The Ganges River Dolphin, India's National Aquatic Animal

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Introduction

The Ganges River dolphin, *Platanistagangeticagangetica*, commonly known as susu, is one of the only three recognized obligate freshwater dolphins, which inhabit rivers and estuaries in Asia and South America, and all are among the most endangered cetaceans on Earth. The remaining species are the Indus River dolphin, *Platanistagangetica minor*, common name bhulan of Pakistan, and the Amazon River dolphin, *Iniageoffrensis*, common name boto of Latin America. The fourth one was the 'baiji' or Chinese river dolphin, *Lipotesvexillifer*, was declared functionally extinct in 2006 (Turvey et al 2007; Hopkin 2007).The Government of India acted on time and Prime Minister declared the animal as National Aquatic Animal on 5th October 2009 and a formal notification was issued by the Ministry of Environment and Forests on 10th May 2010.

Although some marine dolphin species, like Irrawaddy dolphin, *Orcaellabrevirostris*, are facultative and commonly found in rivers quite far upstream, river dolphins are morphologically and phylogenetically distinct from marine dolphins. Because rivers are more vulnerable to degradation than the oceans, river dolphins are facing worse situation compared to the marine cetaceans.

The Ganges River dolphin is endemic to the Indian sub-continent and has a fairly extensive distribution range. It is found in the Ganges-Brahmaputra-Meghna and Karnaphuli-Sangu river systems of India and Bangladesh, while a few individuals may survive in the Karnali, and the SaptaKosi Rivers in Nepal. A meaningful estimate of range-wise abundance is lacking, however, approximately 2500-3000 Ganges River dolphins are assumed to survive across their entire range. The IUCN changed its status from 'Vulnerable' to 'Endangered' in 1996 as the species population was declining in its entire distribution range.

The deliberate as well as incidental killings of Ganges River dolphins for oil and meat still occurs. The construction of more than 50 dams and barrages within the Ganges River dolphin's historic range has drastically altered its habitat and fragmented the meta-population. Construction of embankments as flood control measures in eastern Uttar Pradesh, Bihar and West Bengal has disrupted the connections between the river and its flood plains and wetlands. Embankments interrupt access to the spawning habitat for

floodplain-dependent fish and eliminate eddy-counter currents where the Ganges River dolphins spend much of their time. Dredging and the removal of stones, sand, and woody debris also compromise the ecological integrity of the riverine environment, especially in small tributaries. Increasing pollution in the river may adversely affect dolphin health and their bioaccumulation may have serious consequences.

DISTRIBUTION

Historical distribution

Anderson (1879) recorded its distribution in the Ganges over an area comprised between 77^0E and 89^0E; in the Brahmaputra it occurred throughout the main river, as far eastwards and upstream as 95^0E by $27^0$30'N. He also reported that even in the month of May, when the Ganges was very low, dolphins were seen as far up the Yamuna at Delhi. He also emphasized that the upstream range of this dolphin was only limited by insufficiency of water and by rocky barriers. The Ganges River dolphin occurred in the entire length of the Ganga and Brahmaputra, and all their tributaries from the delta at the Bay of Bengal till the Himalayan foothills, where only rocky barriers, high velocities or shallow water limited its distribution.

Current Distribution

The Ganges River dolphin ranges into most of the large tributaries in the Ganga Basin: the Ramganga, Yamuna, Gomti, Ghaghara, Rapti, Son, Gandak and Kosi besides the main channel of the Ganga. In the Brahmaputra valley it ranges into the major tributaries such as the Tista, Adadhar, Champamat, Manas, Bhareli, Subhansiri, Dihang, Dibang, Lohit, Disang, Dikho and Kulsi rivers. Downstream it ranges through the larger tributaries between the Hugh and Meghna rivers, as far as the tidal limits at the mouth of the Ganges. They are also reported from the Fenny, Karnaphuli, and Sangu rivers to the southeast of the mouths of the Ganges (Rice 1998).

Habitat preference

Although the Ganges dolphin is fluviatile in habit, it may also be found in brackish water, though it never enters the sea. It is generally assumed that salinity defines the downstream limits of its distribution, while physical barriers and low prey densities at high elevations define the upstream limits. Dolphins are abundant in the long stretches of deep water in association with shallow water, meanderings, confluences and mid-channel sand bars.

The primary habitats preferred by the Ganges River dolphins are characterized by an eddy-counter current system in the main river flow caused by a point bar formed from

sediments and deposits, a convergent stream branch, or by an upstream meander. They are also found below sand bars and bridges where eddies are formed.

Being a mammal, the Ganges River dolphin can survive a wide range of temperature fluctuations. It can tolerate temperatures as low as 5^0C in the River Karnali in the winter in Nepal, and as high as 35^0C in the summer in the plains of Uttar Pradesh and Bihar. They have also been found in highly turbid water in monsoon and it is thus assumed that the water temperature and turbidity are not significant factors in determining the distribution of this species.

Habitat Fragmentation

The complex geomorphology of freshwater and estuarine systems tends to concentrate the distribution of cetaceans in counter-currents associated with confluences, meanders and mid-channel islands (Hua et al., 1989; Smith, 1993; Smith et al., 1997, 1998). The Gangetic River dolphin population was fragmented by construction of the dams and barrages on the main stem of the Ganga and its tributaries (Smith et al., 2000). Barrages are low gated diversion dams comprised of a series of gates used to control the elevation of an upstream 'head pond'. Barrages also restrict the movement of river dolphins and other aquatic mega-fauna, thereby separating them into subpopulations. Reeves et al., (1991) questioned the degree to which dolphin subpopulations are isolated, suggesting that individuals may occasionally move downstream through barrages.

Dolphins in the main channel of the Ganga were split into two subpopulations in 1975 when the Farakka Barrage was commissioned. The Lower Ganga Barrage at Narora (1966) and the Middle Ganga Barrage at Bijnor (1984) further fragmented the Ganga main stem population into four subpopulations. Dolphins have now been extirpated above the Middle Ganga Barrage at Bijnor. Today they occur in three subpopulations bounded by the Bijnor, Narora and Farakka Barrages.

CONSERVATION STATUS

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

Taxonomy

Though the names of William Roxburgh and Heinrich Julius Lebeck are associated with the first description of the Ganges dolphin in 1801, priority for the description goes to

Dr. Roxburgh who named it *Delphinusgangetica* (Pilleri 1978). Johann Wagler gave the name *Platanistagangetica*in 1830.

The Indus and Ganges populations were long regarded as identical. However, Pilleri and Gihr (1971) divided them into two species based on differences in skull structure, but Kasuya (1972) reduced the two taxa to subspecies of a single species. This is supported by the results of Yang and Zhou (1999), who found that there was little difference between the cytochrome-b sequences of the Ganges and Indus river dolphins. There was probably sporadic exchange between the Indus and Ganges River dolphin populations by head-stream capture on the low Indo-Gangetic plains between the Sutlej (Indus) and Yamuna (Gangetic) rivers (Rice, 1998). Thus one species is recognized in the genus Platanista ; the Ganges River dolphins are currently *Platanistagangeticagangetica* and the Indus River dolphins are *Platanistagangetica minor*.

Physical description

The Ganges River dolphins have a long, pointed snout that is characteristic of all river dolphins. Both the upper and lower jaw sets of long sharp teeth are visible even when the mouth is closed. While the snout is long and widens at the tip, the female's snout is generally longer than that of the male and may curve upwards and to one side. The eyes are extremely small openings slightly above the mouth. The species does not have crystalline eye lens 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 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

Platanistagangeticagangetica bears some very primitive characters not known in other cetaceans, such as the presence of a caecum at the junction of the small and large intestines. The position of the testis is more dorsal than that in other marine cetaceans and subcutaneous muscle is present between two layers of blubber (Sinha et. al. 2010).

Behaviour

Ganges River dolphins swim and vocalize constantly. Due to the turbid nature of the Ganga, the underwater activities of Ganges dolphins in the wild are difficult to observe. Their short surfacing time is also a major constraint for behavioural studies. A recent study recorded six types of surfacing patterns, which were dependent on age-class and off-shore distance of the individual (Sinha et al. 2010a).
Ganges River dolphins 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. Newborn calves frequently leap completely out of the water.

Reproduction and Life History

Though the breeding season of the Ganges dolphin extends from January to June, newly born calves can be seen even in other months. While mating usually takes place between March and June, it has been observed even in July. Only a single baby is born after a gestation period of about 9 months. At the time of birth the neonate is about 70-90 cm and weighs about 4 kg – 7.5 kg. The mother and calf remain together for about one year. The male attains sexual maturity at an age of about 10 years when they reach a length of 1.7 meters while the females are known to attain sexual maturity at 10 or less years (Kasuya 1972) when they are around 2m long (Harison 1972). During the surveys, newborn calves were sighted throughout the distribution range by various researchers, which indicates that the river habitat is conducive for dolphin breeding in spite of various biotic pressures.

Food and feeding

Ganges River dolphins are catholic feeders and feed on several species of fishes, invertebrates (Sinha et al., 1993). They exhibit active foraging behaviour in the morning (0700 hrs- 1000 hrs) and after noon (1500 hrs - 1700 hrs). The dolphins have been observed chasing and preying upon surface dwelling fish species, such as *Rhinomugilcorsula*. On some occasions it was noticed that they drive fishes to a particular area for community feeding.

Migration and Dispersal

The marked seasonal changes in the dolphin distribution and density over much of its range are due, at least in large part, to fluctuations in water levels. During the dry season from October to April, 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 more than 150kms upstream in the River Son 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). One dolphin, which had entered a deep pool in River Damodar from the River Hooghly, was rescued in January 2001 after it stayed behind even after the end of the flood season.

The Ganges River dolphins even disperse in the main channel of the Ganga in search of prey. Observations in Nepal show that they move in and out of tributaries of the Gandaki, Koshi, and Karnali systems during high water seasons, probably spending low-water seasons in deep pools of the tributaries. In the main rivers, a decrease in abundance during the summer would confirm a seasonal pattern of migration (Shreshtha, 1989).

Relatively high densities of dolphins are found at sites where rivers join or just downstream of shallow stretches, in areas where the current is relatively weak, off the mouths of irrigation canals, and near villages and ferry routes. In the Indus, about 40%-45% of the dolphin population is found at junctions of tributaries with the main river stem, at least during the dry season, presumably being attracted to these areas by concentrations of prey (Reeves and Brownell, 1989).

Threats to the Ganges River Dolphins

Overexploitation

Poaching

In its entire distribution range, and especially in Bihar, the species is facing threats to its existence from poaching. Deliberate killing of 'susus', especially harpooning, is believed to have declined in most areas but some individuals are still killed each year. Their oil and meat is used as liniment, as an aphrodisiac and as bait for catfish. A few cases of poaching are recorded in the middle Ganges in Bihar (Sinha et al., 2000), in the Kalni-Kushiyara River of Bangladesh, and in the upper reaches of the Brahmaputra River in Assam (Mohan et al. 1997). 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.

Accidental killing

Entanglement of Ganges River dolphins in fishing nets causes significant damage to the local population. Accidental killing is a severe problem for Ganges River dolphins throughout most of their range. The primary cause is believed to be entanglement in fishing gear such as nylon gillnets because their preferred habitat is often in the same location as primary fishing grounds. The problem of accidental killing is expected to worsen with increasing fishing intensity. On few occasions accidental killing due to collisions with vessels has also been observed.

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, *Eutropiichthysvacha* and *Clupisomagarua* (Sinha 2002).

Habitat Degradation

Construction of dams and barrages

Development of hydroelectric power and irrigation in the Ganges River system has prevented dolphin migration and has led to the segregation of populations. This fragmentation of the metapopulation has reduced the dolphin gene pool, leading to a loss of genetic diversity.These developments have also altered the overflow and flooding cycles of the Ganga river system, which influences the movements and spawning of flood-plain dependent fishes. In addition to fragmenting dolphin populations, dams and barrages degrade downstream habitat and create reservoirs with high sedimentation and altered assemblages of fish and invertebrates (IWC, 2000). Luxuriant growth of macrophytes and excessive siltation have eliminated suitable habitat immediately above Farakka Barrage (Sinha, 2000).

Riverine resource extraction

Dredging and development of the river environment has altered its nature and eliminated counter currents, one of the most preferred habitats of the dolphin. Increasingly heavy river traffic in the Ganges and Brahmaputra may result in habitat restriction, noise pollution, depletion of prey base and changes in feeding behavior of the 'susus' in the rivers. Other sources of habitat degradation include the removal of stones, sand (Mohan et al. 1997) and woody debris (Smith, 1993). These activities

threaten the ecological integrity of the riverine environment, especially in small tributaries where suitable habitat is more confined and therefore more vulnerable to local sources of degradation.

Sedimentation

Due to loss of vegetation cover in the catchment area and in floodplains, the increasing rates of sedimentation cause a rise of the river bed, reducing the river's water holding capacity. Sedimentation has a direct impact on the physical and biological characteristics of the river basin. It affects the other river biota, including fish, reducing the prey base of the dolphin. High altitude grazing, forest management, limited cultivation, and road building in the mountain ranges from where these rivers originate are the prime factors influencing sedimentation (Wasson, 2003). The River Ganga receives sediments from Himalayas as well as the central India.

Pollution

The concentrations of fertilizer and pesticides 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 Ganga-Brahamaputra river system in India in 2002-2003. Earlier Lal Mohan (1989) reported that the river basin received 1.15 million metric tons of chemical fertilizers and 2,573 tons of pesticides annually. Concentrations of polychlorinated biphenyls(PCBs), hexachlorocyclohexane (HCH), chlordane compounds, and hexachlorobenzene (HCB) in the Gangs River dolphin blubber, muscle, kidney, liver and prey collected from stomach of the dolphins collected during 1993 through 1996 from the River Ganga in and around Patna, India were determined by Senthilkumar et al., (1999). The study compared the organochlorine concentrations with values reported for samples analyzed during 1988 through 1992 and suggested that the contamination by these compounds has increased in the river. Kannan et al., (1997) determined concentrations of butyl-tin compounds in dolphins, fish, invertebrates and sediments collected from the Ganga in and around Patna. Total level in dolphin tissues was up to 2000 ng g^{-1} wet weight, which was about 5-10 times higher than in their diet. The bio-magnification factor for butyl tins in river dolphin from its food was in the range of 0.2-7.5. Butyl-tin concentrations in Ganges River organisms were higher than those reported for several persistent organochlorine compounds. A recently discovered micro-pollutant, perfluorinated compounds (PFCs), was assessed in tissues of the dolphin carcasses collected from the Ganga in and around Patna (Yeung et al., 2009). Organo-chlorine and organo-tin concentrations in the tissues of Ganges River

dolphins are high enough to cause concern about their effects (Kannan et al., 1993, 1994, 1997)

Possible impacts of river traffic

There have been numerous proposals to utilize sections of the Ganga for inland water transport. Currently, cargo steamers carry goods from Haldia to Patna regularly, occasionally travelling up to Varanasi. There is heavy river traffic in and around Kolkata and river tourism has recently been started between Kolkata and Varanasi.

Collisions with these vessels, and the effects of the noise they generate, are a serious concern for the dolphins. Since this species depends upon echolocation for many of its activities, including foraging, sonic pollution may adversely impact their well-being. The Ganges 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).

The depletion of prey base

The sustained and heavy exploitation of small fishes of rivers by the wide spread use of the mosquito nets in river may affect the prey base of the Ganges River dolphin. While the rate of renewal of this resource is remarkable, very few studies have been conducted in a small segment of the river on prey abundance estimates (Choudhay et al. 2006 and Kelkar et al. 2010) and further research is required to quantify this threat in larger areas.

Conservation Strategies

Successful strategies to facilitate the recovery of depleted populations, reverse trends of population decline and habitat deterioration, and to ensure that robust populations with high-quality habitat are secure will need to be multifaceted, adaptable, and tailored to particular local or regional conditions (Reeves et al., 2003). The many elements outlined below are integral to a comprehensive conservation strategy for the Ganges River dolphin.

Ensuring that any catch or other uses of the Ganges dolphin are sustainable

The following factors make the deliberate exploitation of Ganges dolphin a high-risk endeavor from a conservation viewpoint:

(a) They have intrinsically low rates of population increase;

(b) Most populations are subjected to by-catch in fisheries;

(c) There is uncertainty associated with estimates of their life history parameters, absolute abundance, trends in abundance, and total mortality;
(d) The effects of chemical and noise pollution, reduced prey abundance, and habitat degradation are potentially serious but difficult to quantify.

Ganges River dolphins are especially vulnerable because of their inland freshwater distribution. A complicating factor is that their small size makes the carcasses easy to handle, transport, process and conceal from management authorities. Measures to regulate directed takes are not easy to devise and implement, but without them, the species population is at risk. Among the elements needed for an effective management scheme are abundance estimation and reliable demographic knowledge of how many animals are being removed.

Developing and encouraging alternative fishing techniques

Dolphin oil is used as bait to attract two target fish species (*Clupisomagarua* and *Eutropiichthysvacha*), which are then netted or hooked. This use of dolphin oil and their body parts creates an incentive for hunting dolphins and a disincentive for fishermen to release any that may become entangled in their nets.

Oil extracted from fish offal available at outdoor markets has been tested and found to be an effective substitute for dolphin oil (Sinha, 2002), and encouraging its use may result in a reduction of dolphin kills.

Reducing incidental mortality through rescue and release efforts

A program was initiated in Pakistan in 2000 to rescue Indus river dolphins that are stranded in irrigation canals or isolated deep pools where they are unlikely to survive (Braulik, 2000). A similar program in Indian river systems for the Ganges River dolphin will contribute to its conservation.

Managing future dolphin-oriented tourism

Though no dolphin-oriented tourism exists on the Ganga yet, recently introduced river tourism between Kolkata and Varanasi attracted foreign tourists to watch dolphins in the Ganga.

While dolphin watching is a potential sustainable income source for fishermen and locals, it is important to ensure that dolphin watching on the Ganga is conducted in a manner that is respectful to the animals, local people and fellow tourists. Guidelines and codes of conduct should be developed, adopted and promoted by both the tourism industry as well as by government agencies to ensure that unregulated dolphin watch tourism does not become a menace for the Ganges River dolphin.

Habitat protection and restoration

Protected areas

Existing protected areas in the Ganga and its tributaries fall far short of what is needed. A major challenge in extending the coverage and level of protection conferred through protected areas is to convince stakeholders that conservation measures can benefit them and thus deserve their support. Community Reserve may be an alternative choice.

While a buffer zone aids in protection, animals that are relatively safe from entanglement in fishing gear while inside a reserve with strong enforcement may meet a gauntlet of nets as they move beyond its borders.

Researching and reducing environmental pollution

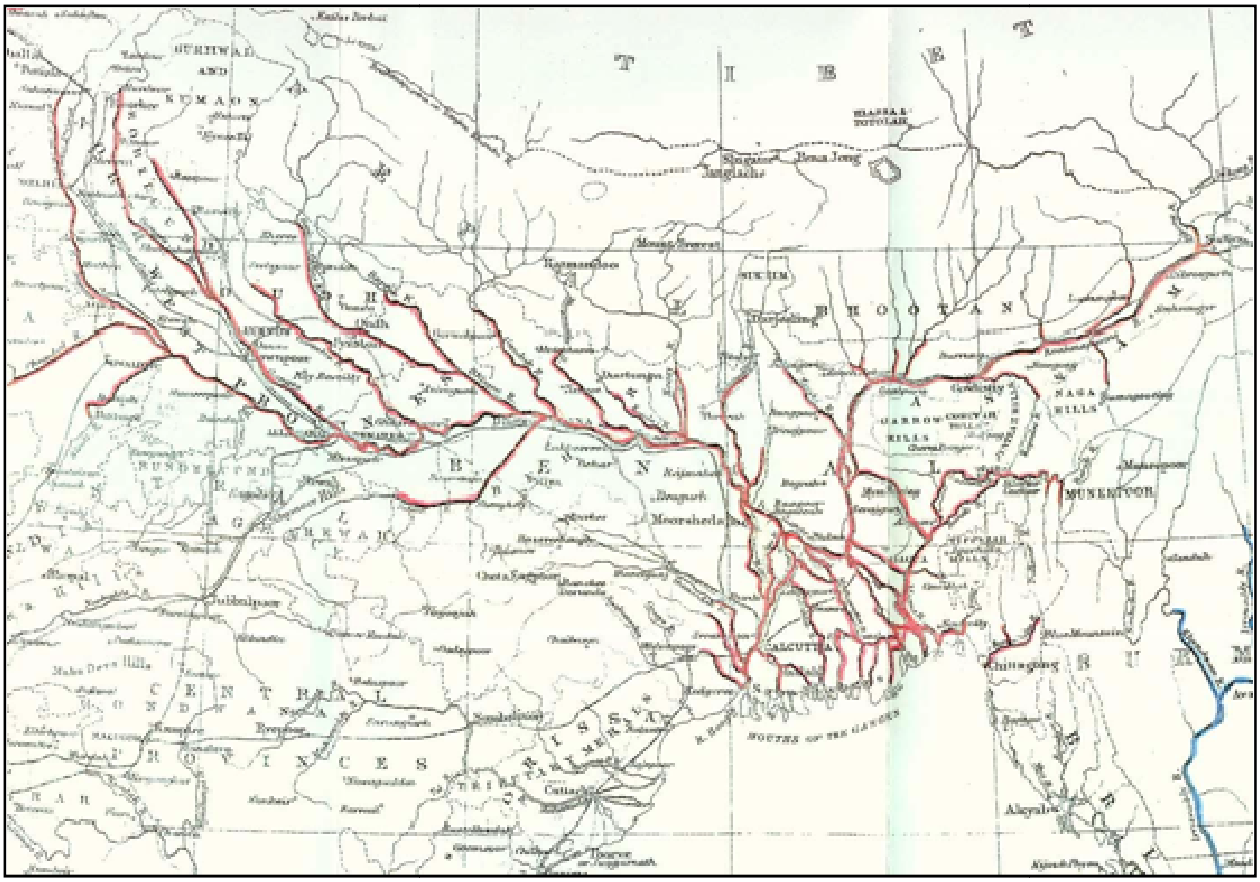
While more research is needed to elucidate the impacts of contaminant exposure on dolphin health, the precautionary principle demands that restrictions on the discharge of untreated effluents into the Ganga river system should be enforced to ensure a reduction in dolphin exposure to toxins.

Reducing the effects of water development on rivers in Ganga basin

The Ganges River dolphins need to be considered in the assessment of impacts of water development projects. The preferred option from a conservation perspective is to refrain from interfering with the natural flow regime and to avoid constructing barriers to animals and sediment movement. However, socio-political conditions make it impractical to completely halt water development activities especially in the Ganga basin, so the immediate goal must be to manage such activities in ways that will minimize the harm to dolphins and other aquatic species.

Enhancing the capacity and governance framework for Ganges dolphin conservation

Capacity-building refers to enhancement of human capabilities through a combination of education and infrastructure improvement. It is vital that local scientists and activists be able to provide the impetus and expertise for dolphin conservation efforts in their own regions.



Map 1: Historical range of the Ganges River Dolphin (Anderson, 1879)

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