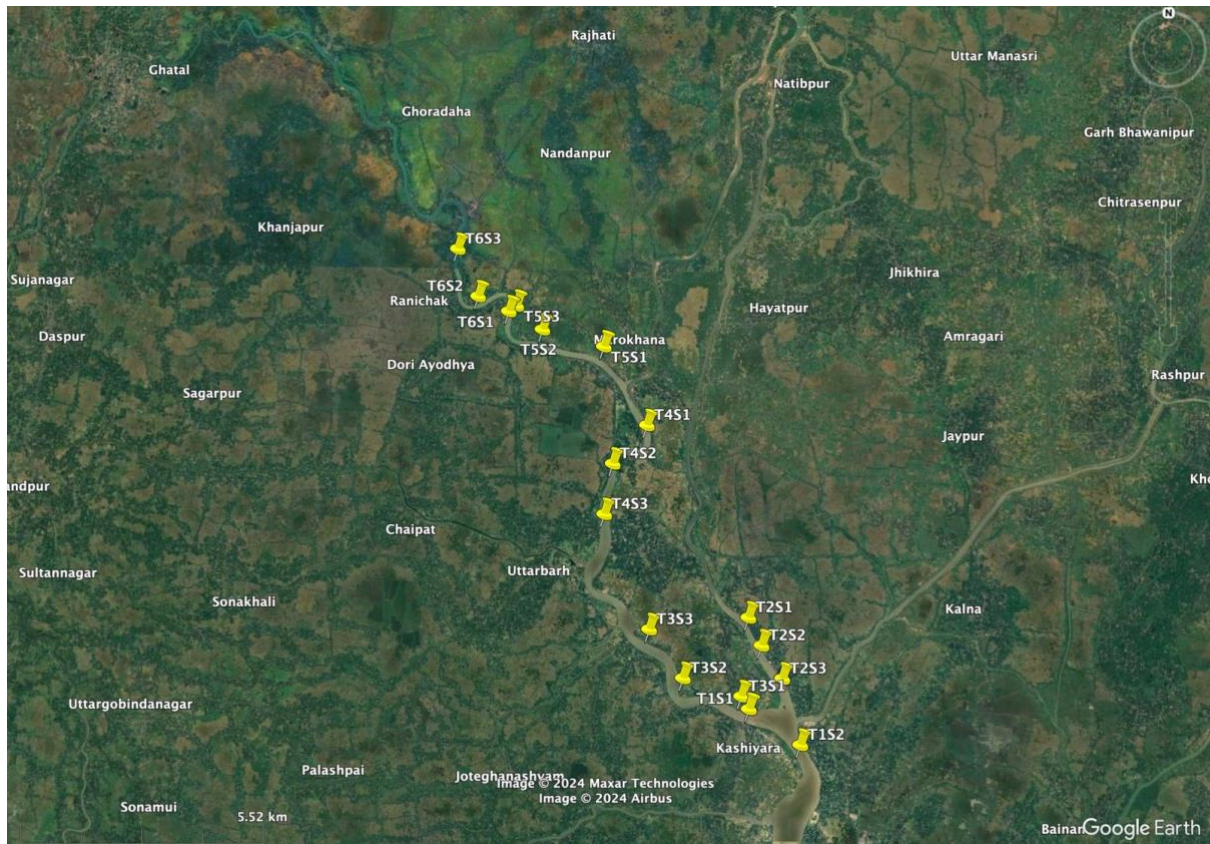
Figure 18 Vegetation sampling in the intensive site of West Bengal

Pinger efficacy on Ganges dolphin

The pingers deployed were at a regular interval of 50 m along the net length following the practice of local fishermen 60m Gillnet. From now on, an FPOD was deployed parallel to the net, referred to as the pingered FPOD. This FPOD was deployed 100 m away from the centre of the net to avoid logging of loud sonic pings that might mask the clicks of the Ganges River dolphins around it. The FPOD was kept active 24 hours a day until the experiment was completed. There were two control FPODs 400 m away (one upstream and one downstream) from the pingered net, where the effect of pingers is near negligible, hereinafter referred to as non-pingered FPODs (Kolipakam et al. 2022). The experiment began with a 'pre-treatment' phase for 7 days, where the FPODs and net were in their respective positions, but the pingers were not deployed. This was followed by a 'treatment' phase for 18 days, where the pingers were active. Subsequently, the pingers were removed, and FPODs were monitored for dolphin presence in the 'post-treatment' phase of 10 days.

Social Surveys

a. Fishing community socio-economic survey

This survey was conducted to understand the socio-economic conditions, fishing practices, cultural beliefs around the river and perceptions of endangered Ganges river dolphins. After initial identification of the participant, river dolphin identification cue card were used. If the participant is able to identify the River Dolphin without assistance, interview is commenced further.

Study sites 1: Katwa in Purba Bardhaman and Berhampore in Murshidabad district of West Bengal. A total of 97 fishermen were interviewed extensively over a period of 2 months with a semi-structured questionnaire. All of the participants were from traditional fishing communities, categorised by scheduled caste certificates. Average age was 43 years and monthly household income was between 10-11 thousand rupees. Most of the fishermen use monofilament gill nets in the rivers. Some of other findings are summarised below (Table 4):

Table 4: Responses of Fisher community of West Bengal

Questions	Response categories		
Fishing occupation	Annual riverine= 58%	Seasonal riverine= 34%	Fishing and extra jobs= 8%
Beneficiary schemes	Availed Fisheries schemes= 33%	Availed other government schemes= 70%	
Personal experiences during fishing	Encountered Ganges river dolphins= 99%	Harmful fishing practices in rivers= 72%	River dolphins breaking away from nets= 57%
River dolphin threats	Personally used dolphin products (oil)= 16%	Decline in river dolphin presence= 75%	

Study sites 2: Bakshi in Howrah district. Fishermen interviews are ongoing.

b. Stakeholder meeting and awareness workshop

a. In Farakka and Katwa, West Bengal, Ganges river dolphin and Fisheries scheme awareness workshop was organised in collaboration with the Block level fisheries office.

Fisheries extension officers from the respective Blocks addressed approximately 150 riverine fishermen participating in the events.

b. Awareness workshops were organised in two Government Colleges at Katwa and Diamond Harbour in collaboration with the state Forest and Fisheries department. Approximately 250 students and faculties participated in the workshop.

c. Two sensitization workshops were conducted at riverside BSF camps of 115 Battalion, stationed on the banks of the river Padma, Murshidabad district. BSF officers and jawans were familiarised with the Ganges river dolphin and its significance in river ecology. Their potential role in the river dolphin conservation efforts was discussed during the meetings. There were 40 participants, including both sessions.

d. Wildlife week and Environment day 2023: a series of 10 Mission Life themed outreach events were organised in West Bengal and Bihar. As a concluding event, environment Day was celebrated at Diamond harbour in collaboration with the State Forest Department.

     i.   Katwa ghat cleaning

     ii.   Art workshops at Kolaghat

     iii.   Art workshop at Kalna

     iv.   Recycled craft workshop in Kolkata survey boat

     v.   Plantation drive at Diamond Harbour

     vi.   River dolphin conservation cycle rally at Kahalgaon

     vii.   Awareness walk along Ganga ghat at Malda

     viii.   River dolphin echolocation game at Old 16 Mile School Malda

     ix.   Katwa college workshop

     x.   Diamond Harbour college workshop

e. River dolphin interactive games and awareness talks were held at 21 riverside schools. Approximately 800 students participated in these games. There were series of games designed with reference to river dolphin ecology and conservation challenges. Students were involved in the games and various river dolphin features were highlighted via them. All of the participants were presented with River dolphin themed gifts as reinforcement for joining river and riverine species conservation. Students shared their feedback after the workshops.

f. Door-to-door outreach activities were conducted across the fishing villages of Katwa, Purba Bardhaman district. Approximately 1250 riverine households were sensitised with river dolphin information. Followed by this, awareness announcements were played in

each of these villages along with pamphlet distribution. Awareness workshops were organised for primary and secondary school students of these villages, simultaneously.

Assam

Double Observer Dolphin Survey
Three repeated double observer dolphin survey was carried out in 30 Km stretch from the Kirakata to Sarighat Bridge (Appendix 15). The average population estimation of Ganges River Dolphin in this stretch was 32 Ganges River Dolphin.

Dolphin survey in Kaziranga National park and Tiger reserve

A total of 136 Km of entire Kaziranga tiger reserve area was covered in 3 Day starting from 12th March to 14th March. A total of 10 Researchers and 4 Forest staff take part in the survey. During the survey Dolphin population estimate, Habitat assessment and Associated fauna were recorded from the area.

The least count of Ganges River dolphin recorded was 32 Dolphins.

Point count for estimating Ganges dolphin Population
Point Count exercise using Acoustics and visual observation was completed in 30 Km Grides (Appendix 16). A total of 16 FPODs were deployed to cover between the Sarighat bridge and the Kerakata(30Km) stretch. ~1000 hrs of acoustic data were collected.

Fish Sampling
Fish sampling of the selected 30 Km stretch was completed with a record of around ~27 species being recorded from the field (Appendix 17). The sampling was done with using gill nets of mesh size 15,25,50,70. Each net is deployed for 2 hrs each. Cast net 15,25,30 mesh size was used for a total of 44 times each sampling point with one 2 Km stretch having 2-3 sampling points. The total effort of 256 Hrs of Gill netting and 1000 hrs of cast netting

Pinger efficacy on Ganges dolphin
In order to understand how Ganges River dolphin will behave in response to an acoustic deterrents (Pingers) a in very narrow river where the option of dolphin movement from the deterrents effect is very limited, we have selected a site near Nagarbera in Kulsi river where there was a good number of Ganges River dolphins. In case of Kulsi River the average river width is not more than 60 m (Appendix 18).

The dolphin pingers, which are an acoustic alarm used to deter the Ganges River dolphins, were developed by the Future Oceans group (www.futureoceans.com). The pingers, when tied to fishing nets, emit sounds that are in the audible range of the Ganges River dolphins which aids in helping them perceive the presence of nets, which are otherwise difficult for them to echolocate. Early study by Kolipakam et al., 2022 have shown a 90% decline in the presence of dolphins near the pinger nets.

The experiment consists of 3 phases Pre-Treatment, Treatment and Post-Treatment. Where 9 days each of Pre-treatment and Post -treatment data was collected and 20 days of Treatment data was collected using Passive acoustic monitoring device FPODs and Visual observation was carried out for all the phases covering a ∼ 34 days.

The total experiment days consist of **40 Days** with acoustic data collection of **~960 Hrs**. Starting from December 17th and ended on 25th January.

Data analysis is ongoing.

Pinger- Fish experiment
To check the effect of Acoustic deterrents pingers will have any effect on the fish catch as the Fishers are the one who will be using the pingers. The dolphin pingers, which are an acoustic alarm used to deter the Ganges River dolphins. The pingers, when tied to fishing nets, emit sounds that are in the audible range of the Ganges River dolphins which aids in helping them perceive the presence of nets, which are otherwise difficult for them to echolocate.

Two sampling sites, within a selected area was chose with similar habitat. The distance between both sites were 600 m. Each site on the basis of pinger activity will became active site and inactive site. The setup was altered in alternative days. The fishing data was recorded according to the type of fishing the fishers were doing which consist of Gill netting and Drag netting.

Early study by Kolipakam et al., 2022 have shown that there was no variation in the fish catch in both active pinger nets and inactive pinger nets.

Three set of experiment was carried out between 28th Dec,2023 - 6th Jan,2024, 10th Jan to 18th Jan, 2024 and 25th Feb-4th March, 2024 each consist of 8 Days each with two set up in Guwahati and 1 setup in Goalpara (Appendix 19). A total of 32 fisher man 19 boats

were participated in this experiment with an ∼ 562 nettings being done on field, the total with an effort of total ∼**3005 hrs.** Data analysis is ongoing

Depth utilization by Ganges River Dolphin
The Riverine habitat which inhabited by Ganges River dolphin in India is facing low water depth throughout its ranges and the situation further exacerbated in lean season which led to the stranding of dolphins and also high chance for mortality. Still now we know from visual record that dolphins are presented up to 2 m water depth. With this experiment we are trying to see if "Sufficient" depth of water is available for Ganges River Dolphin will they use different depth differently.

We used Passive acoustic monitoring device FPODs to recorded the dolphin acoustic activity in varying depths. The Pods were kept at different water depth in selected sites with a very good Ganges River dolphin presence. Each set is consisting of 5 days and the distance between the pods was between 500 m to eliminate the overlap of the same dolphin click in the different PODs

A total of **∼ 700** hrs worth of data was collected at varying depths The depth profile was starting from **2 m to 23 m** PODs

Data analysis is ongoing

Community based surveys
Socio- economic questionnaire surveys

The ongoing intensive survey to understand the trends of fishing, and consequently the overall understanding of Ganges River Dolphin, from the view of the stakeholders concerning them, that is, the fisherfolk, was started in the month of December and in still ongoing. Till date, three sites have been completed, Guwahati, Kurua and Kukurmara. The next sites chosen for the survey are Chandrapur, Sualkuchi and Palashbari and in ongoing. A total of 125 participants were interviewed using purposive sampling and later, a trend was analysed. All the participants were male and are primarily fishermen, who were engaged in other activities during the fishing ban season (Appendix 20).

Site 1: Guwahati

A total of 62 fishermen were interviewed in Guwahati, specifically in Rajaduar Ghat, Post Office Colony and Ananda Nagar in North Guwahati, all exclusively engaged in fishing, with a few also doing odd jobs like daily wage labour.

Types of nets used	Percentage
Gill Net	82.2%
Drag Net	59.68%
Cast Net	22.58%
Mosquito Net	**17.74%**
Lift Net	8.06%

It was seen that the most used net in the Brahmaputra River in Guwahati is the Gill Net (table 5). It is concerning to see mosquito nets is still used in Brahmaputra despite the ban. In the month of January, upon interviewing, it was revealed that in the vicinity of Rajaduar Ghat, a significant area is enclosed for fishing using Mosquito Net. Over time, the net is drawn closer, creating a trap for fish and dolphins in the area. The survey revealed that in this particular area, at least 3 dolphins were at risk of being caught in the net. It was also disclosed that just last year, a dolphin was trapped in the net but was later successfully rescued.

Other fishing trends like awareness about the fishing ban season, what they do during that particular time was also recorded (Table 6).

Table 6 Percentage response of fishers on Fish ban season (part 1)

Awareness about the fishing ban period	Percentage
Yes	98.39%
No	1.61%

Table 7 Percentage response of fishers on Fish ban season (part 2)

During the fishing ban period	Percentage
Continue to fish	8.06%
Follow the ban	91.93%

The participants who follow the ban period either shift to other odd jobs or stay at home due to floods during these months (Table 7). It has also came up that most of the fisher sell the catch to the middle men rather selling it directly to the market (Table 8).

Table 8 Fishers response on the market availability

Where the fish caught is sold	Percentage

Sold to middlemen	83.87%
Sold in the market	9.67%
Sold the fish themselves	6.43%

The participants' general awareness about dolphins was also recorded.

Table 9 Fishers general awareness about Ganges river dolphins (Part 1)

Dolphins depredating from nets	Percentage
Yes	48.38%
No	51.61%

Table 10 Fishers general awareness about Ganges river dolphins (Part 2)

Dolphin entangled in net	Percentage
Yes	20.97%
No	79.63%

All participants who reported encountering dolphins entangled in their fishing nets stated that they release the dolphins. In some instances, it was mentioned that the dolphins could free themselves without any assistance.

Table 11 Fishers general awareness about Ganges river dolphins (Part 3)

Used dolphin oil as bait	Percentage
Yes	0
No	100%

Before the ban on oil bait fishing was implemented, some participants noted instances of using oil as bait. Since the ban, there have been no reported occurrences of using oil as bait.

One unique observation from the field was fisherman blocking a specific area for fishing. The group consist of ~30 fisherman. They corral the area using nets (mosquito nets) and bamboos which make all the fishes and even dophins in the area to get entrapped inside this corral, after that they close off the area into an even smaller area and keep fishing inside this closed off area (like scoop fishing). Pervious year and this year also Ganges River dolphin Got entangled in this corral area. The fisher man is aware about the Ganges River dolphin and they try to release the dolphins back into the river if it gets entangled.

It is important such activities be eliminated as the described area has a very good dolphin population presence.

Site 2: Kurua

A total of 21 participants were interviewed in Kurua. Like in Guwahati, all the participants were male and were primarily engaged in fishing.

Table 12 Responses of Fishers from Kurua

Types of nets used	Percentage
Gill Net	57.14%
Lift Net	19.05%
Mosquito Net	14.28%
Cast Net	9.52%
Hook Fishing	4.76%

Awareness about the fishing ban period	Percentage
Yes	100%
No	0

During the fishing ban period	Percentage
Continue to fish	9.52%
Follow the ban	96.48%

Where the fish caught is sold	Percentage
Sold to middlemen	76.19%
Sold the fish themselves	23.81%

Dolphins depreding from nets	Percentage
Yes	52.39%
No	47.62%

Dolphin entangled in net	Percentage
Yes	14.28%
No	85.71%

Used dolphin oil as bait	Percentage
Yes	0
No	100%

Site 3: Kukurmara

A total of 42 participants were interviewed in Kukurmara, who were primarily fishermen who fished in Kulsi River. Among them, four participants engaged in fishing activities in both the Kulsi and Brahmaputra Rivers.

Table 13 Responses of Fishers from Kukurmara

Types of nets used	Percentage
Cast Net	71.42%
Gill Net	14.28%
Hook Fishing	9.52%
Mosquito Net	4.76%

Awareness about the fishing ban season	Percentage
Yes	100%
No	0

According to the participants, there are no fishing bans imposed in the Kulsi River throughout any season, allowing them to continue their fishing activities uninterrupted. However, they were aware of the fishing ban enforced in the Brahmaputra River. Those participants who usually fished in the Brahmaputra River shifted their fishing activities to the Kulsi River during the ban period.

Where the fish caught is sold	Percentage
Sold to middlemen	88.01%

Sold the fish themselves	11.90%

As previously studied, there has been a significant decline in the number of dolphins observed in the Kulsi River. During interviews, participants disclosed that in areas where fishing activities occur, dolphins are no longer present. According to the participants, this decline occurred gradually over a period of 6-7 years. While participants displayed a general awareness of dolphins, questions regarding net entanglement and dolphin depredation were deemed irrelevant in this particular context, as the existence of dolphins in this small river has nearly become a thing of the past. However, when asked about oil bait fishing, participants asserted that there has never been any usage of oil as bait in the river.

Used dolphin oil as bait	Percentage
Yes	0
No	100%

Capacity Building Program for The Frontline Staff of Kaziranaga National Park And Tiger Reserve On Ganges River Dolphin and Associated Species Monitoring

Stakeholder meeting and awareness workshop

a.   The awareness programs were conducted in five districts of Assam namely Kamrup, Nagaon, Morigaon, Sonitpur and Barpeta covering 22 schools. About 86 teachers and 2083 student participated in the awareness program.

b.   World environment day was celebrated and 40 people participated from Forest staff of Biswanath Wildlife Division, Nagaon Wildlife Division, Western Assam Wildlife Division and Eastern Assam Wildlife Division.

c.   Wildlife week was celebrated and 30 student participated from Students from Uttar Guwahati Girls High School and 30 forest staff of Guwahati Wildlife Divsision and North Kamrup Forest Division participated.

d.   Fishery awareness programs was conducted in total 7 districts of Assam which included 16 fishery society. Total 32 fishery officers and 814 fishers participated.

e.   A training workshop was carried out in the Bomaraguri, Assam for the forest staff of the Kaziranga national park by the CAMPA-Dolphin project supported by MoEFCC and CAMPA and conducted by Wildlife Institute of India (WII). The workshop was conducted for the forest staff of Kaziranga National Park on Ganges River dolphin population

estimation and to make them aware about the river dolphin conservation importance people from 5 divisions were participated in the workshop. The workshop was carried out on 19th Feb. The program was attended by WII team, Forest Department staff and members from Aaranyak. A total of 38 participants in the workshop. The workshop ran for 1 days, with first half with theoretical class of the sampling protocols for the different activities that are part of the Dolphin estimation exercise and second half with in field practices of dolphin population estimation and hands on training for equipment's.

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Appendices
Appendix 1: Visual observation during point count estimation of Ganges dolphin

Appendix 2: Photographs of the Mammalian species seen during the survey: 1) Nilgai; 2) Indian Jackal

Appendix 3: Photographs of the dead specimen of Snakes seen during the survey: 1) Checkered Keelback; 2) Indian Rat Snake

Appendix 4: Photographs of some avian species observed during the survey. From top to bottom: Huge congregation of Black-headed and Brown-headed gull, A Great cormorant with a Painted stork in the background, a small group of Common redshanks, and the Indian Skimmer seen resting and foraging.
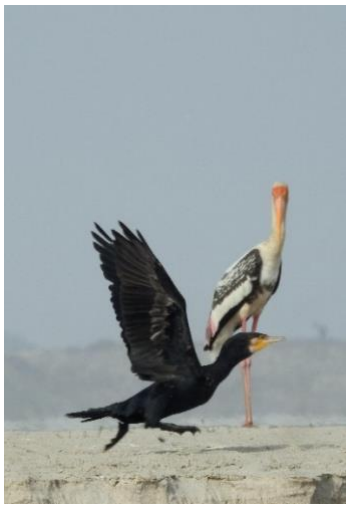
Appendix 5: Photographs of the bird species possibly poisoned seen during the survey

Appendix 6: Photographs of the different parts of turtle skeleton seen during the survey

4)

Appendix 7: Photographs of the animal dens observed, as well as the snare traps found during the survey

5)

Appendix 8: List of Fishes of Ganga that were recorded in Fish Market Survey

S.No	Scientific Name	Common Name	Native/Invasive
1	*Cyprinus carpio*	Common carp (Chinese)	Invasive
2	*Rita rita*	Geghra	Native
3	*Cirrhinus mrigala*	Mrigal (Nayan)	Native
4	*Clupisoma Garua*	Bekri	Native
5	*Eutropiichthys vacha*	Charkhi	Native
6	*Salmophasia bacailia*	Chilwa	Native
7	*Gonialosa manmina*	Fulwa	Native
8	*Mastacembelus armatus*	Bam	Native
9	*Sperata seenghala*	Tangari	Native
10	*Sperata aor*	Tengari	Native
11	*Johnius gangeticus*	Pathari	Native
12	*Catla catla*	Catla	Native
13	*Chanda nama*	NA	Native
14	*Labeo bata*	Bata	Native
15	***Botia rostrata***	**Tel**	**Native**
16	*Mystus vittatus*	Pitara, Desi tengari	Native
17	*Mystus bleekeri*	NA	Native
18	***Bagarius Bagarius***	**Goonch**	**Native**

*Mastacembelus armatus L*ength- 28 cm Weight- 52 gm

Botia rostrate Length- 15 cm Weight- 30 gm

Gonialosa manmina Length- 11 cm Weight- 12.3 gm

Appendix 8: List of Fishes of Ganga that were recorded in Fish sampling

S.No	Scientific name	Common Name	Local Name	Origin	Conservation Status
1	Salmophasia bacaila	Large razorbelly minnow	Chilwa	Native	Least concern
2	Johnius gangeticus		Pathri	Native	Data deficient
3	Sperata aor	Long whiskered catfish	Tenghra	Native	Least concern
4	Sicamugil cascasia	Yellow tail mullet	Rodha	Native	Least concern
5	Barilius barna	Barna baril	Chilwa	Native	Least concern
6	Crossocheilus latius	Gangetic Latia	Lizha	Native	Least concern
7	Gonialisa manmina	Ganges river gizzard shad	Phulai	Native	Least concern

8	Psilorhymchus balitora	Balitora minnow	Botha	Native	Least concern
9	Chanda nama	Elongate glassy perchlet	Chanda	Native	Least concern
10	Rita rita		Gheghra	Native	Least concern
11	Botia rostrate	Gangetic loach	Rani	Native	Vulnerable
12	Ailia coila	Gangetic Ailia	Suti	Native	Near threatened
13	Gagata cenia	Clown catfish	Titki	Native	Least concern
14	Eutropiichthys vacha		Charkhi	Native	Least concern
15	Schistura savona		Girri	Native	Least concern
16	Sperata seenghala	Giant RIver catfish	Tenghra	Native	Least concern
17	Mastacembelus pancalus	Barred Spiny Eel	Goonji	Native	Least concern
18	Glossogobius giuris	Tank Goby	Bulwa	Native	Least concern
19	Mastacembelus armatus	Marbled Spiny Eel	Bam	Native	Least concern
20	Aspidoparia morar		Chilwa	Native	Least concern
21	Paracanthocobitis botia	Zipper Loach	Girri	Native	Least concern
22	Labeo calbasu	Orangefin Labeo	Karonchi	Native	Least concern
23	Mystus bleekeri	Day's mystus	Kattina	Native	Least concern
24	Rhinomugil corsula	Corsula	Advar	Native	Least concern
25	Chagunius chagunio		Patharchata	Native	Least concern
26	Puntius conchonius	Rosy barb	Puthiya	Native	Least concern
27	Cyprinus carpio	Common carp	China	Invasive	Vulnerable
28	Labeo bata		Bata	Native	Least concern
29	Oreochromis niloticus	Nile tilapia	Kawai	Invasive	Least concern
30	Botia lohachata	Yoyo loach	Rani	Native	Least concern

31	Labeo rohita	Rohu	Rohu	Native	Least concern
32	Eutropiichthys murius			Native	Least concern
33	Labeo boga		Boga	Native	Least concern
34	Puntius sophore	Pool barb	Puthiya	Native	Least concern
35	Mystus cavasius	Gangetic mystus	Kattina	Native	Least concern
36	Wallago attu	Helicopter catfish	Pahina	Native	Least concern

Wallagu attu

Salmophasia bacaila

Barilius barna

Sicamugil cascasia

Labeo bata

Aspidoparia morar

Appendix 10 Species Recorded during Riparian Vegetation Survey

S.no	Scientific Name	Common Name
1	*Ranunculus sp*	Buttercup
2	*Achyranthus aspera*	Prickly chaff Flower
3	*Ageratum conyzoides*	Billygoat Weed
4	*Agremone mexicana*	Bermuda grass
5	*Alternanthera philoxeroides*	Alligator weed
6	*Alternanthera sessillis*	Joy weed
7	*Alternanthera sp*	
8	*Althaea officinalis*	marsh mallow
9	*Apium groveolens*	Chinese celry
10	*Argemone mexicana*	Bermuda grass
11	*Brassica rapa*	Sarsso
12	*Brassica sp*	
13	*Callisia repense*	Turtle vine
14	*Coccinia grandis*	Ivy Gourd
15	*Coriandrum sp*	
16	*Crepis sancta*	Holy hawksbreard
17	*Crepis sp*	
18	*Croton bonplandianum*	Ban tulsi
19	*Cynodon dactylon*	Doob grass
20	*Cyperus rotundus*	Motha
21	*Cyperus sp*	
22	*Cyperus sqarrosus*	Bearded Flatsedge
23	*D. aegyptium*	
24	*Dentella repens*	Creeping Dentella
25	*E. uniloides*	
26	*Eclipta alba*	False Daisy
27	*Eclipta prostata*	Brhingraj
28	*Eclipta sp*	

29	*Eichhornia*	
30	*Eichornia crassipes*	**Water hyacinth**
31	*Eragrotis barrelieri*	**Mediterranean lovegrass**
32	*Gnaphalium sp.*	
33	*Gnaphalium sylvaticum*	**Cudweed**
34	*Grengia maderaspatana*	**Madras carpet**
35	*Helianthus sp*	
36	*Hydrocotyle*	
37	*Hydrocotyle sibhto*	**Indian pennywort**
38	*Hydrocotyle sp.*	
39	*Hypochaeris sp*	
40	*Lippia alba*	**Bushy Mat Grass**
41	*Longifolia grass un ID*	
42	*longifoliate grass*	
43	*Medicago sp*	
44	*P hysterophorus*	
45	*Parthenium*	
46	*Persicaria decipiens*	**Slender Knotweed**
47	*Persicaria sp*	
48	*Phyla nodiflore*	**Turkey Tangle Fogfruit**
49	*Poa annua*	**Winter grass**
50	*Ranunculus wild sp*	
51	*Ranunculus wild species*	
52	*Rumex pulcher*	**Fiddle dock**
53	*Sacc. Munja*	
54	*Setaria virdis*	**Green Fpx Taio**
55	*Solanum virginianum*	**Thai-green eggplant**
56	*Spancia sp*	
57	*Trianthema portulacastrum*	**Black pigweed**

58	*Taegetes sp*	
59	*Trianthema sp*	
60	*Trifolium repens*	White clover
61	*Tripidium bangalanse*	Sarpat
62	*Verbascum blattaria*	Moth mullein
63	*Verbascum sp*	
64	*Veronica sp.*	
65	*Youngia japonica*	False Hawksbeard
66	*Ziziphus nummularia*	Jharberi

Poa annua(Winter grass)   *Phyla nodiflore*

Solanum virginianum   *Grengia maderaspatana*

Appendix 11: Photos of Dolphin Estimation using Double Observer Method

Appendix 12: Checklist of species observed during boat survey:

Birds	
1	Asian Open Bill
2	Bar Headed Goose
3	Black stork
4	Brown headed Gull
5	Common Green Shank
6	Common Sand Piper
7	Demoiselle Crane
8	Eurasian Wigeon
9	Gadwall
10	Greater Cormorant
11	Greater Egret
12	Grey Heron
13	Large-billed Crow
14	Lesser Adjutant
15	Little Cormorant
16	Little Egret
17	Marsh Harrier
18	Northern Pintail
19	Northern Shoveler
20	Osprey
21	Peregrine Falcon
22	Pied Kingfisher
23	Pied Kingfisher
24	Red Crested Pochard
25	Red Naped Ibis
26	Ruddy Shelduck
27	Small pratincole
28	White Breasted Kingfisher
29	White-eyed Buzzard

30	Woolly Necked Stork
Reptiles	
1	Gharial
2	Brown Roofed Turtle
Mammals	
1	Golden Jackal

Appendix 13 Showing Plankton net deployment and sample preservation during sampling

Appendix 14: Showing deployment of Secchi Disk at sampling points for measuring Turbidity

Appendix 15: Team dolphin during the Ganges River Dolphin survey

Appendix 16: FPOD Deployment for point count

Appendix 17: Fish team on the field

Appendix 18: Team in Kulsi river During Pinger-Dolphin Experiment

Appendix 19: Team During Fish-Pinger Experiment in Guwahati

Appendix 20: Team conducting Fisherman Questionnaire survey

Appendix 21: Interaction with the Corralling Fisherman and the Net used for the fishing

Appendix 22: Workshop attendees with Kaziranga field Director and members from Wildlife Institute of India

Appendix 23: Community-based participatory research design for Ganges River Dolphin conservation