बिहार सरकार

THE GANGETIC DOLPHIN AND ACTION PLAN
FOR
ITS CONSERVATION IN BIHAR

Department Of Environment & Forests
Government Of Bihar

R. K. SINHA

Shri Nitish Kumar, Hon'ble Chief Minister of Bihar addressing national workshop on Gangetic dolphin at Patna

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I am indebted to Shri Nitish Kumar, Hon'ble Chief Minister of Bihar who gave a high priority to conservation of the Gangetic dolphin considering its ecological and cultural importance. The state government put the dolphin on a very high priority. I am highly obliged to Hon'ble Chief Minister that on my request to get the Gangetic dolphin status of National Aquatic Animal in 2006, he took initiatives and successfully impressed upon Hon'ble Prime Minister, Dr. Man Mohan Singh to declare the Gangetic dolphin as National Aquatic Animal of India in the first meeting of the National Ganga River Basin Authority on 5th October, 2009. A formal notification was issued on 10th May, 2010 by the Ministry of Environment and Forests, Government of India. This attracted the attention of the entire nation and world scientific and conservation communities to save this species.

I am extremely grateful to Hon'ble Chief Minister who decided to constitute a committee for conservation and development of the Gangetic dolphin in Bihar under my chairmanship in the State Wildlife Board Meeting on 20.4.2011.

The then Minister of Environment and Forests, Principal Secretary, Mr. Shubhkriti Mazumdar and the present Secretary, Mr. Dipak Kumar Singh encouraged me to conduct research on the status of the dolphins and their habitats by conducting surveys in the River Ganga and Gandak. I express my deepest gratitude to all of them. I acknowledge support of the wildlife officials, Sri B. N. Jha, PCCF, Sri B. A. Khan, Additional PCCF cum Chief Wildlife Warden, Dr. D. K. Shukla, Additional PCCF, Development, Sri S. S. Choudhary CCF and Chief Executive Officer, Bihar Forests and Wildlife Conservation Society, and the DFOs and field officers of the Department for research and conservation activities for saving the Gangetic dolphins in Bihar.

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Executive Summary

The Gangetic dolphin, *Platanista gangetica gangetica*, is an obligate freshwater dolphin distributed in the Ganga-Brahmaputra-Meghna river basin in India, Nepal and Bangladesh; and also in Sangu-Karnaphuli river systems in Bangladesh. It is one of the only three obligate freshwater dolphins of the world. The Gangetic dolphin belongs to Order Cetacea of Class Mammalia and has been categorized as 'Endangered' by the International Union for Conservation of Nature (IUCN) in 1996. It is included in Appendix I of the Convention on International Trade in Endangered Species of Flora and Fauna (CITES), and in Appendix II of Convention on Migratory Species (CMS). Government of India provided legal protection to this species by including it in Schedule I of the Wildlife (Protection) Act 1972. It was declared as the National Aquatic Animal of India by Honourable Prime Minister, Dr. Man Mohan Singh, on 5th October, 2009.

This document is divided into three sections: Section I contains introduction of river dolphins in general and the Gangetic dolphin in particular including historical and current distribution, habitat preference and conservation status in Chapter 1; scientific account of the Gangetic dolphin including taxonomic status and genetics, physical description, life span and behavior in Chapter 2; threats to the Gangetic dolphins including exploitation, habitat degradation, noise and chemical pollution, and depletion of prey base in Chapter 3. Section II, Chapter 4 contains current status and details of results based on surveys conducted in 2012. It includes study area, survey methods, results etc. Section III, Chapter 5 contains action plans for conservation of the Gangetic dolphins in Bihar.

Present report is based on scientific and systematic continuous surveys in the River Ganga between Sahibganj and Chausa (526 km), and in Gandak from its confluence with Ganga at Patna to as far up as 152 km during October – December 2012. The density of the dolphin in the stretch of Ganga under study was recorded to be 1.52 per linear km, whereas in the Gandak it was 0.55 per linear km.Besides, we recorded other wildlife along the Ganga and Gandak Rivers and their environs: 90 species of birds were recorded in Ganga and 39 species in Gandak. Eight rare and one endangered species of birds were documented from River Ganga, and one rare species from the Gandak River. Altogether twenty five gharials (*Gavialis gangeticus*) including 23 adult, two subadult and one hatchling were sighted in Gandak in the first half of December 2012. We also recorded soft-shell (*Aspideretes gangeticus*) and hard-shell turtles (*Kachuga tecta*), Monitor Lizard, water snakes, Cobra in the rivers. Blue bulls and jackals were commonly sighted. We encountered a herd of Black Buck with one male and four female on the right bank of the Ganga near Dumraon.

There is a serious need to assess and evaluate the current status of the Gangetic dolphin in all the major and minor rivers especially in North Bihar as most of these rivers are unsurveyed. The Mass Awareness Campaign to educate the local people including fishermen and create awareness among different strata of our society including concerned authorities must continue on long term basis as it leaves long lasting good impact on the masses to conserve the rare, endangered, endemic and charismatic megafauna of the Indian subcontinent. The proposed National Dolphin Research Center at Patna will continue scientific researches and conservation efforts on long term basis. Sincere efforts of the state government of Bihar in saving the dolphin from extinction will help survive this species for our future generations.

Contents

SECTION I:
General account of Gangetic dolphins

Chapter 1

Introduction

This Report on Gangetic dolphin and its habitat is an outcome of initiative of Government of Bihar. The Department of Environment and Forests, Government of Bihar constituted a committee vide Notification No. 290 (E) dated the 5th July, 2011 for conservation and development of Gangetic dolphin in Bihar. The committee was assigned the task to submit a detailed report on the dolphin and its habitat. Besides, this report includes Conservation Action Plan for the dolphin in Bihar.

Ganges River dolphins, commonly known as susu, *Platanista gangetica gangetica,* are endemic to the Indian sub-continent and distributed in the Ganges-Brahmaputra-Meghna and Karnaphuli-Sangu river systems of Nepal, India, Bangladesh, and possibly Bhutan (Mohan et al. 1997, Sinha et al. 2000, Smith et al. 2001). There is no credible estimate of range-wise abundance, but the subspecies was listed as "Endangered" in the 2004 IUCN Red List due to a reduction in its historical distribution range and projected declines in population size due to increasing threats (Smith et al. 2004).

There are 88 recognized extant species of cetaceans, out of which 41 species under 21 genera are dolphins (iucn-csg.org, 2013 browsed on May 7, 2013), most of which are exclusively marine, but several species live sporadically or exclusively in freshwater. The majority of the world's dolphins live in saltwater habitats but some are obligate to freshwater. The three obligate riverine dolphin species are: (i) the blind river dolphin, or "susu" (*Platanista gangetica*) live in the Ganges, Brahmaputra and Meghna river systems in India, Nepal and Bangladesh; and in the Indus river system in Pakistan; (ii) the Yangtze river dolphin, or "baiji" (*Lipotes vexillifer*), which lived in the lower and middle reaches of the Yangtze river in China, now extinct, and (iii) the Amazon river dolphin, or "boto" (*Inia geoffrensis*), which is largely distributed in northern South America in the Orinoco and Amazon River systems, and the upper Rio Madeira drainage. The fourth species classified as a river dolphin is the La Plata dolphin, or "franciscana" (*Pontoporia blainvillei*). It is found not only in estuaries but also in coastal waters of eastern South America from 19°S (Brazil) to 42°S (Argentina).

Though the Ganges dolphin was mentioned in the Indian mythological and historical literature, it was brought to the knowledge of the scientific world from the River Hooghly in 1801 by William Roxburgh, Superintendent of the Botanical Garden, Calcutta (Roxburgh, 1801). Anderson (1879) gave an account of distribution range, besides morphology and anatomy of the dolphin, but no account on population status. After more than one hundred years, though, few papers were published with population status in 1980s (Jones 1982, Mohan 1989), apparently these reports are not based on systematic scientific surveys conducted in

the rivers and the population status was probably guess-estimate. Information on ecology and conservation status of river dolphins in India is spatially and temporally patchy.

Researchers of Patna University under the leadership of Prof. R. K. Sinha carried out researches on the Gangetic dolphins in 1980s mainly in the River Ganga in and around Patna under Ganga Basin Research Project sponsored by the Ganga Project Directorate of Government of India. Based on the Final Report of Ganga Basin Research Project submitted in 1988, the Ganga Project Directorate sponsored a separate Dolphin Conservation Project to Patna University in 1991. The researchers conducted surveys in discrete segments in 600 km stretch of the River Ganga from Chausa near Buxar in Bihar to Farakka Barrage in West Bengal near India-Bangladesh border using oar driven country boat during 1991-94. A continuous survey in the Ganga from Patna to Farakka Barrage, and from Allahabad to Patna was conducted in November 1994, and October 1995, respectively; and downstream Farakka Barrage in the Bhagirathi-Hooghly rivers in April 1995 (Sinha 1996, and 1997). During the same period a study was carried out in discrete segments of the upper reaches of the Ganga from Haridwar to Kanpur (approx. 600 km) on gavialis ('Gharial' in local parlance), *Gavialis gangeticus*, and Ganges dolphin by Jiwaji University Gwalior (Behera 1995). Continuous surveys were conducted in Karnali-Girwa rivers from Kachali (15km upstream Chisapani Bridge) on the Karnali gorge in Nepal to Girijapuri Barrage 20 km inside India-Nepal border in 1993 (Smith et al. 1994) and in the River Sarda from Lower Sarda Barrage at Sardanagar to Palya up to which the river was navigable in low water season in March 1994 (Sinha and Sharma 2003a). Later on continuous surveys were conducted in the Ganga in a stretch of over 1800 km from Haridwar at the foothill of the Himalayas, to Farakka near India-Bangladesh border in 1996-98 (Sinha 1999, Sinha et al. 2000). Thus majority of information on river dolphins in India come from several studies carried out by Patna University in middle and lower reaches of the Ganga and its tributaries, and by WWF-India in upper reaches of Ganga and some small tributaries (Sinha et al. 2000, Sinha and Sharma 2003a, 2003b; Behera and Rao 1999). Again, with support of the National River Conservation Directorate, Government of India, Patna University undertook intensive studies from 2001 to 2007 in 500 km stretch of the Ganga in Bihar from Buxar to Manihari Ghat (Katihar). Almost 50% of the total population of the Ganges River dolphin (total population over 3000) is surviving in rivers of Bihar. During the same period, continuous surveys were conducted in the River Brahmaputra, a large river of the Ganges system in India, in the state of Assam by local researchers (Biswas and Boruah 2000; Wakid, 2005, and 2009).

Besides the status survey, we documented various threats the Ganges dolphins were exposed to including directed and incidental killings by the fishermen to extract oil from its blubber to sustain the oil fishery in its distribution range. Also we collected dolphin carcasses from the Ganga and the tributaries in 1980s and 1990s during our studies, tissues of which were analyzed for pollutants like heavy metals, organochlorines including PCBs (Polychlorinated biphenyls), organo-tin compounds, and per-fluorinated chemicals (PFCs) (Kannan et al. 1993, 1994, 1997, Senthilkumar et al. 1999, and Yeung et al. 2009).

One of the projects (Project No. 23) recommended by the IUCN/ SSC Cetacean Specialist Group Action Plan was to develop an alternative to dolphin oil as a fish lure (Perrin 1988). As a part of this investigation, we discovered effective oil from fish scrap as an alternative to dolphin oil (Sinha 2002). Effects of dams and barrages on Ganges dolphins and its prey base in the entire distribution range in India were studied by Sinha (2000) and Smith et al. (2000).

We conducted study in collaboration with the Centre for Cellular and Molecular Biology, Hyderabad, India to establish the evolutionary relationship of the Ganges River dolphin with extinct and extant cetaceans based on comprehensive analyses of the mitochondrial cytochrome b and nuclear interphotoreceptor retinoid-binding protein gene sequences (Verma et al. 2004). Some more related phylogenetic analyses of nucleotide sequences from mitochondrial and nuclear genes were carried out by Cassens et al. (2000), Nikaido et al. (2001) and Yan et al. (2005).

We studied six types of surfacing patterns, of the dolphin at the confluence of the Ganges and Gandak near Patna, which were dependent on age-class and offshore distance of the individual (Sinha et al. 2010a). Studies were conducted on acoustics of the Ganges dolphin in the upper reaches of the Ganga at Narora (Akamatsu et al. 2013). Studies on Gangetic dolphin were also conducted in Nepal and Bangladesh (Kasuya 1972, Kasuya and Haque 1972, Smith 1993, Smith et al. 1998, 2001, 2006 and 2010).

Our constant efforts and untiring strong support of Hon'ble Chief Minister of Bihar, Sri Nitish Kumar led to the declaration of the Ganges dolphin as 'National Aquatic Animal of India' on October 5, 2009 by Hon'ble Prime Minister of India. Despite its importance as the National Aquatic Animal of India, the species is facing severe threats of extinction throughout its distributional range. Under the circumstances, renewed efforts are needed to generate consistent information about the ecological requirements of this species throughout its distributional range, and its response to anthropogenic and natural disturbances, as the basis for the design and implementation of relevant conservation strategies. A Conservation Action Plan for the Gangetic dolphin was prepared for the Government of India in 2010 (Sinha et al. 2010b). Since maximum population of the dolphin is in Bihar and the only protected area for the Gangetic dolphin is in Bihar, the state government desired to have a separate Conservation Action Plan for the dolphin in Bihar. We conducted survey in the main stem of the Ganga both upstream and downstream from Chausa near Buxar to Sahibganj (526km), and in the River Gandak in October – December in 2012 to generate current data on status of the dolphin to prepare this Conservation Action Plan.

Distribution

Historical distribution: Anderson (1879) depicted distribution range of Platanista in the Ganges between longitudes 77° and 89°E from Sagar Island at the mouth of the Ganga to as far up as the rivers were navigable near the foothill of the Himalayas (Figure 1). But the dolphin did not enter the sea at any season. In the Brahmaputra, he stated that Platanista was present "throughout all the main rivers, as far eastwards as longitude 95°E by latitude 27°30'N, frequenting also all its larger streams." Outside the Ganga-Brahmaputra-Meghna River systems, susus are present in the Karnaphuli River (Anderson 1879) and

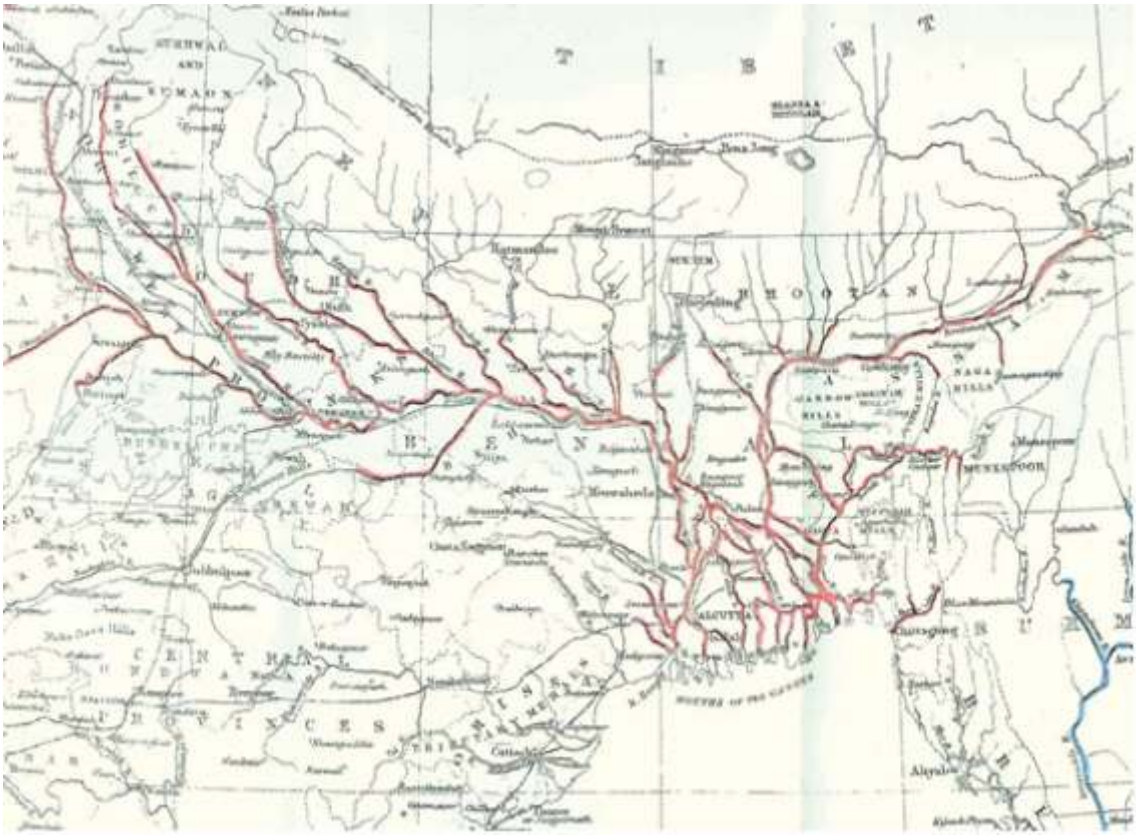

Figure 1: Distribution Map of *Platanista gangetica* (Anderson 1879)

possibly the Sangu River in eastern Bangladesh (Haque, 1976).

Current distribution: The Gangetic River dolphin, susu, (*Platanista gangetica gangetica*) is an endangered species that is distributed in the Ganga-Brahmaputra-Meghna River systems in India, Nepal and Bangladesh; and Sangu-Karnaphuli Rivers in Bangladesh from the deltas upstream to where they are blocked by rocky barriers, shallow water, dams and barrages. These river dolphins prefer areas that create eddy countercurrents, such as small islands, river bends, and convergent tributaries. In the monsoon season, Ganges River dolphins locally migrate to tributaries and then return back to larger river channels in the dry, winter season. They also move along the coast of the Bay of Bengal when monsoons flush freshwater out along the southeastern coast of India (Moreno, 2003).

Kasuya and Haque (1972) recorded susus as far as Dioghat on the Narayani River of Nepal which is 250m above sea level and about 100 km farther upstream than Anderson ever recorded. Shreshtha (1989) reported dolphins in the four main river systems of Nepal: the Mahakali, Karnali, Narayani and Kosi. Susus ascend the Meghna River systems in Bangladesh at least to Sunamganj (Jones, 1982). Susus were also sighted in the River Barak at Silchar in Assam (pers. comm. Paulan Singh) in India (River Barak in India is called River Meghna in Bangladesh). Jones (1982) suggested that the broad plume of freshwater created by the Ganga outflow in the Bay of Bengal may facilitate the dispersal of susus to rivers outside the main Ganga-Brahmaputra-Meghna systems. In 2006 one susu entered in River Burhabalang in the state of Orissa which discharges in to the Bay of Bengal almost

300 km south-west of the mouth of the Ganga. This river is not connected with the Ganga system.

In recent past, dolphin's range in substantial portions of the Ganga system especially in upstream areas has shrunk. For example, no dolphins could be sighted in the 100 km stretch of the River Ganga between Bhimgoda Barrage, at Haridwar, and Middle Ganga Barrage at Bijnor, at the upstream limit of their historical range in the river during a continuous survey in low water season in December 1996 (Sinha et al. 2000). No dolphins have been reported from this segment since then. In recent years, dolphins have not been reported in the Yamuna River above the Chambal River confluence to Tajewala near foothill of the Himalayas (736 km) during the non-monsoon season (Sinha et al, 2000). Historically, dolphins were found year-round in the Yamuna River at Delhi (Anderson 1879), 512 km upstream Chambal confluence. Finally, Ganges dolphins apparently have been extirpated from a 300 linear km segment of the Sone River, above and below the Indrapuri Barrage (at least during the dry season, October-June) and upstream of the Ganga confluence (Sinha and Sharma, 2003b), and 163 km stretch of the Sarda River (River Mahakali in Nepal) during the dry season between Lower Sarda Barrage at Sardanagar in Uttar Pradesh and Upper Sarda Barrage also called Banbasa Barrage at Tanakpur on India-Nepal border in Uttarakhand (Sinha and Sharma 2003a). We did not find any dolphin crossing the Lower Sarda Barrage during flood. No dolphins were observed in the section of the Mahakali River that flows through Nepal (Smith et al.1994).

It is difficult to assess if the extirpations were due to population fragmentation or habitat degradation caused by construction of dams and barrages. But physiographic and hydrologic complexity play an important role in making rivers suitable for dolphins whereas dams and barrages degrade dolphin habitat as they reduce such complexity (Reeves and Leatherwood, 1994).

Importance of the species

The Ganges dolphin is at the apex of the food chain of the river ecosystems, and thus is an indicator of the health of the river ecosystems. It is an endemic and rare aquatic mammal found only in the Indian subcontinent and has been part of our natural aquatic heritage. It is a unique charismatic mega-fauna of the Indian subcontinent and has been given the status of National Aquatic Animal of India on 5th October, 2009. India is the last stronghold with extant populations in the Ganga-Brahmaputra river systems. The species is in peril in Nepal and many parts of Bangladesh. Almost half of the total population of over 3000 of this species is found in the rivers of Bihar. Thus developing a comprehensive action plan to conserve the Gangetic dolphin especially in the state of Bihar is urgently required.

Habitat Preferences

The preferred habitats in rivers are: downstream of shallow places, in narrow places (Kasuya and Haque 1972), narrow and deep sections of river (Pilleri 1970), in deep locations (Bairagi et al. 1997) where the current is weak (Pilleri and Zbinden, 1973-74), in deep water pools (Bashir et al. 2010) off the mouths of irrigation canals, near villages and ferry crossings (Pilleri and Bhatti, 1982; Sinha 1997), downstream of

bridge pilings (Choudhary et al. 2006; Sinha 1997; Smith et al. 2001), downstream of sand bars and sharp meanders, near bathing ghats, cremation ghats (Sinha 1997) and in channels with muddy, rocky substrates (Kelkar et al. 2010). The river dolphins occurred in the same locations preferred by fishermen, and sites with dolphins had a higher biomass of smaller sized fish than area from which they were not recorded (Kelkar et al. 2010). In the area of human activities like bathing and washing ghats, ferry ghats and cremation ghats people throw some eatables which attract the fishes and ultimately the dolphins.

River dolphins are expected to be most vulnerable during the low-water season when habitat is limited and it is therefore important to determine which habitats are preferentially used at this time, so that conservation effort can be focused in these locations.

Conservation Status

This species has been included in Schedule I of the Indian Wildlife (Protection) Act 1972; categorized as Endangered on the International Union for Conservation of Nature (IUCN) Red List; included in Appendix I of the Convention on International Trade in Endangered Species of Flora and Fauna (CITES); and in Appendix II of the Convention on Migratory Species (CMS).

Chapter 2

A Scientific Account of the Species

Taxonomic status and genetics: William Roxburgh, a botanist working in Botanical Garden, Calcutta gave the first scientific description of the Gangetic dolphin in 1801 from the River Hooghli, and named it *Delphinus gangetica* (Roxburgh 1801). In 1828 Rene Lesson adopted a genus based on the Bengali name 'Susuk' and described the species as *Susu platanista*. However, Johann Wagler adapted Platanista as a genus in 1830 and from then onwards it is known as *Platanista gangetica*.

All river dolphins have a peculiar morphology with a characteristic long and narrow rostrum (beak) with numerous prehensile teeth, a low triangular dorsal fin supported by connective tissue, broad and visibly fingered flippers, and a unfused cervical vertebrae (which allows considerable neck movement), making the neck flexible . Their eyes have also been reduced to various degrees (the *Platanista gangetica* even lacks eye lenses and is virtually blind) whereas their echolocation abilities could be more refined than in other cetaceans. Considering the early divergence of the "true" river dolphins within the order Cetacea, these shared features offer an excellent example of convergent evolution despite little genetic connection. Many morphological analyses emphasized the substantial divergence among the four species (Kasuya 1972, and Zhou et al. 1979), and this eventually led to the classification of the four genera in four monotypic families (Pilleri and Gihr 1980, Zhou 1982). Rice (1998) considered each of the four families to contain only a single living species, each endemic to a well-defined and restricted geographic setting. In case of Platanistidae and Iniidae, he designated subspecies. The Platanistidae consists of subspecies: *Platanista gangetica gangetica* (Ganges River dolphin), and *Platanista g. minor* (Indus River dolphin). Guang and Kaiya (1999) observed that the difference between cytochrome b sequence of Ganges River dolphin and Indus River dolphin was very small, which supported that Ganges River dolphin (*P. g. gangetica*) and Indus River dolphin (*P. g. minor*) were probably two subspecies of a single species. They also suggested that among the four river dolphin families, Platanistidae was the earliest divergent clade. Thus, Platanistidae consists of the "blind" dolphins of the South Asian subcontinent: species *Platanista gangetica*, subspecies *P. g. gangetica* (Ganges or gangetic dolphin), and *P. g. minor* (Indus dolphin).

Verma et al. (2004) established the evolutionary relationship of the Ganges River dolphin with extinct and extant cetaceans based on comprehensive analyses of the mitochondrial cytochrome b and nuclear interphotoreceptor retinoid-binding protein gene sequences. The study suggested that *P. g. gangetica*, a toothed cetacean, is significantly closer to Mysticeti (Toothless whales) than to any other group of toothed whales. However, Yan et al (2005) observed that the Platanista lineage is always within the odontocete clade

instead of having a closer affinity to Mysticeti. Nevertheless, they opined that the position of the Platanista is more basal, suggesting separate divergence of this lineage well before the other one. And they agree that they could not resolve with high significance the exact phylogenetic position of Platanista. Nikaido et al. (2001) corroborated the Platanista lineage as ancient. This genus is the only living member of this once diverse clade. The looming extinction of this unique clade should be a major conservation priority.

Physical Description :

Their beaks are distinctively swollen at the tip and are highly elongated with large visible teeth. The female beak is generally longer than that of the male and may curve upwards and to one side. We observed beaks attain 15 to 27 percent of the body length. Both the upper and lower jaw sets of long sharp teeth are visible even when the mouth is closed. We counted about 140 prehensile teeth in both jaws of adult Ganges dolphins; the upper jaws have relatively more teeth. Although narrow and sharp in young, the teeth become worn and flattened with age (Anderson 1879). We noticed rear teeth more flattened in a pregnant dolphin (2.5 m). At the time of birth, the baby was without teeth, but both the jaws had teeth like elevations. The eyes are extremely small openings slightly above the mouth. The species does not have crystalline eye lens thus rendering it effectively blind, although it may still be able to detect the intensity and direction of light. Navigation and hunting are carried out using echo-location. The body is a deep brown colour, stocky in the middle and attenuating to a narrow tail stalk behind the dorsal fin. The dorsal fin is a very low triangular hump located at two-thirds of the body length from the anterior end. The broad flippers have a crenellated margin, with visible hand and arm bones. The flippers and flukes are thin and large in relation to the body size.

Body size is about 2m - 2.2m in males and 2.4m - 2.6m in females. At the time of birth they measure 70cm - 90 cm and weigh between 4 kg to 7.5 kg. While adults usually weigh between 70 kg and 90 kg, an adult pregnant female (2.5 m) caught at Araria in north-eastern Bihar in February 1993 weighed 114 kg. Similarly an adult female (2.4 m) killed in the Ganga at Patna on the 29th of April 2010 weighed 97 kg.

Primitive characters:

Platanista g. gangetica bears some of the very primitive characters not known in other cetaceans, viz. presence of ceacum at the junction of small and large intestine (Anderson 1879), position of testis is much more dorsal compared to other marine cetaceans (testes are extra-peritoneal in terrestrial mammals), male oceanic dolphins have the testes dorsally and much less descended than Platanista; subcutaneous muscle between two layers of blubber (Sinha et al. 2010c). Besides, simple air sacs around nasal passage: accessory air sacs around the nasal passage might indicate that the Palatanista are more primitive than other oceanic dolphins.

Life span/Age:

Not much is known about the longevity of the Gangetic dolphin. The sexual and physical maturity seems to be attained at the age of about 10 or less, and more than 20 years, respectively. The physical maturity is attained when all the intervertebral discs get completely fused with the respective vertebra. Females attain sexual maturity between 170 and 200 cm in body length. At the age of 28 years the male

Ganges dolphin was physically immature (Kasuya, 1972). Anderson (1879) reported a physically mature 211 cm male. We observed a Similarly 238 cm female physically immature and a 250 cm female physically mature. Based on above observations made by several researchers we expect life span of the Gangetic dolphin to be between 40 and 50 years.

Behaviour

The Gangetic dolphin is a solitary animal, but occasionally congregates in groups of three to ten individuals. Mother and calves stay together until the infants are weaned. They are found in loose congregations, especially at the confluences where prey congregate.

The Gangetic dolphins swim and vocalize almost constantly; often they swim on their sides – a method of progression previously unknown among cetaceans (Herald et al. 1969). They exhibit greater preference for the surface than other river dolphins; even when swimming which they do on their sides, they occasionally keep their beaks out of water.

While the dolphins were side-swimming, the pectoral flipper either touched the bottom or trailed about 2 to 3 cm above it. The tail was higher in the water than the head, so that the body was at an oblique angle with respect to the bottom of approximately 10°. If the dolphins were vertical in the water, the head would be bobbing up and down; but since the dolphin is on side, the head motion becomes a lateral sweep over the bottom (Herald et al. 1969). The flippers are thought to have an important tactile function (Pilleri 1970; Pilleri et al., 1976). This probably explains why the flippers almost feel the bottom to identify the habitat by the nature of its bottom.

Surfacing behavior and dive times: Gangetic dolphins surface alone; only mothers and very young calves have been surfacing in near synchrony. We studied the surfacing and diving behavior vis-à-vis several co-variates in the free-ranging Gangetic dolphin where the species showed great diversity in surfacing pattern depending upon several environmental factors and age-class. The surfacing types were significantly dependent on age-class of the dolphins also. The adults and sub-adults were found to have different types of surfacing in different day-hours. The morning (7-10AM) and afternoon (3-5PM) were observed to be feeding hours in the Gangetic dolphin (Sinha et al. 2010a) like *Truncatus truncates* (Shane et al. 1982). The dolphins were following or aggregating in and around the drift fishing nets in shallow zones most probably to steal or catch entangled / escaped fish from the fishing nets (Sinha et al. 2010a). Dive-time in the Gangetic dolphins ranged from 10 to 465 seconds. Dive-time of adult was found to be 129 seconds whereas that of neonate was 59 seconds. (Sinha et al. 2010a).

Dispersal :

During the dry season from October to May, many dolphins leave the tributaries of the Ganga and Brahmaputra systems and congregate in the main channels, only to return to the tributaries the following monsoon. Dolphins were seen 100 km upstream in the River Sone in the flood season in the early 1990s, returning to the main stem of the Ganga after the floods abated in October. They may become isolated in pools and river branches during the dry season (Reeves and Brownell, 1989). Some individuals stay back in pools of the tributaries during the dry season (Pelletier and Pelletier, 1980) and become vulnerable.

Many times such individuals are killed by the local fishermen. In March 2013 two dolphins were rescued from a small River Donk and translocated to the River Mahananda in Kishanganj District in Bihar.

Mating and Birth :

Not much is known about mating systems in Ganges River dolphins. Many times we observed some activities in low water season between March and May which may be considered as mating. We noticed 4-5 adult males chasing one female adult dolphin. It was a vigorous movement with lots of water splashing. After chase was over, one male remained with the female. Nothing was visible inside turbid water but the two were surfacing together vertically few times and both hitting their lower portion with each other. Apparently it was mating and local fishermen also agreed with us. Further studies are needed to provide information regarding their mating behavior. Anderson (1879) reported the gestation period to be 8 to 9 months. Gangetic dolphins bear a single offspring of 70 to 90 cm long. Weaning can begin as early as two months or as late as 12 months, typical time to weaning is at age of nine months. Once offspring have been weaned, they disperse and become independent (Jefferson et al. 2008; Moreno 2003; Nowak 2003; Reeves et al. 2002). Kasuya (1972) estimated the age of sexual maturity to be 10 years or less in both sexes.

The parturition season appears to last for a long time in Platanista, or there might be two peaks, one in early winter (December-January) and the other in early summer (April-May). We sighted 3-4 neonates of the Gangetic dolphin in the River Ganga at Buxar in the second week of November, 2012. Also we noticed good number of newly born calves in the third week of February 2010 and 2012 at Patna. Neonates have been sighted in April and October also. It appears that the parturition takes place between October and April-May.

We found a 70 cm long dead male fetus with placenta attached floating in the River Ganges in April 1987; it weighed 4 kg. While doing necropsy on an adult pregnant dead dolphin (2.5 m long and weighing 114 kg) we found a 57 cm fetus in its womb in February 1993. Apparently it was not mature for birth. We found a dead pregnant dolphin which had collided with a mechanized vessel in the first week of September 2005 in the Ganga at Patna. We noticed the viscera of the dolphin and a 24 cm long and 116gm fetus, attached to mother's womb with placenta, floating in the River Ganga. We collected a carcass of 95 cm long male dolphin whose stomach had only milk; whereas another carcass of 105 cm long male had both milk and remains of immature insects and shrimps in its stomach. Probably the later one was preparing for weaning.

Food and feeding :

Gangetic dolphins are catholic feeders and feed on several species of fishes, invertebrates (Sinha et al. 1993), and possibly turtles and birds. The dolphins have been observed chasing and preying upon surface dwelling fish species such as *Rhinomugil corsula* called Aruari in local parlance. On some occasions it was noticed that they drive fishes to a particular area for community feeding. Also they grovel their prey in mud bottom of rivers.

Chapter 3

Threats to the Gangetic dolphins

The threats to the Gangetic dolphin are diverse, longstanding, and very difficult to assess or manage. These dolphins are endangered mainly due to human activity and the multiple threats including directed or incidental catch; construction of dams, barrages and embankments; strikes with vessels; chemical pollution from domestic effluents, agriculture, industry, mining, and health sector; noise pollution due to underwater explosions and vessels; and deforestation leading to heavy load of silt and overall competing demand of freshwater for irrigation in the entire distribution range in Indian subcontinent. It requires adequate water flow and water quality in rivers; these are the basic elements of suitable habitat and are needed by the animals to support their physical health, mobility, and ability to forage efficiently and find prey.

The future of the Gangetic dolphins is intimately tied to the region's water security. South Asia has approximately 25% of the world's human population but only 4.5% of its renewable water resources (Babel & Wahid 2008). The average population density in the India's Ganga Basin is 581.4 /km^2 whereas in Bihar is 1102/km^2 compared to the world's average population density 13.3/km^2; thus the Ganges basin in general and Bihar in particular is one of the most densely populated areas in the world.

Human – Dolphin Conflict:

Directed killings :

In its entire distribution range, more so in Bihar, the species is facing threats to its existence due to poaching. Deliberate killing of the Gangetic dolphins is believed to have declined in most areas but still occurs at least occasionally in the middle Ganges (Sinha 2002), for their meat and oil, which is used as liniment and fish attractant. With very low population of the species in rivers, even a few catches will have devastating effects on long-term survival of this endemic species.

Incidental catches :

Mortality in fishing gears, especially monofilament nylon gillnets, is a severe problem for Gangetic dolphins throughout most of their range. They are particularly vulnerable because their preferred habitat is often in the same location as the fishing grounds. A specific problem is that, because dolphin oil is highly valued as a fish attractant, fishermen have a strong incentive to kill any dolphins found alive in their nets and even to set their nets strategically in the hope of capturing dolphins, which is "assisted incidental capture" (Sinha 2002).

Though the Gangetic dolphin was given legal protection in India under the Wildlife (Protection) Act 1972, it remained completely ineffective till the end of 20th century. The efficacy of the Act became visualized after the proceedings of the Patna High Court (CWJC No. 5628 of 2001). However, some of the fishermen continue to use dolphin oil by preference. During continuous survey in the Ganga in Bihar in November 2012 we encountered couple of fishermen fishing with dolphin meat and oil at Sultanganj, just a kilometer upstream of the Vikramshila Gangetic Dolphin Sanctuary in Bihar, and one fisherman at

Barh in Patna District. Some fishermen practice oil fishery using dolphin oil at Patna also. After these observations, we organized an interactive meeting on 25th January 2013 with such fishermen in their village near Sultanganj to create awareness, educate and motivate them to save the dolphin. The state government wildlife officials also participated in the meeting.

Field trials have shown that fish scrap oil is an efficient substitute for dolphin oil as a fish attractant (Sinha 2002). We conducted several extension programs to popularize the use of fish scrap oil as an alternative to dolphin oil with the help of an NGO, Wildlife Trust of India (Sinha 2004). Many groups of fishermen from Assam visited our laboratory in the last ten years; the recent one was in 2012, to get training to obtain oil from fish scraps and its use in oil fishery. Such meetings and extension programs to popularize the fish scrap oil will help in saving the species.

Impacts of river traffic :

Injury or death can also be caused by vessel strikes. Currently, cargo steamers carry goods from Haldia to Patna regularly, occasionally traveling up to Varanasi. Large number of mechanized boats operate in the entire stretch of the Ganga in Bihar. Besides, river tourism has recently started between Kolkata and Varanasi. Collisions with these vessels, and the effects of the noise they generate, are a serious problem for dolphins. In the first week of September 2005 we found a mutilated carcass of a female dolphin, viscera and a fetus (24cm long and weighing 116g) attached with placenta, in the Ganga at Patna. During our continuous survey in the Ganga in 2012 we photographed two dolphins, one with broken upper jaw and another with broken lower jaw.

Since this species depends upon echolocation for many of its activities, including foraging, noise pollution may adversely affect their well-being. The Gangetic dolphins were seen to be avoiding the river stretch with heavy traffic in the River Hooghly in and around Kolkata, preferring relatively undisturbed areas where a lower number of mechanized vessels ply (Sinha 1997).

Use of dolphin products :

The fishermen and other riparian people in many areas have traditionally been using dolphin oil for burning and as a liniment (Anderson 1879). Some people regularly eat the meat and in Bangladesh pregnant women consume the dolphin oil (Smith et al. 1998). Currently the dolphin oil is used as fish bait in Bihar and Assam for catching two economically important fish, *Eutropiichthys vacha* and *Clupisoma garua*. Demand for these products creates an incentive for poaching and a disincentive to dolphin conservation.

Habitat Degradation :

All freshwater cetaceans require adequate water flow and water quality within their range; these are the basic elements of suitable habitat and are needed by the animals to support their physical health, mobility, and ability to forage efficiently and find prey. The constricted nature of riverine habitat, and the inescapable need to share that habitat with humans, increases the vulnerability of these dolphins to bycatch in fisheries and overfishing of their prey.

Effects of dams and barrages :

Construction of dams and barrages in the Ganges River system has prevented dolphin migration/dispersal and has led to fragmentation of populations into many sub-populations. It leads to inbreeding and reduces the dolphin gene pool, leading to a loss of genetic diversity and makes the

dolphin population vulnerable. In addition to fragmenting dolphin populations, dams and barrages degrade both upstream and downstream habitats and create reservoirs with high sedimentation and altered assemblages of fish and invertebrates (IWC, 2000).

Construction of at least 50 dams and barrages within the known or suspected historical range of the Gangetic dolphin (Smith et al. 2000) has dramatically affected its habitat, abundance, and population structure.

The Farakka Barrage has affected the dolphin population in the Ganges as the barrage has not only created a physical barrier for movement of the dolphin but reach of the river has been changed from a lotic to a lentic environment (Sinha, 2000). Luxuriant growth of macrophytes and excessive siltation have eliminated suitable habitat immediately above Farakka Barrage (Sinha, 2000). Increased sedimentation in the head pond has created big sand bar (3 km x 0.3 km) by 2004 (Figure 2). Sediments are trapped behind dams and barrages, and reduce the volume of suspended matter transported downstream, lessening the potential for bars and sand islands to form in the lower reaches of the river. They reduce or eliminate the "freshet effect," which in many wild rivers renews the floodplains and contributes to meandering (Reeves and Leatherwood, 1994).

Figure 2: A sand bar (3 km x 0.3 km) in the head pond of Farakka Barrage in December 2004

Dams and barrages have a number of potential problems including downstream effects on prey caused by changes in flow rate, sediment transport etc (Reeves and Leatherwood, 1994).

Construction of Embankments:

It causes sediments deposit in the river bed instead of on the floodplains, thereby eliminating or reducing the extent of the eddy-counter currents where dolphins are generally found (Smith et al. 1998). The embankments also restrict access of riverine fishes to floodplain habitat critical to their reproduction and growth (Boyce 1990). Approximately 3,500 km of embankments have been constructed in the Ganges main stem and Gandak, Burhi Gandak, Bagmati, Kamala, Yamuna, and Son tributaries in Bihar (Mishra 1999). Dolphins were apparently extirpated from at least 35 km of the Punpun tributary of the Ganges after embankments were constructed in 1975 (Sinha et al. 2000).

Irrigation :

Excess extraction of the river water for irrigation has lowered water levels throughout the species range and has threatened suitable habitat in the Ganges. The long-term implications of the reduction of dry-season flow in the Ganges are catastrophic for the survival of the dolphins.

Pollution

Chemical Pollution :

The concentrations of fertilizer and pesticide residue, and industrial and domestic effluents are very high in the Ganges River. The effects of such pollutants may be deleterious to dolphin populations, and pollutant loads are expected to increase with industrialization and the spread of intensive modern agricultural practices (Smith and Reeves 2000a).

About 1.5 million metric tons of chemical fertilizers and about 21,000 tons of technical grade pesticides are dumped annually to the Ganges-Brahamaputra river system in India in 2002-2003. Concentrations of polychlorinated biphenyls (PCBs), hexachlorocyclohexane (HCH), chlordane compounds, and hexachlorobenzene (HCB) in the Ganges River dolphin blubber, muscle, kidney, liver and prey collected from stomach of the dolphins collected during 1987 through 1996 from the River Ganges in and around Patna, India were determined (Kannan et al. 1993, Senthilkumar et al. 1999). Kannan et al. (1997) determined concentrations of butyl-tin compounds in dolphins, fish, invertebrates and sediments collected from the Ganges in and around Patna. Total level in dolphin tissues was up to 2000 ng g-1 wet wt, which was about 5-10 times higher than in their diet. Butyl-tins induce immune-depression in dolphins and also in human. A recently discovered micro-pollutant, perfluorinated compounds (PFCs), was assessed in tissues of the dolphin carcasses collected from the Ganges in and around Patna (Yeung et al. 2009).

Noise Pollution :

As most of the dolphin activities depend on echo-location, noise pollution in rivers caused by mechanized boats and other vessels, seismic tests and other developmental activities, interferes and adversely affects dolphin's natural behavior.

The depletion of prey base

The sustained and heavy exploitation of small fishes of rivers by the wide spread use of the mosquito nets may affect the prey base of the Gangetic dolphin. While the rate of renewal of this resource is remarkable, there is no data on abundance estimates, and further research is required to establish this threat.

It is suggested that future management strategies include population abundance monitoring, further research on bycatch mortality, awareness campaigns and involvement of local people in dolphin conservation program, protection of dolphins that migrate through high-use areas in the rainy season, and legal consequences for purposeful dolphin killing.

SECTION III:
Report on Current status

Chapter 4

Dolphin Surveys in the Ganga and Gandak rivers

Continuous dolphin surveys, both upstream and downstream, were conducted both in the Ganga and Gandak rivers in Bihar during October to December 2012. Major objectives of the continuous surveys were to generate current data/ information on status of the Gangetic dolphins and their habitat in the River Ganga and Gandak in Bihar which were required to develop conservation action plans for the same.

Study area

The study area in the Ganga extended from Patna to Sahibganj (located on right bank of the Ganga) about 11 km downstream Maniharighat (located on left bank of the Ganga); and Patna to Chausa near Buxar covering a total distance of 526km one way. The survey in the River Gandak could be conducted from Gandak-Ganga confluence at Patna to Tengarahi ghat (Mangalpur), Gopalganj covering a total distance 152km one way.

Survey methods

Statistically robust and standardized density and population estimates are necessary to know the conservation status and to monitor trends of river dolphin population worldwide (Reeves and Leatherwood 1994, IWC 2000, Smith and Reeves 2000). In the absence of a robust method, direct counts in discrete river sections have generally been conducted (Smith and Reeves 2000). Capture-recapture analysis of photo-identified animals is commonly used to estimate abundance of cetaceans (Hammond 2009). This method relies on capturing images of uniquely marked animals; the proportion of identified individuals recaptured during subsequent sampling events is then used to estimate population abundance (Borchers et al. 2002). This method has substantial limitations for the survey of Platanista spp. because (1) Tropical rivers such as the Ganges are often turbid as they carry heavy loads of silt and therefore underwater photography is almost impossible, (2) these animals are extremely difficult to photograph as they surface alone, unpredictably, for about one second or less and they seldom approach boats or vessels, and (3) they lack a prominent dorsal fin and the individuals rarely possess any readily identifying marks or features (Braulik et al, 2012). In an earlier survey, not a single individual could be identified from 1200 photographs of Gangetic dolphins taken during that time (Smith & Reeves 2000). During 2012 surveys in the River Ganges, we took about one thousand photographs of susu, of which three had identifying features: upper jaw and lower jaw of two individuals were broken, and a deep cut in the dorsal fin of the third.

The primary challenge to the application of line or strip transect methods in the Indus, Ganges and Brahmaputra Rivers is that rivers are very shallow and survey vessels are restricted to traveling down or up the thalweg (the line that follows the deepest part of the river) along a single curving transect that periodically approaches alternate banks as the river meanders. A thalweg transect survey unavoidably samples unrepresentative habitat as it passes through areas with higher densities, and in addition the animals are unlikely to be uniformly distributed in the surveyed strips (Braulik et al. 2012).

Transects running from bank to bank, perpendicular to the flow, are used for line transect surveys of cetaceans in the Amazon River (Vidal et al. 1997, Martin & da Silva 2004), but in the comparatively shallow, sand-bedded, South Asian rivers navigational constraints preclude this approach. A single transect parallel to, and a standard distance from, the river banks has also been used for strip transect surveys in the Amazon (Vidal et al. 1997, Martin & da Silva 2004) and for adapted line transect surveys on the Yangtze River (Zhao et al. 2008), but this is not possible on South Asian rivers as channel width changes rapidly and vessels cannot maintain a standard distance from the banks due to shallow depths (Braulik et al. 2012). In the Ganges and tributaries, we followed the direct count method suggested by Smith and Reeves (2000).

The downstream survey was started on 25th October from Patna to Sahibganj, using a mechanized country boat. There were five technical personnel, besides three boatmen and one cook and one helper in the survey team. It took four days in completing the stretch of the Ganga from Patna to Sahibganj. The upstream survey from Sahibganj started on 29th October early morning. On our invitation Dr. Fernando Trujillo, an internationally acclaimed river dolphin scientist from Colombia working on Amazon – Orinoco River dolphins in South America joined the survey team during upstream survey from Sahibganj to Buxar. Dr. Fernando had worked with us in the Ganga during 1995-96 also. The other team members continued upstream survey up to Chausa (Buxar), and downstream survey to Patna. The same team surveyed the River Gandak but due to thick fog the survey could not be completed in the entire length of Gandak, and the team returned from Tengarahi ghat (Mangalpur), Gopalganj.

Besides, dolphin we recorded wild mammals, avian fauna and reptiles associated with the rivers.

Results

Gangetic Dolphins :

The dolphins were sighted throughout the stretch of the Ganga barring few segments between Sahibganj and Kahalgaon, Mokama and Patna and Patna and Chausa. Dolphin population in the River Gandak was more scarce. Details of the dolphin sightings in the Ganga and Gandak are shown in Table 1, 2 and 3, respectively. More sightings were recorded during upstream survey because of average boat speed in Ganga was 6.45 km per hour whereas in downstream survey the same was 11.95 km per hour. Thus survey team got more time for dolphin sightings during upstream survey.

In some segments like Patna-Mokama, and Mokama-Munger, the Ganga flows through two major channels. At Khajekalan

ghat of Patna, Ganga divides into two major channels, one passes along right bank through Fatuha and another along left bank via Chechar and Mahnar and both channel rejoin downstream Bakhtiarpur. The stretch of left channel is 45km. After flowing for about 20km, the river again divides into two major channels at Barh, one along right bank towards Mokama for 30.5km, and the another channel flows towards north for 3-4km and turns east along left bank towards Simariaghat. The two channels rejoin just upstream Simariaghat. After Simariaghat the Ganga flows for about 8-10km in single channel and again divides into two channels, one along left bank and another along right bank and both rejoin at Munger. The left channel was surveyed during downstream survey and the right channel during upstream survey to get comprehensive dolphin count in the river.

During upstream survey in the Ganga we had to float in some segments of the river in dark after sunset due to logistic constraints. Also we had one interactive meeting with fishermen at Kahalgaon in early morning on 30th October before starting the dolphin survey, and same day media people interacted with us at Bhagalpur. This delayed our arrival at Sultanganj, the camp site. In other stretches, relatively longer distance took more time to arrive at camp site. The distance covered in dark has been depicted in the table 1. Out of total distance of 526.7 km, we were in dark in 5 km before arriving at Kahalgaon, 8 km before Sultanganj, 6 km before Mokama and 10 km before arriving at Bakhtiarpur between Mokama and Patna. Accordingly the dolphin population and density have been calculated.

Gandak was flowing very fast which resulted in average boat speed of only 3.93km per hour during upstream survey.

Dolphin presence was recorded throughout stretch of the Ganga, with best count of 756 (range 736 - 781 $\pm$ Std. Dev. 2.12), and average encounter rate at 1.52 dolphins per linear km was sighted. Similar density was recorded in the same stretch in November-December 2004 and 2006 by us. The Gangetic dolphin abundance was positively influenced by river depth, mid-channel sand bars, meanders, eddy counter currents and hydro-geomorphology complexities. Maximum density of 2.22 dolphins per linear km was recorded in Vikramshila Gangetic Dolphin Sanctuary between Kahalgaon and Sultanganj, followed by Sultanganj – Mokama segment (1.76 dolphin per linear km), and Patna – Chausa segment (1.48 dolphin per linear km). The minimum density (1.12 dolphins per linear km) was in Mokama – Patna segment. Eighteen neonates were sighted in the entire stretch of Ganga in the first week of November 2013; 4-5 were only near confluence of the River Thora at Buxar.

In the Vikramshila Gangetic Dolphin Sanctuary (VGDS), a protected area, in about 60 km stretch, dolphin density was 2.22 dolphins/km. Besides the VGDS, ten segments, with equally or more densely populated dolphins, were identified in the Ganga during upstream survey, viz. 6 km stretch downstream Maniharighat (16 dolphins), the habitat characteristics of the river channel was wide single straight with several sand bars; 6 km stretch at Karhagola (17 dolphins), the river stretch was wide single straight and braided; 6km at Kosi confluence (10 dolphins), the river stretch

was wide single straight and braided; 12 km stretch between Sultanganj and Bariarpur (34 dolphins), the river stretch was wide single straight with sand bars; 30 km stretch between Munger and Hamzapur village (83 dolphins), the river channel was narrow, deep and between the islands; and 18 km stretch from Simariaghat upstream (34 dolphins), the channel was between the islands; 12 km in and around Fatuha (14 dolphins), River Punpun joins Ganga at Fatuha, the channel was between the islands; 24 km from Digha Bridge to upstream Danapur (45 dolphins), the river channel was wide single, deep and straight with a large meander; 24 km stretch from Sone confluence to upstream Ghaghara confluence in and around Doriganj, Chapra (63 dolphins); the channel was wide single straight and with sand bars; and 12km stretch from Buxar to Karmnasa confluence at Chausa (36 dolphins), a rivulet called Thora joins Ganga at Buxar, and the channel of the Ganga is wide single with large meanders. These segments need special attention of government officials and other conservation activists for protection of the dolphins. Out of 89 segments, each of 6km, no dolphin was encountered in four segments, i.e. only in 4.5% segments. Thus dolphin distribution in Ganga in Bihar is almost continuous and not patchy (also see Annexure 1).

About one thousand large sand mining mechanized boats operate in and around confluence of River Sone round the clock throughout the year. The large number of mechanized boats have been found to be dangerous for the dolphins as two dolphins with broken jaw, one upper jaw and another lower jaw, and the third one with deep cut in dorsal fin were captured in our camera in this area.

Continuous survey in the Gandak was conducted in 152 km in the first and second week of December, 2012. Regulated flow in the river due to the Gandak Barrage at India-Nepal border at Trivenighat near Valmikinagar. and high gradient in the stretch under survey resulted in fast flow with high suspended particulate matter in the river. This also resulted in less hydro-physiographic complexities in the stretch under survey. Under the circumstances the river had less dolphin habitats compared to the Ganga. As the river channel was narrow, there were less chances of missing the dolphin in the river. In the River Gandak the dolphin density (0.55 per linear km) was almost 1/3rd that of Ganga (1.52 dolphin/km). The best count of the dolphin in upstream survey in 152km stretch was 84 (range 80 - 92 $\pm$ Std. Dev. 0.76). No neonate was sighted in Gandak.

Though the density of dolphin in the Gandak was thin compared to the Ganga, the dolphin distribution was almost continuous as only in two segments, out of 25 segments, each of 6km, no dolphin was encountered, i.e. dolphin was encountered in 92% segments of the River Gandak. Choudhary et al. (2012) recorded dolphin only in 40% segments in the Gandak River. However, they did not mention length of the each segment.

In the Gandak we identified two segments with relatively more dolphin population. 12km stretch from village Sabalpur upstream to village Sikarpur (15 dolphins) in and around Hajipur, and 12km stretch from Dumri Bridge upstream (11 dolphins).

Other wild animals :

One family of 5-6 smooth coated otters, *Lutra perspicillata*, was sighted in VGDS between Sultanganj and Bhagalpur during earlier surveys. However, in the current survey only burrows of the otters were sighted but not the animals. One small herd (one male and four females) of Black Buck, *Antilope cervicapra*, was observed on the river floodplain near Dumraon. Blue Bulls, *Boselaphus tragocamelus*, and jackals, *Canis aureus*, were common along the Ganga in Patna – Buxar stretch (Table 6).

Monitor Lizards, *Varanus bengalensis*, were commonly sighted on the river bank with natural vegetation throughout the stretch. We sighted 25 gavialis, 'gharial' in local parlance, in the River Gandak; 22 were adult, one hatchling and two sub-adults. The only predator that may have rivaled the dominance of Gangetic dolphin in their distribution range is the gharial, *Gavialis gangeticus*, a critically endangered exclusively riverine and fish eating crocodile with a highly modified long snout. Both Hard-shell turtles, *Kachuga tecta*, and Soft-shell turtles, *Aspideretes gangeticus*, were sighted in the rivers. As reported by the local fishermen, a large number of soft-shell turtles were poached in the Ganga at Patna during April-May, 2013. Organized smugglers are operating for these turtles in this area. Reportedly the turtles are smuggled to Kolkata or Siliguri after sun-drying the same. A number of water snakes, *Xenochrophis piscator* (Schneider), were sighted in the Ganga. One big size cobra snake, Naja naja, was found crossing the Ganga downstream Fatuha (Table 6 and 7).

Avian Fauna :

Avian fauna in and along the River Ganga and Gandak are rich and highly diversified. We recorded 90 species of birds belonging to 66 Genera and 29 families in and along 526 km of the River Ganga (Table 4). In 152 km of the Gandak River we encountered 39 species of birds belonging to 31 genera and 18 families (Table 5). Only one endangered species Greater Adjutant (*Leptotilus dubius*) and nine rare species: Caspian Tern (*Sterna caspia*), Black-tailed Godwit (*Limosa limosa*), Peregrine Falcon (*Falco peregrinus*), Greater Spotted Eagle (*Aquila clanga*), Brahminy Kite (*Haliastur indus*), Common Shelduck (*Tadorna tadorna*), Pied Harrier (*Circus melanoleucos*) Indian Cormorant (*Phalacrocorax fuscicellis*), Great White Pelican (*Pelicanus onecrotalus*) were recorded from the Ganga whereas three rare species, Pied Harrier (*Circus melanoleucos*), Indian Cormorant (*Phalacrocorax fuscicollis*) and Common Shelduck (*Tadorna tadorna)* were found in the Gandak.

Physico-chemical characteristics of Ganga and Gandak water :

During the survey in October-November in Ganga and in December in Gandak we estimated the physico-chemical characteristics of Ganga and Gandak water at different locations depicted in Table 9 and 10. Besides, we also measured depth and river velocity which is shown in Table 8

Average Ganga water temperature was 25.78 (range 23-28°C, S.D. 1.72), pH was 8.3 (range 8.1-8.6, S.D. 0.15), Conductivity 322.7 µS/cm (range 301-403, S.D. 31.28), turbidity 51.78 NTU (range 9-103, S.D. 33.71), Dissolved Oxygen 6.73 mg/l (range 6.15-7.75, S.D. 0.5), Total Hardness 143.56mg/l

(range132-157, S.D. 7.35), Chloride 11.81mg/l (range 5.77-25.49, S.D. 5.49), Nitrate Nitrogen 0.103 mg/l (range 0.059-0.306, S.D. 0.079), Phosphate 0.035 mg/l (range 0.021-0.051, S.D. 0.009), Sulphate 21.75 mg/l (range 17.56-27.44, S.D. 2.7).

Maximum depth of 12.25m and velocity of 1.14m/second was recorded at Kahalgaon, followed by 7.68m depth and 0.81m/sec velocity at Buxar, 4m depth and 0.78m/sec velocity each at Patna and Sultanganj, respectively. The minimum depth of 1.22m and velocity of 0.58m/sec were recorded at Mokama.

Thus the physico-chemical characteristics of Ganga water were found to be suitable for river bio-productivity. Based on our observation of different higher vertebrates, apparently the River Ganga is productive and sustains rich species diversity in the stretch of Bihar. However, oil fishery using dolphin oil and poaching of turtles and birds are matter of great concern.

SECTION III:
Conservation Action Plans

Chapter 5

Objective 1: Scientific Research and Monitoring

Description: The whole state of Bihar lies in the Ganga basin where the basin is very complex network of rivers and rivulets, especially in the North Bihar. The occurrence of dolphins is heterogenic in the basin. Most of the tributaries are yet to be surveyed. It is important to conduct surveys in the rivers, not yet surveyed, to estimate the abundance and population dynamics (relative abundance and population structure) of the dolphins. The rivers already surveyed and the 'critical areas' (the stretches in the rivers that contain healthy breeding dolphin populations with long term survival potential) identified must be surveyed and monitored regularly.

Action Points

(a) Survey and monitoring of dolphin population in the unsurveyed rivers within two years.

(b) Survey and monitoring of River Ganga, especially identified 'critical stretches' annually.

(c) Assessment and characterization of dolphin habitats in larger rivers, viz. Ganga, Gandak, Kosi, etc. in next three years.

(d) Identification of various threats the dolphins are facing in different rivers within two years.

(e) Study the movement and dispersal pattern of the Gangetic dolphin to assess its home range using modern technology in next five years.

(f) Study and monitoring of bio-accumulation of toxic chemicals in dolphin tissues.

(g) Conduct basic research on biology of the dolphin, viz. natural breeding, prey base and feeding, social behavior of the dolphin.

(h) Conduct a study on mortality of river dolphin throughout the river stretch to identify the causal factors and find out remedial measures.

Objective 2: Protection of the dolphin and its habitat

Description: It is important to protect the dolphin from being killed intentionally or accidentally. As maximum death of dolphins is in fishing sector, the existing fishing practices need to be reviewed and also there take place a need for development of fishery management plan making fisheries sustainable and reducing risk to the dolphin and other aquatic wildlife. Rivers are getting polluted mainly from domestic effluents, and toxic chemicals from health and agriculture sectors in Bihar. Solid municipal wastes are being dumped in the Ganga at almost all the cities and towns. Similarly the brick kilns along banks of rivers are dumping their solid wastes in rivers. Declining flow

in rivers is a matter of serious concern. Such activities and issues are adversely affecting the dolphin habitats in rivers and also associated habitats like floodplains.

Action Points

(a) Sensitizing and training the field staff of forest department for protection of Gangetic dolphins. (Regular)

(b) Gather intelligence on dolphin oil fishing and identify the areas with intense dolphin oil fishing. (Within 1-2 years)

(c) Sensitization of police stations and administration along the rivers to take necessary measures in case of dolphin killing. (Regular)

(d) Strict enforcement of laws that prevent use of detrimental fishing methods, especially in the dolphin sanctuary.

(e) Reminding the concerned government agencies from time to time to take necessary steps to reduce pollution load.

(f) Government should take up the issue of declining flow with central government so that environmental flow in rivers is ensured for survival of the dolphin.

Objective 3: Education and awareness

Description: It is essential to educate and create awareness about the importance of the dolphin as a flagship species and our National Aquatic Animal among various strata of society, viz. school and college students, fishermen, policy makers, executives, journalists etc.

Action Points

(a) Didactic materials for public discussion should be produced. Education and awareness programs should be organized in schools and colleges to motivate the students to save dolphins.

(b) Publicity campaigns should be organized for the common mass about the dolphin as a flagship species. Publication of educational brochures in local language, radio and television programs, posters, handbills, workshops etc. should be given high priority as it may help to involve local participants.

(c) Participation of traditional fishing communities and other riparian communities in education and awareness program is essential for dolphin conservation.

Objective 4: Livelihood securities to river dependent communities.

Description: The fishing community in Bihar is very poor and is dependent on fish catch from rivers. Many of their fishing gears are detrimental to the dolphins. Some of them practice oil fishery using dolphin oil and meat as bait for the target fishes. Livelihood securities for the local stakeholders, like traditional fishing community and other river dependent communities are essential for dolphin conservation.

Action Points

(a) The fishing community should be encouraged to use fish scrap oil as

alternative to dolphin oil. The alternative oil should be popularized through Extension Program.

(b) 'Dolphin Watch' and eco-tourism program at different locations may be initiated with appropriate guidelines and environmental safeguards. The State Tourism Department may play nodal role in this exercise. It will help generate livelihoods for the local fishermen / boatmen, and help in community involvement in dolphin conservation. They should be provided financial help through 'Micro-financing' to buy good quality comfortable boats for tourists and dolphin watchers.

(c) Capacity building and skilled enhancement to such communities will be a great help to them.

(d) Some of the fishermen should be encouraged to get engaged in fish-culture/aquaculture and for this also they should be provided financial help.

(e) The initiative like 'Briksh Mitra' in Bihar is getting popular. Similarly, 'Dolphin Mitra' may be initiated and promoted. It will help in documenting the accidental killings of dolphin which is otherwise difficult in unorganized fishery in rivers.

(f) Conduct a socio-economic survey of people's dependence on river resources and apply the results to dolphin conservation programs.

Objective 5 : Capacity building of officials and staff.

Description: The frontline and field protection staff are not well exposed to the Gangetic dolphins. They do not have adequate knowledge of biology, behavior, habitat preference, rescue and translocation, and status survey of the dolphin. Government should deploy dedicated and interested staff for dolphin conservation.

Action Points

(a) The field and frontline staff interested in dolphin program should be identified and given regular training by experts on different issues of dolphin conservation.

(b) They should be taken to rivers where they can get exposure and learn about the dolphin.

(c) Orientation program should be organized to motivate the staff.

(d) Facilitate and support a range of research programs targeted at river dolphins in order to provide a scientific basis for conservation and management actions and capacity building.

Objective 6: Creation / extension / strengthening of Protected Areas

Description: The Gangetic dolphin moves and disperses to more than 100 km especially in floods. During other seasons also they keep on moving and dispersing, though, its home range is not known. There is only one protected area, Vikramshila Gangetic Dolphin Sanctuary, especially for the Gangetic dolphin. As per State Government Notification of 22nd August, 1990 and Gazette Notification, S.O. 382 of 7th August 1991, the sanctuary is in the stretch of the River Ganga from

Sultanganj to KahalgaonHill in middle of the Ganga.The current stretch is about 60 km which seems to be not sufficient for animal like Gangetic dolphin. Moreover, we identified several 'critical stretches', the stretches that contain healthy breeding dolphin populations with long-term survival potential, in the River Ganga during our 2012 survey. The stretches on both sides of the sanctuary, up to Kosi confluence downstream Kahalgaon, and up to Bariarpur upstream Sultanganj were identified as such critical stretches. Similarly, 30km stretch from Munger to Hemzapur village; 24 km stretch from Sone confluence to upstream Ghaghara confluence in and around Doriganj, Chapra; and 12km stretch from Buxar to Karmnasa confluence at Chausa are 'critical stretches' of the Ganga.

Action Points

(a) Vikramshila Gangetic Dolphin Sanctuary may be extended from Bariarpur to Kosi confluence.

(b) The stretch of Ganga from Munger to Hemzapur, stretch from Sone confluence to Ghaghara confluence in and around Doriganj, Chapra; and stretch from Buxar to Karmnasa confluence at Chausa may be considered to be declared as protected areas like conservation reserve.

(c) There is serious need to strengthen VGDS which does not have a management plan, and dedicated well trained field staff.

(d) Improve links between government agencies and other stakeholders in the VGDS and involve local communities in planning stages of VGDS management.

(e) Ensure enforcement of laws and regulations protecting the dolphins (and other fauna) for which the protected area was created.

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Table 1: Summary of Dolphin (*Platanista gangetica gangetica*) sightings in the River Ganga between Sahebganj and Chausa (Buxar) during October – November 2012 (Upstream survey)

Parameters ↓ / Stations →		Sahebganj to Kahalgaon	Kahalgaon to Sultanganj	Sultanganj to Mokama	Mokama to Patna	Patna to Chausa (Buxar)	Sahebganj to Chausa (Buxar): Pooled estimate
Total Survey Distance, in km (including distance covered in dark*)		74.7 (5.0)	63.9 (8.0)	107.2 (6.0)	107.7 (10.0)	173.2 (Nil)	526.7 (29.0)
Total Survey Time, in hours (including survey time spent in dark*)		11.67 (0.78)	10.05 (1.26)	17.85 (1.00)	17.17 (1.59)	24.97 (Nil)	81.70 (4.62)
Average Speed (km/ hour)		6.40	6.36	6.01	6.27	6.94	6.45
Total No. of Dolphins sighted		89	124	178	109	256	756
Total No. of Sightings		54	58	83	52	109	356
Estimate of Dolphin group size	Best	89	124	178	109	256	756
	High	93	130	181	111	266	781
	Low	87	119	173	104	253	736
Mean group size of dolphins	Mean	1.65	2.14	2.14	2.08	2.35	2.12
	Std. Dev.	0.70	1.16	1.97	1.16	1.49	1.45
	Range	1 – 3	1 – 5	1 – 15	1 – 5	1 – 8	1 - 15
Encounter Rate	Dolphin/ hour	8.17	14.11	10.56	7.00	10.25	9.81
	Dolphin/ km	1.28	2.22	1.76	1.12	1.48	1.52
Number of Age-class	Adult	76	81	145	96	184	582
	Sub-adult	11	40	26	9	61	147
	Neonate	2	3	2	1	10	18
	Calf	-	-	-	-	-	-
	Unclassified	-	-	5	3	1	9

Table 2: Summary of Dolphin (*Platanista gangetica gangetica*) sightings in the River Ganga between Chausa (Buxar) and Sahebganj during October – November 2012 (Downstream survey)

Parameters ↓ / Stations →		Chausa (Buxar) to Patna	Patna to Mokama	Mokama to Sultanganj	Sultanganj to Kahalgaon	Kahalgaon to Sahebganj	Sahebganj to Chausa (Buxar): Pooled estimate
Total Survey Distance (km)		175.3	101.3	103.3	65.4	74.0	519.3
Total Survey Time (hours)		15.02	8.08	8.37	5.83	6.15	43.45
Average Speed (km/ hour)		11.67	12.54	12.34	11.22	12.03	11.95
Total No. of Dolphins sighted		193	35	75	85	51	439
Total No. of Sightings		77	22	37	39	26	201
Estimate of Dolphin group size	Best	193	35	75	85	51	439
	High	210	38	83	92	53	476
	Low	182	33	70	81	49	415
Mean group size of dolphins	Mean	2.51	1.59	2.03	2.18	1.96	2.18
	Std. Dev.	1.80	0.73	1.19	1.17	0.96	1.41
	Range	1 - 11	1 - 3	1 - 5	1 - 6	1 - 4	1 - 11
Encounter Rate	Dolphin/ hour	12.85	4.33	8.96	14.58	8.29	10.10
	Dolphin/ km	1.10	0.35	0.73	1.30	0.69	0.85
Number of Age-class	Adult	124	22	48	52	31	277
	Sub-adult	54	12	22	26	16	130
	Neonate	8	1	3	4	2	18
	Calf	5	-	1	2	2	10
	Unclassified	2	-	1	1	-	4

Table 3: Summary of Dolphin (*Platanista gangetica gangetica*) sightings in the River Gandak between Patna and Tengarahi ghat (Mangalpur), Gopalganj during December 2012

Parameters ↓ / Direction →		Upstream survey	Downstream survey
Total Survey Distance (km)		152.0	156.0
Total Survey Time (hrs.)		38.68	15.90
Average Speed (Km/ hour)		3.93	9.81
Total No. of Dolphins sighted		84	36
Total No. of Sightings		61	28
Estimate of Dolphin group size	Best	84	36
	High	92	38
	Low	80	34
Mean group size of dolphins	Mean	1.38	1.29
	Std. Dev.	0.76	0.60
	Range	1 – 4	1 – 3
Encounter Rate	Dolphin/ hour	2.17	2.26
	Dolphin/ km	0.55	0.23
Number of Age-class	Adult	62	28
	Sub-adult	20	7
	Neonate	-	-
	Calf	2	1
	Unclassified	-	-

Table 5: List of Birds sighted and identified during continuous dolphin survey in the River Gandak between Patna and Tengarahi ghat (Mangalpur), Gopalganj during December 2012

Sl. No.	Common Name	Scientific Name	Population Status	IUCN THR 2013
1. Family : Podicipitidae				
1	Little Grebe	*Tachybaptus ruficollis*	C	
2	Great Crested Grebe	*Podiceps cristatus*	MC	
2. Family : Pelecanidae				
3	Great White Pelican	*Pelecanus onocrotalus*	R	
3. Family : Phalacrocoracidae				
4	Little Cormorant	*Phalacrocorax niger*	VC	
5	Indian Cormorant	*Phalacrocorax fuscicollis*	R	
6	Great Cormorant	*Phalacrocorax carbo*	MC	
4. Family : Ardeidae				
7	Little Egret	*Egrtetta garzetta*	MC	
8	Grey Heron	*Ardea cinerea*	VC	
9	Purple Heron	*Ardea purpurea*	MC	
10	Great Egret	*Casmerodius albus*	C	
11	Intermediate Egret	*Mesophoyx intermedia*	MC	
12	Cattle Egret	*Bubulcus ibis*	VC	
13	Indian Pond Heron	*Ardeola grayii*	VC	
14	Black-crowned Night-Heron	*Nycticorax nycticorax*	C	
5. Family : Ciconiidae				
15	Painted Stork	*Mycteria leucocephala*	MC****	NT
16	Asian Openbill	*Anastomus oscitans*	VC	
17	Black Stork	*Ciconia nigra*	MC	
18	Wooly-necked Stork	*Ciconia episcopus*	MC	
19	Black necked Stork	*Ephippiorhynchus asiaticus*	MC****	NT
20	Lesser Adjutant	*Leptoptilos javanicus*	MC***	VU
21	Greater Adjutant	*Leptoptilos dubius*	MC**	EN
6. Family : Threskiornithidae				
22	Black-headed Ibis	*Threskiornis melanocephalus*	MC****	NT
23	Black Ibis	*Pseudibis papillosa*	VC	
24	Eurasian Spoonbill	*Platalea leucorodia*	MC	
7. Family : Anatidae				
25	Lesser Whistling Duck	*Dendrcygna javanica*	MC	
26	Greylag Goose	*Anser anser*	MC	
27	Bar-headed Goose	*Anser indicus*	MC	
28	Ruddy Shelduck	*Tadorna ferruginea*	VC	
29	Common Shelduck	*Tadorna tadorna*	R	

30	Gadwall	*Anas strepera*	VC	
31	Mallard	*Anas platyrhynchos*	MC	
32	Northern Pintail	*Anas acuta*	VC	
33	Common Teal	*Anas crecca*	C	
34	Red-crested Pochard	*Rhodonessa rufina*	C	
35	Ferruginous Pochard	*Aythya nyroca*	MC****	NT
36	Tufted Duck	*Aythya fuligula*	MC	
16. Family : Accipitridae				
37	Black Kite	*Milvus migrans*	VC	
38	Black-shouldered Kite	*Elanus caeruleus*	MC	
39	Brahminy Kite	*Haliastur indus*	R	
40	Eurassian Marsh Harrier	*Circus aeruginosus*	MC	
41	Pied Harrier	*Circus melanoleucos*	R	
42	Long-legged Buzzard	*Buteo rufinus*	MC	
43	Greater Spotted Eagle	*Aquila clanga*	R***	VU
44	Booted Eagle	*Hieraaetus pennatus*	MC	
9. Family : Pandionidae				
45	Osprey	*Pandion haliaetus*	MC	
10. Family : Falconidae				
46	Common Kestrel	*Falco tunnunculus*	MC	
47	Peregrine Falcon	*Falco peregrinus*	R	
11. Family : Phasianidae				
48	Grey Francolin	*Francolinus pondicerianus*	MC	
12. Family : Gruidae				
49	Common Crane	*Grus grus*	MC	
13. Family : Rallidae				
50	White-breasted Waterhen	*Amaurornis phoenicurus*	C	
51	Common Coot	*Fulica atra*	VC	
14. Family : Charadriidae				
52	Little Ringed Plover	*Charadrius dubius*	MC	
53	Kentish Plover	*Charadrius alexandrinus*	MC	
54	River Lapwing	*Vanellus duvaucelii*	C****	NT
55	Red-wattled Lapwing	*Vanellus indicus*	C	
15. Family : Scolopacidae				
56	Black-tailed Godwit	*Limosa limosa*	R****	NT
57	Eurasian Curlew	*Numenius arquata*	MC****	NT
58	Common Redshank	*Tringa totanus*	MC	
59	Marsh Sandpiper	*Tringa stagnatilis*	MC	
60	Common Greenshank	*Tringa nebularia*	VC	
61	Green Sandpiper	*Tringa ochropus*	C	
62	Common Sandpiper	*Actitis hypoleucos*	VC	
63	Temminck's Stint	*Calidris temminckii*	MC	
16. Family : Recurvirostridae				
64	Pied Avocet	*Recurvirostra avosetta*	MC	

17. Family : Glareolidae				
65	Small Pratincole	*Glareola lactea*	C	
18. Family : Laridae				
66	Pallas's Gull	*Larus ichthyaetus*	MC	
67	Brown-headed Gull	*Larus brunnicephalus*	C	
68	Black-headed Gull	*Larus ridibundus*	C	
69	Caspian Tern	*Sterna Caspia*	R	
70	Common Tern	*Sterna hirundo*	MC	
19. Family : Columbidae				
71	Rock Pigeon	*Columba livia*	MC	
72	Eurasian Collared Dove	*Streptopelis decaocto*	MC	
20. Family : Cuculidae				
73	Greater Coucal	*Centropus sinensis*	MC	
21. Family : Alcedinidae				
74	White-throated Kingfisher	*Halcyon smyrnensis*	VC	
75	Pied Kingfisher	*Ceryle rudis*	VC	
22. Family : Upupidae				
76	Common Hoopoe	*Upupa epops*	MC	
23. Family : Hirundinidae				
77	Plain Martin	*Riparia paludicola*	C	
78	Barn Swallow	*Hirundo rustica*	VC	
24. Family : Motacillaidae				
79	White Wagtail	*Motacilla alba*	VC	
80	Yellow Wagtail	*Motacilla flava*	C	
81	Paddyfield Pipit	*Anthus rufulus*	VC	
25. Family : Turdinae				
82	Common Stonechat	*Saxicola torquata*	MC	
26. Family : Passerinae				
83	House Sparrow	*Passer domesticus*	C	
27. Family : Sturnidae				
84	Asian Pied Starling	*Sturnus contra*	VC	
85	Common Myna	*Acridotheres tristis*	C	
86	Bank Myna	*Acridotheres ginginianus*	VC	
28. Family : Dicruridae				
87	Black Drongo	*Dicrurus macrocercus*	C	
29. Family : Corvidae				
88	Rufous Treepie	*Dendrocitta vagabunda*	C	
89	House Crow	*Corvus splendens*	VC	
90	Large-billed Crow	*Corvus macrorhynchos*	C	
Note * = Critically endangered, ** = Endangered, *** = Vulnerable, **** = Near threatened				
VC - very common, C - Common, MC - Moderately common, R - Rare				

Common Names have been incorporated from 'Birds of the Indian Subcontinent (1998) by Richard Grimett, Carol Inskipp and Tim Inskipp and Classification was done according to BNHS-ENVIS Centre, 'Buceros' Vol. 2, No.4 and Vol.3, No. 2, 2001.

Table 5: Compiled list of Birds sighted and identified during continuous dolphin survey in the River Gandak between Patna and Tengarahi ghat (Mangalpur), Gopalganj during December 2012

Sl. No.	Common Name	Scientific Name	Population Status	IUCN THR-2013
1. Family : Podicipitidae				
1	Great Crested Grebe	*Podiceps cristatus*	MC	
2. Family : Phalacrocoracidae				
2	Little Cormorant	*Phalacrocorax niger*	VC	
3	Indian Cormorant	*Phalacrocorax fuscicollis*	R	
4	Great Cormorant	*Phalacrocorax carbo*	MC	
3. Family : Ardeidae				
5	Little Egret	*Egrtetta garzetta*	MC	
6	Grey Heron	*Ardea cinerea*	VC	
7	Great Egret	*Casmerodius albus*	C	
8	Intermediate Egret	*Mesophoyx intermedia*	MC	
9	Cattle Egret	*Bubulcus ibis*	VC	
10	Indian Pond-Heron	*Ardeola grayii*	VC	
4. Family : Ciconiidae				
11	Painted Stork	*Mycteria leucocephala*	MC****	NT
12	Asian Openbill	*Anastomus oscitans*	VC	
13	Black Stork	*Ciconia nigra*	MC	
5. Family : Threskiornithidae				
14	Eurasian Spoonbill	*Platalea leucorodia*	MC	
6. Family : Anatidae				
15	Greylag Goose	*Anser anser*	MC	
16	Bar-headed Goose	*Anser indicus*	MC	
17	Ruddy Shelduck	*Tadorna ferruginea*	VC	
18	Common Shelduck	*Tadorna tadorna*	R	
19	Gadwall	*Anas strepera*	VC	
20	Red-crested Pochard	*Rhodonessa rufina*	C	
7. Family : Accipitridae				
21	Pied Harrier	*Circus melanoleucos*	R	
8. Family : Pandionidae				
22	Osprey	*Pandion haliaetus*	MC	
9. Family : Phasianidae				
23	Grey Francolin	*Francolinus pondicerianus*	MC	

10. Family : Charadriidae				
24	River Lapwing	*Vanellus duvaucelii*	C****	NT
25	Red-wattled Lapwing	*Vanellus indicus*	C	
11. Family : Scolopacidae				
26	Eurasian Curlew	*Numenius arquata*	MC****	NT
27	Common Greenshank	*Tringa nebularia*	VC	
28	Common Sandpiper	*Actitis hypoleucos*	VC	
12. Family : Columbidae				
29	Spotted Dove	*Streptopelia chinensis*	VC	
30	Eurasian Collared Dove	*Streptopelis decaocto*	MC	
13. Family : Cuculidae				
31	Greater Coucal	*Centropus sinensis*	MC	
14. Family : Alcedinidae				
32	Common Kingfisher	*Alcedo atthis*	MC	
33	White-throated Kingfisher	*Halcyon smyrnensis*	VC	
34	Pied Kingfisher	*Ceryle rudis*	VC	
15. Family : Upupidae				
35	Common Hoopoe	*Upupa epops*	MC	
16. Family : Motacillaidae				
36	White Wagtail	*Motacilla alba*	VC	
17. Family : Dicruridae				
37	Black Drongo	*Dicrurus macrocercus*	C	
18. Family : Corvidae				
38	House Crow	*Corvus splendens*	VC	
39	Large-billed Crow	*Corvus macrorhynchos*	C	
* = Critically endangered, ** = Endangered, *** = Vulnerable, **** = Near threatened				
VC - very common, C - Common, MC - Moderately common, R - Rare				

Note: Common Names have been incorporated from 'Birds of the Indian Subcontinent (1998) by Richard Grimett, Carol Inskipp and Tim Inskipp and Classification was done according to BNHS-ENVIS Centre, 'Buceros' Vol. 2, No.4 and Vol.3, No. 2, 2001.

Table 6: Other Riparian fauna and aquatic wildlife in the River Gandak from Chausa (Buxar) to Sahebganj sighted during continuous Dolphin survey (October – November 2012)

Sl. No.	Common name	Scientific name
1	Blue bull	*Boselaphus tragocamelus*
2	Black buck	*Antelope cervicapra*
3	Jackal	*Canis aureus*
4	Soft Shell Turtle	*Aspideretes gangeticus*
5	Hard-shell turtles	*Kachuga tecta*
6	Water Snake	*Xenochrophis piscator* (Schneider)
7	Cobra Snake	*Naja naja*
8	Monitor Lizard	*Varanus bengalensis*
9	Gharial	*Gavialis gangeticus*

Table 7: Other Riparian fauna and aquatic wildlife in the River Gandak from Patna and Tengarahi ghat (Mangalpur), Gopalganj during December 2012

Sl. No.	Common name	Scientific name
1	Blue bull	*Boselaphus tragocamelus*
2	Jackal	*Canis aureus*
3	Soft Shell Turtle	*Aspideretes gangeticus*
4	Hard-shell Turtle	*Kachuga tecta*
5	Water Snake	*Xenochrophis piscator* (Schneider)
6	Gharial	*Gavialis gangeticus*

TABLE 8: HYDROLOGICAL CHARACTERISTICS AT DIFFERENT SAMPLING SITES OF THE RIVER GANGA FROM CHAUSA (BUXAR) TO SAHEBGANJ AND OF THE RIVER GANDAK FROM PATNA TO TENGARAHI GHAT (MANGALPUR), GOPALGANJ DURING CONTINUOUS DOLPHIN SURVEY (OCTOBER - DECEMBER, 2012)

Parameter ↓ / River →	Ganga									Gandak	
Locations →	Buxar	Doriganj	Patna	Mokama	Munger	Sultanganj	Bhagalpur	Kahalgaon	Manihari ghat	Fatehabad	Tengarahi ghat (Mangalpur)
Geographical Coordinates →	25°35'16'' N 83°59'15''E	25°43'56'' N 84°49'10''E	25°37'17'' N 85°12'04''E	2502'310'' N 85°59'27''E	25°22'59'' N 86°27'32''E	25°15'27'' N 86°44'21''E	25°16'33'' N 87°01'13''E	25°15'56'' N 87°13'32''E	25°14'57'' N 87°38'26''E	26°04'12'' N 84°58'02''E	26°33'58'' N 84°26'22''E
Depth (mtr.)	7.68	3.84	4.08	1.22	4.02	1.45	3.14	12.25	3.75	4.08	2.19
River Velocity (m/sec.)	0.81	0.68	0.78	0.58	0.71	0.78	0.54	1.14	0.45	0.86	0.78
River Flow Direction	N82°	N75°	N140°	N97°	N330°	N77°	N98°	N135°	N105°	N170°	N197°

TABLE 9: PHYSICO - CHEMICAL CHARACTERISTICS OF WATER OF THE RIVER GANGA IN THE STRETCH OF BIHAR FROM CHAUSA (BUXAR) TO SAHEBGANJ DURING OCTOBER - NOVEMBER, 2012

Sl. No.	Stations▶ Parameters▼	Buxar	Doriganj	Patna	Mokama	Munger	Sultanganj	Bhagalpur	Kahalgaon	Sahebganj	Mean ± S. Dev.	Range
1	Water Temperature	24.0	23.0	25.0	26.0	28.0	25.0	28.0	27.0	26.0	25.78±1.72	23.0 – 28.0
2	pH	8.5	8.1	8.2	8.4	8.4	8.4	8.4	8.3	8.6	8.37±0.15	8.1 – 8.6
3	Elec. Conductivity (µS/cm)	403	316	331	315	301	306	313	307	312	322.7±31.28	301 – 403
4	Turbidity (NTU)	9	103	42	82	10	55	90	39	36	51.78±33.71	9 – 103
5	Phenolphthalein Alkalinity	5.8	Nil	Nil	4.8	4.0	4.4	4.0	3.0	6.4	3.60±2.27	Nil – 6.4
6	Methyl Orange Alkalinity	150	142	80	134	130	150	134	130	126	130.7±20.88	80 - 150
7	Free CO_2	Nil	9.86	6.16	Nil	Nil	Nil	Nil	Nil	Nil	1.78±3.65	Nil – 9.86
8	CO_3^{--}	11.6	Nil	Nil	9.6	8.0	8.8	8.0	6.0	12.8	7.20±4.55	Nil – 12.8
9	HCO_3^-	144.2	142.0	80	129.2	126.0	145.6	130.0	127.0	119.6	127.07±19.83	80 – 145.6
10	Dissolved Oxygen	7.75	6.65	7.18	6.30	6.70	6.30	6.15	6.70	6.86	6.73±0.50	6.15 – 7.75
11	Chemical Oxygen Demand	8.28	4.83	5.52	5.52	8.28	6.90	8.28	6.21	13.11	7.44±2.51	4.83 – 13.11
12	Total Hardness (as $CaCO_3$)	145	151	143	132	136	157	142	143	143	143.56±7.35	132 – 157
13	Calcium Hardness (as $CaCO_3$)	85	92	90	92	96	92	81	94	98	91.11±5.28	81 – 98
14	$Calcium^{++}$	34.24	36.74	35.91	36.74	38.41	36.74	32.57	37.58	39.25	36.46±2.04	32.57 – 39.25
15	$Magnesium^{++}$	14.58	14.34	12.88	9.72	9.72	15.80	14.82	11.91	10.94	12.75±2.29	9.72 – 15.80
16	Chloride	25.49	5.77	12.99	12.03	10.10	10.10	10.10	9.62	10.10	11.81±5.49	5.77 – 25.49
17	Nitrate - Nitrogen	0.306	0.097	0.072	0.063	0.080	0.063	0.118	0.059	0.067	0.103±0.079	0.059 – 0.306
18	Sulphate	27.44	22.56	20.24	20.49	23.41	17.56	21.95	21.34	20.73	21.75±2.70	17.56 – 27.44
19	Phosphate	0.051	0.028	0.021	0.031	0.034	0.047	0.034	0.030	0.036	0.035±0.009	0.021 – 0.051
20	Total Iron	1.63	12.41	8.07	12.37	3.73	12.09	15.38	9.39	6.71	9.09±4.49	1.63 – 15.38
21	Total Solid.	264	411	324	440	242	365	459	340	270	346.11±79.08	242 – 459
22	Total Volatile Solid	47	37	48	60	23	32	62	62	29	44.44±14.94	23 – 62
23	Total Fixed Solid.	217	374	276	380	219	333	397	278	241	301.67±71.01	217 – 397
24	Total Suspended Solid	29	221	124	260	63	189	269	159	90	156.00±85.93	29 – 269
25	Total Vol. Suspended Solid	11	25	12	16	12	22	24	17	16	17.22±5.31	11 – 25
26	Total Fixed Suspended Solid	18	196	112	244	51	167	245	142	74	138.78±81.89	18 – 245
27	Total Dissolved Solid	235	190	200	180	179	176	190	181	180	190.11±18.45	176 – 235
28	Total Vol. Dissolved Solid	36	12	36	44	11	10	38	45	13	27.22±15.25	10 – 45
29	Total Fixed Dissolved Solid	199	178	164	136	168	166	152	136	167	162.89±19.85	136 – 199
30	Sodium	64.2	16.3	38.1	29.9	26.8	26.1	26.3	26.6	25.5	31.09±13.62	16.3 – 64.2
31	Potassium	8.9	6.3	7.5	7.1	7.3	6.9	7.4	7.1	7.1	7.29±0.70	6.3 – 8.9

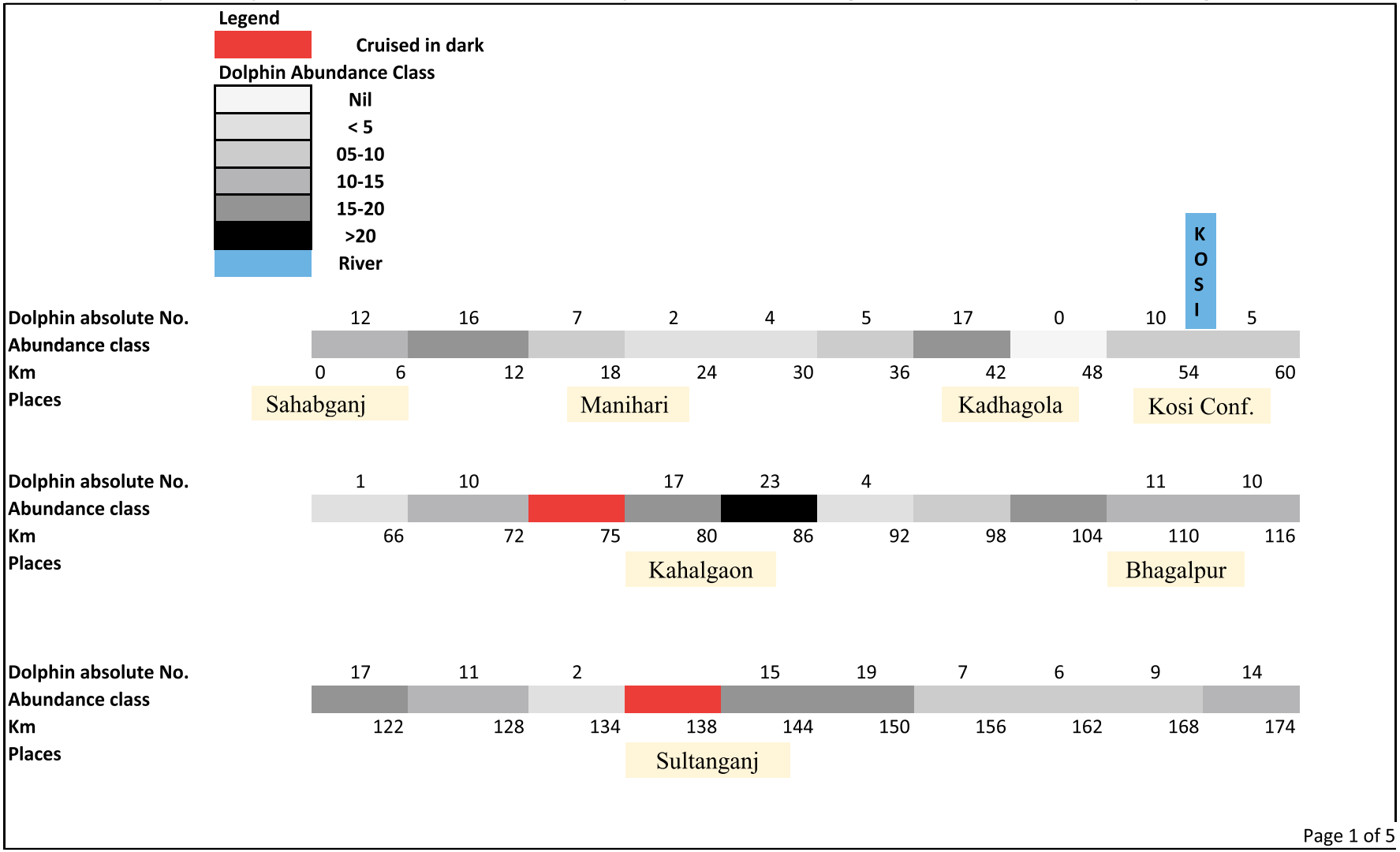
TABLE 10: PHYSICO - CHEMICAL CHARACTERISTICS OF WATER OF THE RIVER GANDAK FROM PATNA TO TENGARAHI GHAT (MANGALPUR), GOPALGANJ IN DECEMBER, 2012

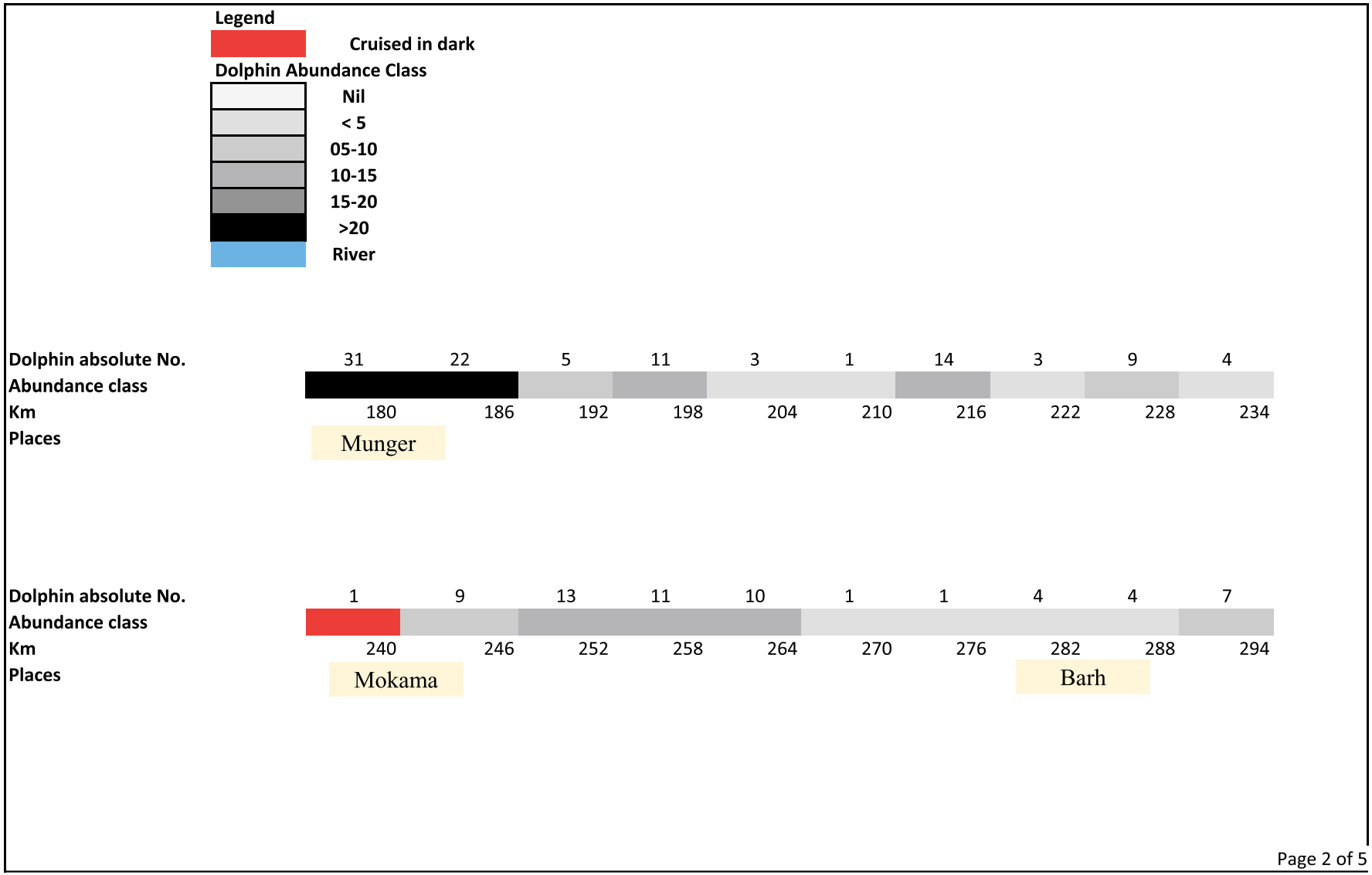
Sl. No.	Parameters	Fatehabad	Tengarahi ghat (Mangalpur)
1	Water Temperature	18.0	18.0
2	pH	8.2	8.2
3	Elec. Conductivity (µS/cm)	290	276
4	Turbidity (NTU)	100	40
5	Free CO_2	3.17	3.17
6	Phenolphthalein Alkalinity	Nil	Nil
7	Methyl Orange Alkalinity	130	124
8	CO_3^{--}	Nil	Nil
9	HCO_3^-	130	124
10	Dissolved Oxygen	7.56	7.56
11	Chemical Oxygen Demand	4.52	16.59
12	Total Hardness (as $CaCO_3$)	143	145
13	Calcium Hardness (as $CaCO_3$)	92	87
14	$Calcium^{++}$	36.74	35.07
15	$Magnesium^{++}$	12.39	14.09
16	Chloride	6.73	7.22
17	Nitrate - Nitrogen	0.097	0.046
18	Sulphate	27.80	27.32
19	Phosphate	0.026	0.013
20	Total Iron	11.69	5.71
21	Total Solid.	512	297
22	Total Volatile Solid	51	34
23	Total Fixed Solid.	461	263
24	Total Suspended Solid	293	127
25	Total Vol. Suspended Solid	32	16
26	Total Fixed Suspended Solid	261	111
27	Total Dissolved Solid	219	170
28	Total Vol. Dissolved Solid	19	18
29	Total Fixed Dissolved Solid	200	152
30	Sodium	8.5	9.2
31	Potassium	6.2	6.0

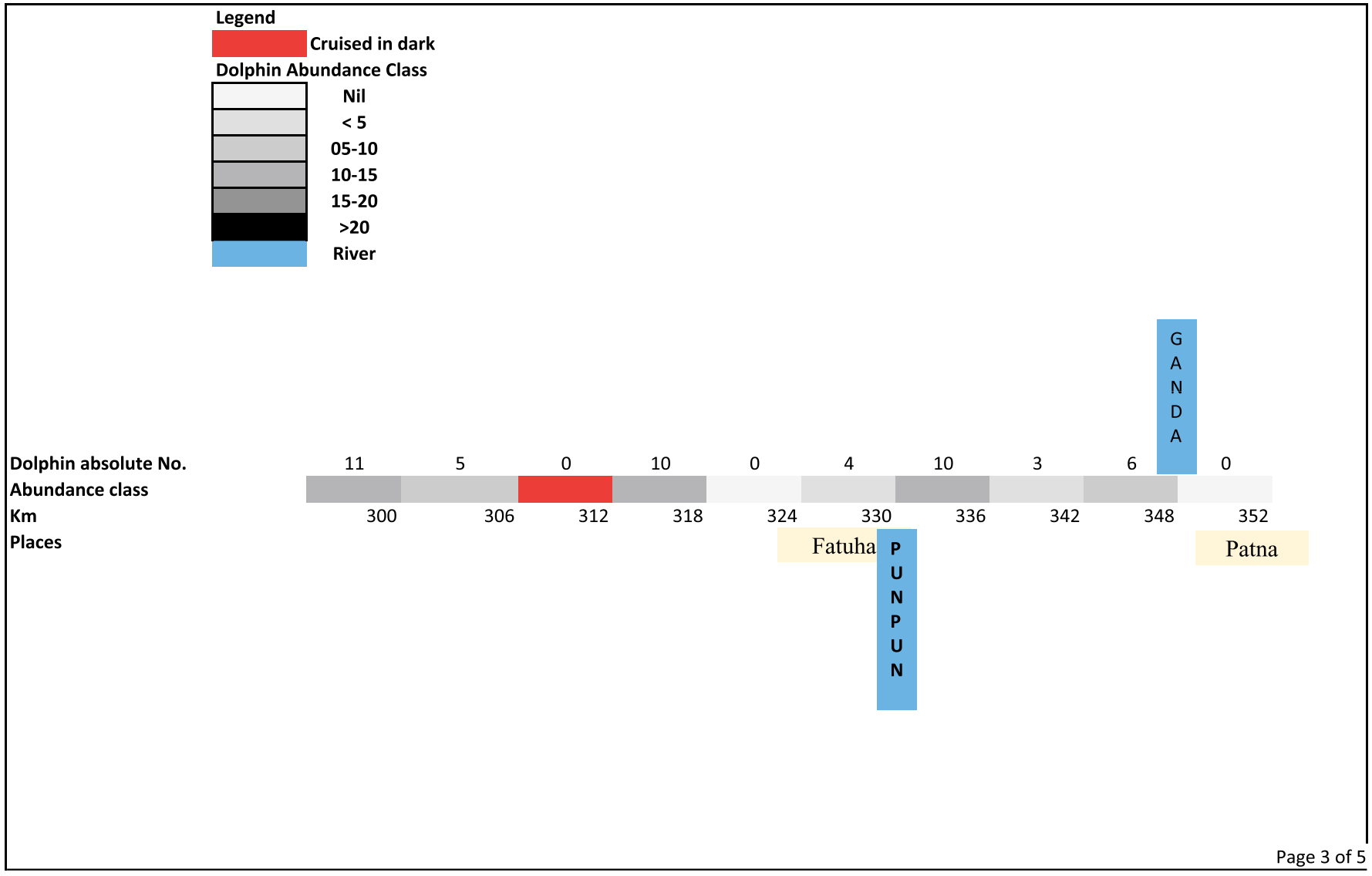
All values are in mg/l except pH, temp., conductivity and turbidity.

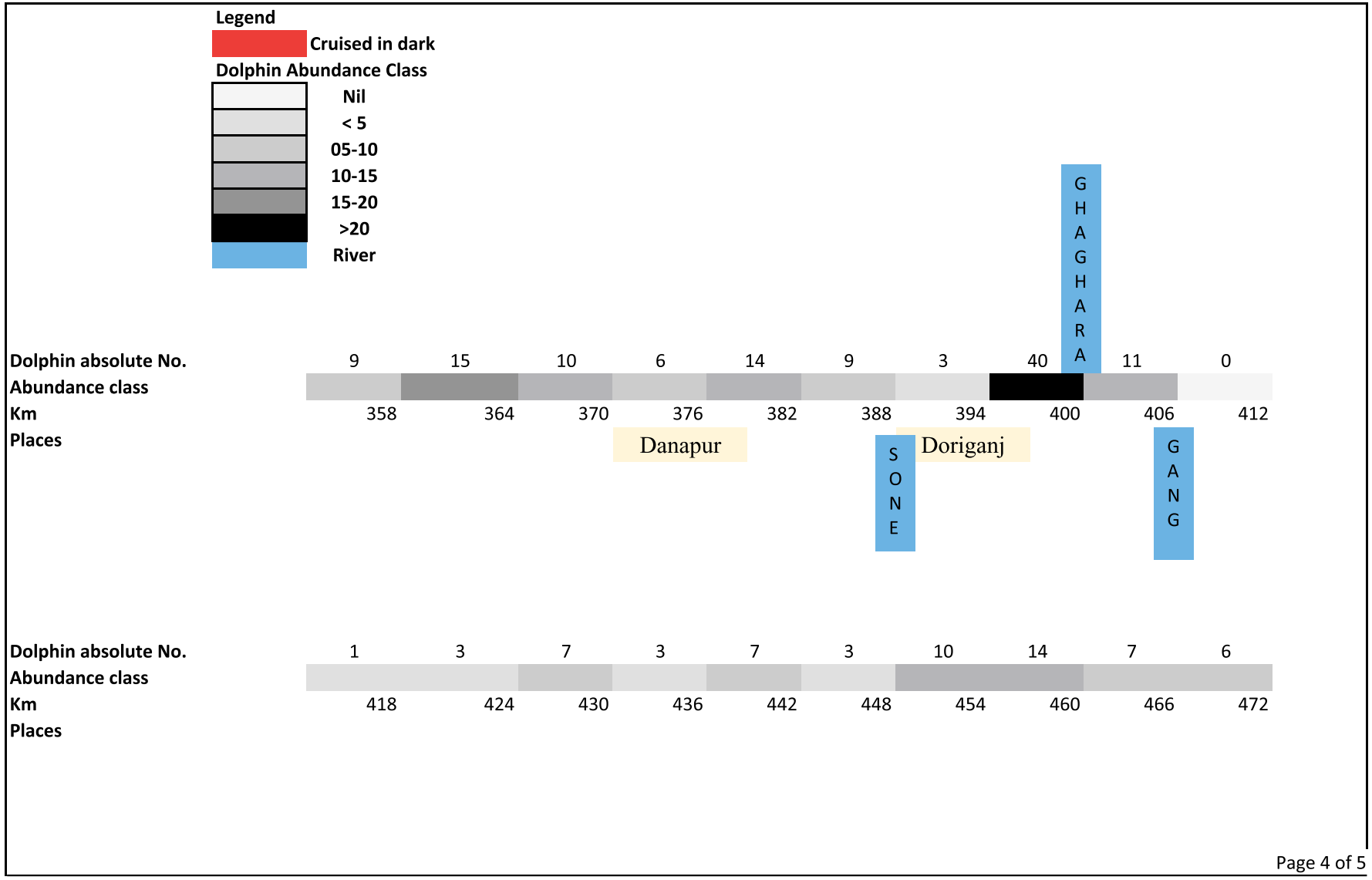
Annexure 1

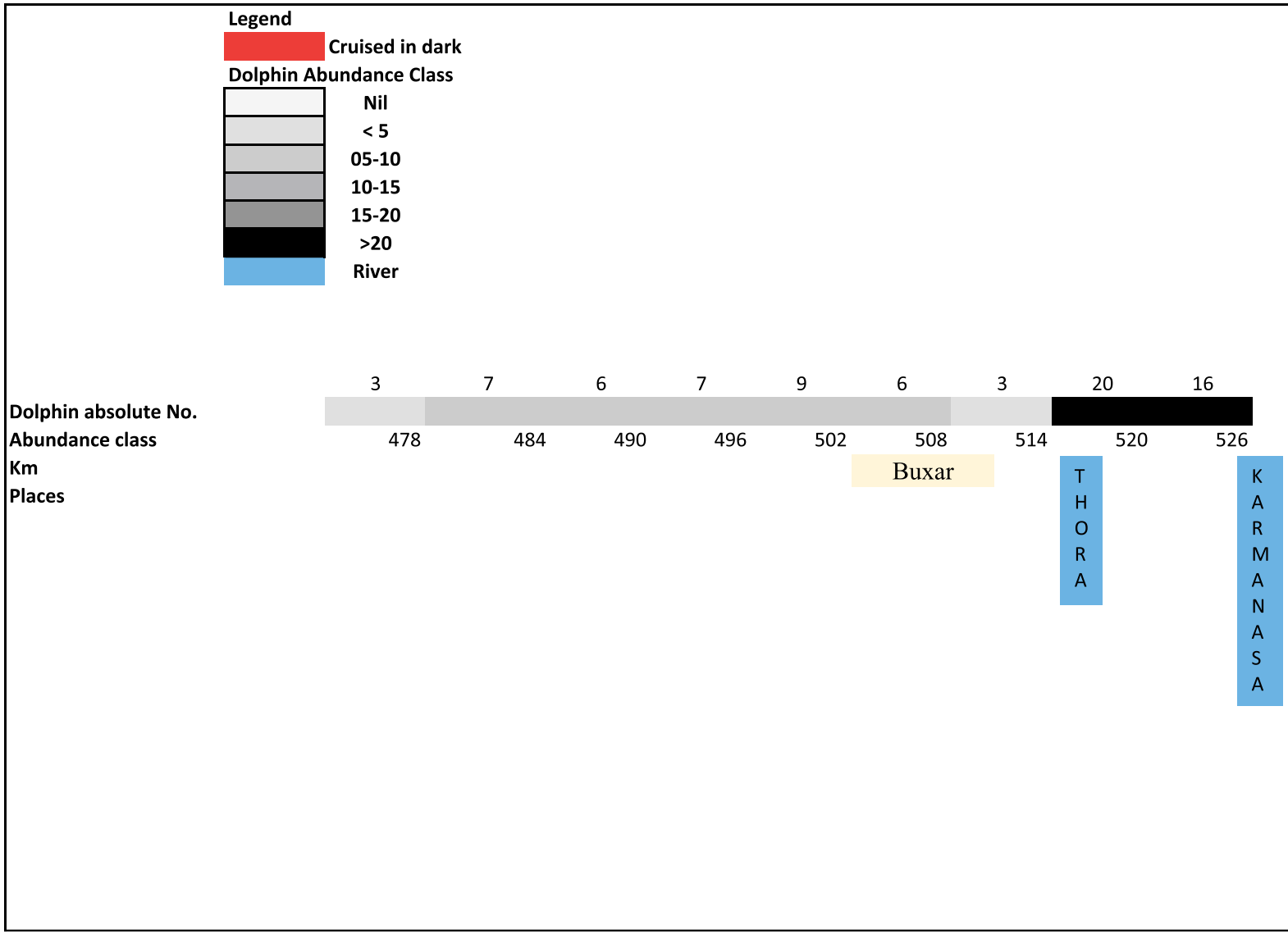
Graphical representation of distribution of dolphin in the river Ganga divided into 6 km surveyed segments




Legend
Cruised in dark
Dolphin Abundance Class
Nil
< 5
05-10
10-15
15-20
>20
River
Dolphin absolute No.
31 22 5 11 3 1 14 3 9 4
Abundance class
Km
180 186 192 198 204 210 216 222 228 234
Places
Munger
Dolphin absolute No.
1 9 13 11 10 1 1 4 4 7
Abundance class
Km
240 246 252 258 264 270 276 282 288 294
Places
Mokama
Barh


Legend
Cruised in dark
Dolphin Abundance Class
Nil
< 5
05-10
10-15
15-20
>20
River
GANDA
PUNPUN
Dolphin absolute No.
11 5 0 10 0 4 10 3 6 0
Abundance class
Km
300 306 312 318 324 330 336 342 348 352
Places
Fatuha
Patna


Legend
Cruised in dark
Dolphin Abundance Class
Nil
< 5
05-10
10-15
15-20
>20
River
GHAGHARA
Dolphin absolute No.
9 15 10 6 14 9 3 40 11 0
Abundance class
Km
358 364 370 376 382 388 394 400 406 412
Places
Danapur
SONE
Doriganj
GANG
Dolphin absolute No.
1 3 7 3 7 3 10 14 7 6
Abundance class
Km
418 424 430 436 442 448 454 460 466 472
Places


Legend
Cruised in dark
Dolphin Abundance Class
Nil
< 5
05-10
10-15
15-20
>20
River
Dolphin absolute No.
Abundance class
Km
Places
3
7
6
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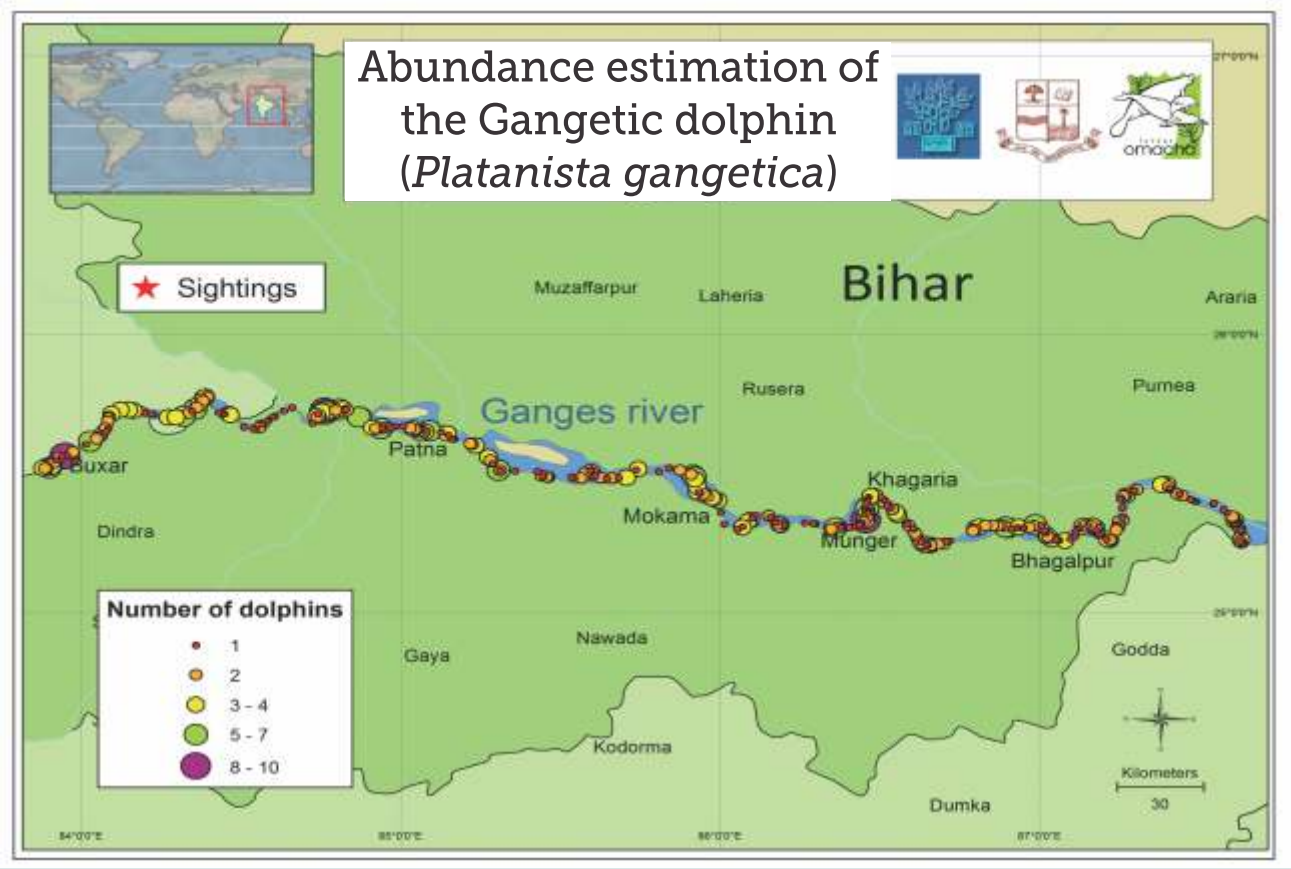

Five Gangetic dolphins surfacing together; four are visible and fifth has just submerged (Photo: Padam Bist)

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