Status of

Higher Aquatic Vertebrates in the Ganga River

GRB EMP : Ganga River Basin Environment Management Plan

by

Indian Institutes of Technology

| IIT Bombay | IIT Delhi | IIT Guwahati | IIT Kanpur | IIT Kharagpur | IIT Madras | IIT Roorkee |

Preface

In exercise of the powers conferred by sub-sections (1) and (3) of Section 3 of the Environment (Protection) Act, 1986 (29 of 1986), the Central Government has constituted National Ganga River Basin Authority (NGRBA) as a planning, financing, monitoring and coordinating authority for strengthening the collective efforts of the Central and State Government for effective abatement of pollution and conservation of the river Ganga. One of the important functions of the NGRBA is to prepare and implement a Ganga River Basin: Environment Management Plan (GRB EMP).

A Consortium of 7 Indian Institute of Technology (IIT) has been given the responsibility of preparing Ganga River Basin: Environment Management Plan (GRB EMP) by the Ministry of Environment and Forests (MoEF), GOI, New Delhi. Memorandum of Agreement (MoA) has been signed between 7 IITs (Bombay, Delhi, Guwahati, Kanpur, Kharagpur, Madras and Roorkee) and MoEF for this purpose on July 6, 2010.

This report is one of the many reports prepared by IITs to describe the strategy, information, methodology, analysis and suggestions and recommendations in developing Ganga River Basin: Environment Management Plan (GRB EMP). The overall Frame Work for documentation of GRB EMP and Indexing of Reports is presented on the inside cover page.

There are two aspects to the development of GRB EMP. Dedicated people spent hours discussing concerns, issues and potential solutions to problems. This dedication leads to the preparation of reports that hope to articulate the outcome of the dialog in a way that is useful. Many people contributed to the preparation of this report directly or indirectly. This report is therefore truly a collective effort that reflects the cooperation of many, particularly those who are members of the IIT Team. Lists of persons who are members of the concerned thematic groups and those who have taken lead in preparing this report are given on the reverse side.

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Contents

1. Introduction

Freshwater ecosystems are fragile environments, and are rich in biodiversity. No other group of organisms are believed to be more at risk than freshwater animals. Riverine wetlands are among the most productive life support systems in the world and are of immense socio-economic, ecological and bio-esthetic importance to mankind. Understanding the mechanism, driving losses in aquatic biodiversity, is important to the conservation and restoration of freshwater environments worldwide (Strayer and Dudgeon, 2010).

1.1 The River Ganga

The Ganga originating from the mighty Himalayas, transverses a distance of 2525 km to meet the sea, at Bay of Bengal (Krishnamurti *et al.*, 1991). Of this total length, 1450 km falls in Uttar Pradesh (including Uttaranchal), 445 km in Bihar and 520 km in West Bengal. The Ganga basin, 8, 61, 404 sq. km is the largest in India. The Ganga is unique among the mighty rivers of the world because of its largest delta - the Sunderbans (Behera, 1995).

Ganga river system comprise of numerous torrents and tributaries. Most of the north-India tributaries like Ram Ganga, Sharda, Gandak, Gomti, Ghagra, Gandok and Kosi arise from the lower Himalayas passes through the Terai region before joining the Ganga. The major southern tributaries are the Chambal, Yamuna, Son and Subarnarekha rivers (Rao, 1995).

The land around the river is used largely for agriculture and fisheries. The fishery resources of the Ganga river system are of tremendous economic and nutritional sustenance to the people of riparian states.

2. Biological Resources (Higher Aquatic Vertebrates) of the River Ganga

The river Ganga sustains diverse group of flora and fauna. Record of 268 fishes from the Ganga was the first-ever scientific documentation of the fauna of the river (Hamilton, 1822). Before that, Roxburgh (1801) reported *Platanista gangetica* from the river Hooghly near Calcutta. Anderson (1879) gave a detailed account of biology of the Gangetic Dolphin *Platanista gangetica*. Menon (1963) recorded fishes of the Ganga river in Himalayan region. Jayaram (1974) gave an account on distribution of freshwater fishes, amphibians and reptiles of the river Ganga. Jhingran and Ghosh (1978) studied the fisheries of the Ganga river system in the context of aquaculture. Zoological Survey of India has documented 27 species of reptiles from the river (Sharma, 1991). Gharial (*Gavialis gangeticus*), a fish eating crocodile, *Aspideretes gangeticus*, a soft shell turtle, are some endemic reptiles of the river. One of the most rare, endemic and endangered mammals of the Ganga is the Ganga river dolphin, *Platanista gangetica gangetica*. These species have been heavily exploited in the last few decades, which have pushed them near to extinction.

2.1 Status of River Dolphin

River dolphins are represented mainly by three species (*Platanista gangetica gangetica, P. gangetica minor, Pontoporia blainvillei*). Two species of Ganga river dolphin (*Platanista gangetica gangetica*) and Indus river dolphin (*P. gangetica minor*) are found in the Indian subcontinent. The Ganga river dolphin, locally known as Susu, is restricted to the Ganga, Brahamputra, Karnaphuli- Sangu, and Meghna river systems and their tributaries, from the foot hills of the Himalaya to the limits of the tidal zone in India, Bangladesh, and Nepal. In Ganga river, Dolphins are also present in its tributaries like Yamuna, Chambal, Ghaghra, Gandak, Rapti, Narayani and Kosi rivers (Roberts, 1997; Reeves and Brownell, 1989; Shrestha, 1989; Mohan *et al.,* 1997; Smith *et al.,* 2001).

In recent years several workers estimated the population of Ganga river dolphin in different segments of Ganga river and its tributaries in Ganga and Brahmaputra river system and Sundarbans delta. Once believed to be in the tens of thousands their number has gradually reduced to four to five thousand with a further decline to a mere 1,800 individuals in all the tributaries of its distribution (Anderson, 1879; Jones, 1982; Behera *et al.,* 2008; Behera, 1995; Bashir *et al.,* 2007, 2010; Singh, 2008).

This species is exclusively riverine. 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 river basins in India, the Ganga river dolphin is present mostly in plains where the rivers run slowly. This seems to be opposite to the habitat observed in Nepal, where the dolphin can be found in relatively clear waters and rapids. In both areas, however, there is a preference for deep waters (Reyes, 1991). Primary habitats are characterised by an eddy counter-current system in the main river flow caused by a fine sand/silt point bar formed from sediment deposits of a convergent stream branch or tributary. Marginal habitats are characterised by a smaller eddy counter-current system caused by an upstream meander. Dolphins concentrate in locations of high prey availability and reduced flow (Smith, 1993). South Asian river dolphins have been found in water as cold as 8°C and as warm as 33°C (Reeves and Brownell, 1989). In the river Bramaputra , the number of dolphins occurring in different depths were found to be significantly different and the highest numbers were found in depths of 4.1-6.0 m (Wakid, 2009). In the Sundarbans mangrove forest of Bangladesh, Ganga river dolphin distribution was conditionally dependent on low salinity, high turbidity, and moderate depth during both low and high freshwater flow. Animals prefer wide sinuous channels with at least two small confluences or one large confluence (Smith *et al.,* 2009).

Dolphins are social animals and live in small to large groups, associated with many animals like crocodiles, turtles and wetlands birds. But in adulthood they turn solitary, remain alone or best in pairs, and may group during mating season where several males display courtship for the attention of the females (Behera and Rao, 1999; Hussain, 1993; Singh and Sharma, 1985). Calving apparently can occur at any time of the year, but there may be peaks in

December to January and March to May. Newborn calves have been observed mainly in April and May. Calves are weaned within one year of birth (Jefferson *et al.,* 2008). Gestation lasts 10.5 months (Reidenberg and Laitman, 2009).

South Asian river dolphins feed on several species of small fish and invertebrates. They mostly feed at or near the bottom, echolocating and swimming on one side (Reeves and Brownell, 1989; Jefferson *et al.,* 1993). The Ganga river dolphins show seasonal and diurnal migration for feeding and maintaining their territorial behaviour. The marked seasonal changes in Susu distribution and density over much of its range at least in large part, are due to fluctuations in water levels. During the dry season from October to April, many dolphins leave the tributaries of the Ganga - Brahmaputra systems and congregate in the main channels, only to return to the tributaries the following rainy season. They may become isolated in pools and river branches during the dry season (Reeves and Brownell, 1989).

The species is facing a series of threats for its survival due to poaching, construction of dams and barrages pollution; mining of sand and stones, and incidental catches in gillnets. The Ganga river dolphin is important not only because it is endangered, but perhaps more so because, it is a reliable indicator of the health of the Ganga river, in fact the whole river ecosystem. In spite of being a "flagship" species, representing an ecosystem in need of conservation, its status has become a matter of grave concern over the past few decades. This is why the government of India declared this animal as the "National Aquatic Animal", during the year 2009. Close monitoring of dolphins and their habitats involving local communities is required for long term conservation of the species. It has been placed in Schedule-I of Wildlife (Protection) Act of India (1972). Appendix-1 reported in the Convention on International Trade in Endangered Species (CITES) (IUCN, 2009) had listed the species as "Endangered" (Behera, 1995; Singh, 2001; Anon, 2006; Choudhary *et al.*, 2006; Behera *et al.,* 2008).

The population status of dolphins in the Ganga river and its tributaries are given in Table 1 and Table 2.

Table 1:   Population status of dolphins in Ganga river and its tributaries

Name of the river	Length of the river surveyed	Dolphin number	Source
The Ganga main stem			
The Ganga (Haridwar to Bijnor Barrage)	100 km	Nil	Behera, 1995, Sinha *et al.* (2000)
The Ganga (Bijnor Barrage to Narora Barrage)	169 km	56	WWF-India Survey Report (pers. comm. S. Behera (2010)
The Ganga (Narora to Kanpur)	300 km	03	WWF-India Survey Report (pers. comm. S. Behera (2010)
Kanpur to Allahabad Survey Report	200 km	78	WWF-India Survey Report (pers. comm. S. Behera (2010)
The Ganga (Allahabad to Buxar)	425 km	172 (d/s survey)	Sinha *et al.* (2000)
The Ganga (Buxar to Maniharighat)	500 km	808 (u/s survey)	Sinha *et al.* (2000)
The Ganga (Maniharighat to Farakka)	100 km	24 (d/s survey)	unpublished data of Dec. 2004 (Sinha, 2004)
The Farakka Feeder canal	38 km	21 (d/s survey)	Sinha *et al.* (2000)
The Bhagirathi (Jangipur Barrage to Triveni)	320 km	119 (d/s survey)	Sinha *et al.* (2000)
The Hooghli (Triveni Ganga Sagar)	190 km	97 (d/s survey)	(pers. comm. G. Sharma 2008)
Tributaries of the Ganga			
The Yamuna (from Confluence of Chambal to Hamirpur)	350 km	60 (d/s survey)	WWF-India Survey Report (pers. comm. S. Behera 2010) Sinha *et al.* (2000)
The Kosi (Kosi Barrage to Kursela)	200 km	85 (discrete survey)	Sinha and Sharma (2003)
The Gandak (Gandak Barrage to confluence with Ganga at Patna)	320 km	290 (d/s survey)	multi-organizational survey 2010
The Gherua (India-Nepal border to Girijapuri Barrage)	20 km	23 (d/s survey)	Smith *et al.* (1994)
The Sarda (Sarda Barrage to Palya)	100 km	Nil	Sinha and Sharma (2003)
The Chambal (Pali to Pachhnada)	425 km	79	Singh (2010)
The Ken (from confluence of Yamuna at Chilla to Sindhan Kala village)	30 km	08 (d/s survey)	Sinha *et al.* (2000)
The Kumari (from confluence of Sind River)	100 km	Nil	Sinha *et al.* (2000)

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Name of the river	Length of the river surveyed	Dolphin number	Source
Tributaries of the Ganga			
The Betwa (from confluence of the Yamuna at Hamirpur to Orai	84 km	06 (d/s survey)	Sinha *et al.* (2000)
The Sind (from confluence with the Yamuna)	110 km	05 (d/s survey)	Sinha *et al.* (2000)
The Son	130 km	10 (d/s survey)	Sinha *et al.* (2000)
The Brahmaputra	600 km 856 km	400 (1996) 197 (2004-05)	Mohan (1997) pers. comm. A. Wakid
The Barak river	17 km	02 (1999), 08 (2004), 06 (2006)	Pers. comm. Paulan Singh
The river Subhansiri	99 km	26	Wakid (2009)
The river Kulsi	76 km	27	Wakid (2009)

2.2 River Dolphin in Ganga River

Study of the stretch from Bijnor to Narora to know the status of Ganga river dolphin began in 1993 and recorded a population of 22 Ganga river dolphins in 1993 to 95. This comprise of eight calves, four adolescents and ten adults (six females and four males) (Rao, 1995; Behera and Rao, 1999; Behera, 1995).

During the study period of 1997 a total of 35 dolphins were recorded in a stretch of 165 km from Bijnor to Narora. The concentrated population was recorded in between Brijghat and Narora. However during flood these animals migrate up to Bijnor. The crude population density is estimated as 1 dolphin per 4.71 km. Ecological density of dolphins in between Brijghat and Narora was also estimated as 1 dolphin per 2.34 km. During dry seasons the dolphins preferred only 82 km of the river stretch whereas during monsoon they inhabited in a stretch of 165 km. These results indicate that the dolphin in the study area gets a proper habitat of around 82 km during dry season and 165 km during monsoon (WWF, 1997, Unpublished). However, a year later (January 1998) the same stretch showed the population of 35 individuals of which 7 were identified as males, 8 were females, 11 were adolescents and 9 were calves. In the year 2002 WWF, India conducted a survey from 15th December to 31st December 2002 in the upper Ganga river from Brijghat to Narora covering a distance of approx. 85 km and estimated a population of around 39 dolphins (WWF-1998; Behera, 2002). Plate 1 showing the image of Ganga river dolphin (*Platanista gangetica gangetica*). Plate 1 showing the dolphin (*Platanista gangetica gangetica*) in the Ganga.

Plate 1: Ganges river dolphin (*Platanista gangetica gangetica*) in river Ganga

Table 2: The survey conducted by WWF (Year wise) between 2003-2010 recorded the dolphin population as

Year	Adult	Young	Calves	Total
2003	27	7	8	42
2004	19	7	13	39
2005	30	-	10	42
2007	30	-	15	45
2008	32	-	14	46
2009	32	18	4	54
2010	35	17	8	60

2.3 Status of Crocodiles

Crocodilians are survivors from the great reptilian age and are recognized as keystone species in their environment due to the role they play in maintaining the ecosystem and function by their activities. Gharial, a mythical creature, is revered as the vehicle (Vahana) of Ganga (River Deity) and Varuna (God of winds). Traditionally the animal has been identified with water, the source of all existence and fertility. It is the lone survivor of family Gavialidae.

In India many rivers, lakes and marshes offer a variety of habitats for three species of crocodiles (Gharial, mugger and salt water crocodile). Of these Gharials (*Gavialis gangeticus*, Hussain, 2009) are present in the Ganga river and its tributaries particularly in northern India. Gharials are also recorded in Mahanadi river of Orissa and Brahmaputra river in Assam, and the salt water crocodile lives in the brackish waters in the coastal states. The early records reveal that these aquatic reptiles at one time were very abundant throughout their distribution range. However due to commercial exploitation and habitat destruction populations of crocodile species were reduced to near extinction. In many of the habitats the crocodile populations were totally wiped out. Considering their vulnerability, the Government of India enforced protective legislation through the Indian Wildlife (Protection) Act, 1972 which prohibits killing (Smith, 1933; FAO, 1974; Rao, 1994).

All the three species of Indian crocodiles have been extensively studied in different corners

of the country but the microhabitat of the crocodiles was not studied in details. To conserve crocodiles generally and to develop crocodile farming in India, a captive breeding programme for all three species of crocodiles found in India (Indian mugger crocodile, saltwater crocodile, and the Gharial) was initiated in 1975. As a part of this programme, captive reared crocodiles were reintroduced into newly created protected wetland areas to boost wild populations (Singh, 1978, 1985; Bustard, 1980; Kar, 1981; Choudhury, 1981; Whitaker and Basu, 1983; Whitaker and Whitaker, 1989; Sharma and Basu, 2004).

The Gharials (*Gavialis gangeticus*, Hussain, 2009), endemic to the Indian subcontinent, was once common in the river systems of Pakistan, Northern India, Bangladesh, Myanmar and Bhutan. However, they are now restricted to a few, scattered locations in India and Nepal. The Gharial, is becoming increasingly rare due to land-use changes, reduction in water flow, modification in river morphology, loss of nesting sites, increased mortality in fishing nets, egg collection for consumption, and is especially at risk from flow regulation because it prefers fast flowing river habitats, which are prime sites for dams (Whitaker and Basu, 1983; Hussain, 1999; Dudgeon, 2000). By 1976, the estimated adult population of wild Gharial had declined from what is thought to have been 5,000 to 10,000 in the 1940s to less than 200. In 2006, the mature Gharial population in India stands at a similar figure, less than 200 (Whitaker *et al.*, 1974). The Gharial population is given in Table 3, 4 and current distribution (IUCN) in Figure 1.

In general the river Chambal holds the largest population with an upper estimate of 306 adult animals. Katerniaghat Wildlife Sanctuary holds the second largest population with an upper estimate of 68 adult animals (Converse, 2009). The other smaller populations of Gharial is in Ken and Son rivers in Madhya Pradesh, Hooghly river in West Bengal, Corbett Tiger Reserve in Uttarakhand and Gandak river in Bihar.

The Ganga river is a major habitat for both the species of freshwater crocodile. Old records indicate that the crocodile abounded in all the great rivers of northern India including the Ganga river. However, by early 1970's populations of crocodiles has been very much reduced. Crocodiles in many rivers including river Ganga have been illegally hunted for skin, meat and medicine. Under the crocodile project, few important crocodile habitats were identified in India and protected by declaring them as crocodile sanctuaries. In these sanctuaries captive reared crocodile were released regularly since 1977. The Uttar Pradesh forest department had released a total of 225 captive reared Gharial in the Ganga river upstream of Bijnor in the Hastinapur sanctuary in the year 1991-92. Majority of the crocodile releasing sites have received protection under Indian Wildlife Protection Act 1972 (Shortt, 1921; FAO, 1974; Rao, 1994).

Rao (1995) conducted a survey in the river Ganga and found a significant record of adult Gharial from Anupsahar in district Bulandshahar. During October 1994, three Gharials were reported in the river Ganga downstream of Narora barrage. The Gharials in the Hastinapur sanctuary have been released in an area, where large scale fishing has been noticed. Due to

the fishing activities in this stretch all Gharials might have been killed in fishing nets. Possibility of migration of released Gharial may be another factor for not locating them in the study area. These animals always avoid human interference in their habitats. Figure 1 showing the current distribution of the Gharial. Rao, in 1995 conducted a survey in the upper Ganga river and reported presence of mugger from many places of the Ganga river at Narora downstream of barrage, a total of 20 mugger hatchlings have been located. Since there is a heavy human activity along the river Ganga, it was observed that mugger prefer living in the lower Ganga river canal.
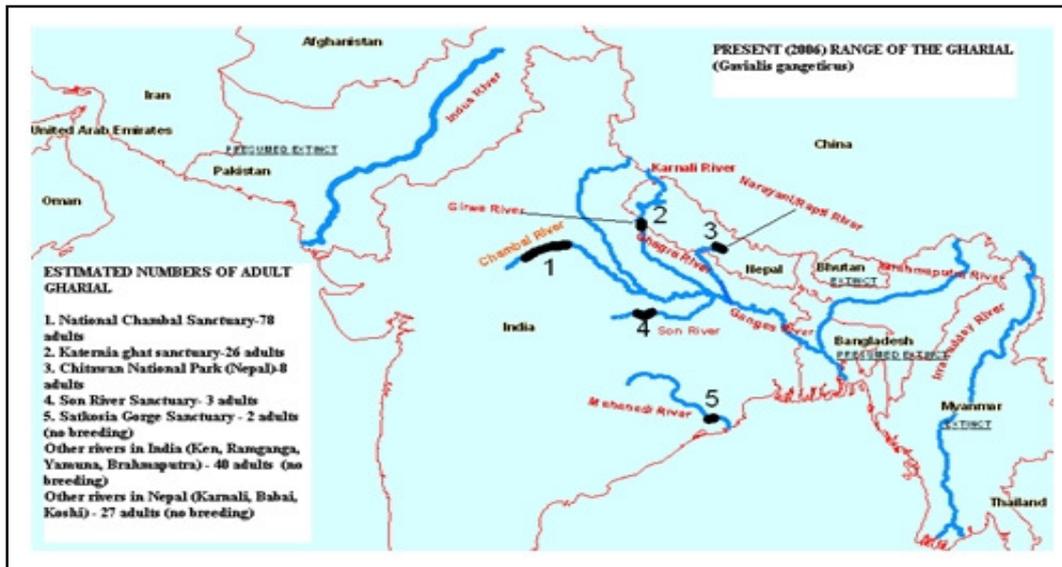
Figure 1: Current distribution of the Gharial (Source: IUCN)

Table 3: Gharial population size reduction (Source: IUCN, 2009)

River systems	Population size (inferred) three generations ago (1946)	Population size at present (2006)	Estimated reduction
Ganga River		<200	
Mahanadi River		2	
Overall	**5,000 to 10,000**	**<200**	**96%**

Table 4: Recent declines in the number of adult Gharial by subpopulation
     (Source: IUCN, 2009)

Sub population	Past	Present	Estimation % reduction within one generation
Chambal	226 (1977)	78 [2006] [68 f + 10 m]	13%
Katerniaghat	30 (1997)	26 [2006] [20 f + 6 m]	66%
Others	50 (1997)	40 [2006]	20%
Overall	**306**	**114**	

(f = females, m = males)

Gharial arguably are the most thoroughly aquatic of the extant crocodilians, and adults apparently do not have the ability to walk in a semi-upright stance as other crocodilians do. They are typically residents of flowing rivers with deep pools that have high sand banks and good fish stocks. Exposed sand banks are used for nesting (Whitaker and Basu, 1983).

Young gharials eat insects, larvae, and small frogs. Mature adults feed almost solely on fish, although some individuals have been known to scavenge dead animals. Their snout morphology is ideally suited for preying on fish. Their long, narrow snouts offer very little resistance to water in swiping motions to snap up fish in the water. Their numerous needle-like teeth are ideal for holding on to struggling, slippery fish. Gharials will often use their body to corral fish against the bank where they can be more easily snapped up (Piper, 2007).

The mating season is during November through December and well into January. The nesting and laying of eggs take place in the dry season of March, April and May. This is because during the dry season the rivers shrink a bit and the sandy river banks are available for nesting. Between 30 and 50 eggs are deposited into the hole that the female digs up, before it is covered over, carefully. After about 90 days, the juveniles emerge, although there is no record of the female assisting the juveniles into the water after they hatch (probably because their jaws are not suited for carrying the young due to the needle like teeth). However, the mother does protect the young in the water for a few days until they learn to fend for themselves.

2.4 Mugger Habitat

Mainly a freshwater species, the mugger crocodile is found in lakes, rivers and marshes. Muggers prefer slow-moving, shallower bodies of water rather than, fast-flowing, deep areas. Also known to thrive in man made reservoirs and irrigation canals. Although it prefers freshwater, it has some tolerance to saltwater therefore is occasionally reported from saltwater lagoons. It is sympatric with the gharial (*Gavialis gangeticus*) in some areas of India and with the saltwater crocodile (*Crocodylus porosus*) in other areas, but separated by habitat most of the time. It is adapted to terrestrial life like its cousin, the Cuban crocodile, more than most crocodilians, but is ecologically most similar to the African Nile crocodile. It is known to be more mobile on land, can migrate considerable distances over land in search of a more suitable habitat. It can chase prey on land for short distances. They are also known to dig burrows as shelters during the dry season.

Being a large carnivorous reptile, the mugger crocodile eats fish, other reptiles and small mammals, such as monkeys. In fact, most vertebrates who approach the river to drink water are potential prey, and may suffer being seized and dragged into the water to be drowned and devoured at leisure. Large adults will sometimes prey on large mammals such as deer, including the 225-kg sambar deer, and the 450-kg domestic water buffalo. At night they sometimes hunt on land, lying in ambush near forest trails (Dinets, 2011). This species is

generally considered to be occasionally dangerous to humans, but no where near as notorious as the much larger (and, in India, less common) saltwater crocodile.

2.5 Status of Turtles

India is bestowed with a great variety of Chelonian fauna. Five families of Chelonians in the class Reptilia are represented in India. Among them 2 families Emydidae and Trionychidae are freshwater turtles, with 16 and 6 species, respectively. A nation wide project on distribution of turtles and tortoises has been carried out by Wildlife Institute of India in collaboration with U.S. Fish and Wild-life Service (Choudhury and Bhupathy, 1993).

Rao (1991) studied ecological relationship among turtles in the Chambal river. According to him, 7 species of freshwater turtles are distributed throughout the 500 km stretch of the Chambal river which is a major tributary in Ganga river system. Occurrence of freshwater turtles in Ganga river and its tributaries were recorded by many authors. In the middle Ganga (Haridwar- Allahabad) a total of 12 freshwater turtle species have been identified. The *Kachuga* sp. is dominated with 5 species (*K. smithii, K. tecta, K. tentoria, K. dhongoka* and *K. kachuga*) followed by two species of Aspideretes (*A. gangeticus* and *A. hurum*) and one each species of *Chitra indica, Lissemys punctata, Hardella thurjii, Geoclemys hamiltoni* and *Melanochelys trijuga* (Sharma, 1991; Choudhury and Bhupathy, 1993; Rao, 1995; Smith, 1933; Das, 1985; Sharma and Tikedar, 1985; Krishnamurthy *et al.,* 1991). *Kachuga dhongoka* was reported from Northeast India in river Ganga at Allahabad and in river Yamuna at Bateswar (U.P.). Occurrence of *Kachuga dhongoka* in Chambal was reported by Rao (1991). In middle Ganga from Gangdaspur in Bijnor district distribution of common species of turtles in Ganga is given in Table 5.

Table 5: Status and distribution and of freshwater Turtles in river Ganga

S.N	Common name	Species	IUCN
1	Three striped roof turtle	*Batagur dhongoka*	Endangered
2	Red crowned roof turtle	*Batagur kachuga*	Critically Endangered
3	Narrow headed soft shell turtle	*Chitra indica*	Endangered
4	Spotted pond turtle	*Geoclemys hamiltonii*	Vulnerable
5	Crowned river turtle	*Hardella thurjii*	Vulnerable
6	Indian flap shell turtle	*Lissemys punctata*	Lower risk
7	Indian black turtle	*Melanochelys trijuga*	NT
8	Indian soft shell turtle	*Nilssonia gangeticus*	Vulnerable
9	Indian peacock soft shell turtle	*Nilssonia hurum*	Vulnerable
10	Brown roofed turtle	*Pangshura smithii*	NT (lower risk)
11	Indian roofed turtle	*Pangshura tecta*	Lower risk
12	Indian tent turtle	*Pangshura tentoria*	Lower risk

2.6 Turtle Habitats

In order to describe the habitat preference of the turtles, the Ganga river was classified into following habitat types depending on the nature of the bank and the river depth during hot season.

1) Both banks are muddy, formed by the soil erosion of the adjacent land. The river depth varies from 5-15 m. Most of these banks are used for extensive agricultural. These are the basking site of both hard-shell and soft-shell turtles.

2) One bank is sandy and the other bank is either muddy or hard soil. The river is shallow as well as deep, 2-15 m. Mid river islands with alluvial deposit are also present. There are alterations to the sand banks every year due to erosion and deposition during monsoon high water. Hard shell turtles construct nests on the sand banks or the islands are used for laying eggs. The sand banks are used for cultivation, mostly of water melons, vegetables, etc. during different seasons.

3) At many places long rivulets bring rain water from the surrounding catchments area. Some of these canals extend more than 1 km from the main river. During the monsoon season, the flood waters enter into the canals and thereby the water levels fluctuate depending on the rains. Soft shell turtles nest in these canals. Villagers carry out agricultural activities during the post monsoon season.

4) Due to the construction of the Madhya Ganga and Lower Ganga barrages at Bijnor and Narora, respectively the water has been stored upstream, resulting into large reservoirs and downstream barrages the river is very shallow with less flow of water. Soft shell turtles prefer to live in reservoirs here unlike the hard shell turtles which live in the flowing waters as these animals require large tracts of sand banks for nesting.

5) Freshwater turtles in the river Ganga use all the above mention habitat types for basking, feeding and nesting purposes. It was observed that all age classes of each species of turtles were encountered frequently. This is a good indication of successful natural breeding of turtles in the Ganga river. The nesting and breeding status of different turtle species occurring in the Ganga river are shown in Table 6 and Table 7. Plate 2 showing the Chelonian fauna in the Ganga and its tributaries.

Plate 2: Chelonian fauna in the Ganga and its tributaries

Table 6: Nesting sites of turtles between Bijnor to Kanpur

S. No.	Place	GPS location	
		Latitude	Latitude
1	Bijnor	29°34´214	78°05´971
2	Maqdoompur	29°08´743	78°04´546
3	Kalagarh	28°86´390	78°12´504
4	Tighri ghat	28°79´329	78°14´148
5	Garh	28°74´214	78°17´678
6	Pooth	28°69´419	78°18´501
7	Bhagwanpur	28°62´831	78°18´827
8	Farida	28°49´750	78°24´590
9	Awantika Devi	28°40´066	78°28´274
10	Anoopshehar	28°32´633	78°29´149
11	Karnavas	28°26´552	78°35´458
12	Rajghat	28°21´067	78°19´228

Table 7: Breeding status of fresh water Turtles occurs in the Ganga river between Rishikesh and Kanpur

S. No.	Species	Nesting season	Hatching season
1	*Geoclemys hamiltone*	?	?
2	*Melanochelys trijuga*	?	?
3	*Batagur dhongoka*	December-February-April	May
4	*Batagur kachuga*	December-February-April	May
5	*Pangshura smithii*	October-December	May
6	*Pangshura tentoria*	September-February	May
7	*Pangshura tecta*	October-December	May
8	*Lissemys punctata*	July-October	July
9	*Chitra indica*	September	October
10	*Nilssonia gangeticus*	August-October	June/July
11	*Nilssonia hurum*	?	?
12	*Hardella thurjii*	?	?

? – represents unknown nesting season

2.7 Conservation Constraints

A myriad range of anthropogenic activities have changed the site's ecological characteristic. Overpopulation in the Ganga basin has exerted the population pressure and has changed the water and land use patterns drastically. Water is being extracted in a significant

proportion for industrial and irrigation purposes. A large amount of treated and untreated sewage is also being discharged into the river from the larger towns around the banks of the river. Large numbers of industries are situated on the banks of the river. The discharge from them enters the river Ganga directly or indirectly.

Agricultural activities in and around river basin is contributing to pesticides and herbicides through surface runoffs. Pollution through fertilizers is significantly high as the farmers are using more chemical fertilizers to increase the production. The contamination is further enhanced by flooding of irrigation lands caused by irregular water flow from the reservoirs in the upper reaches and inconsistent rainfall in the catchment.

Irregular water flow from the reservoirs in the upper reaches also cause disturbance to the natural habitat of different aquatic animals including the dolphins. Irrigation canals have further decreased the water flow in the river which made the river too shallow for the dolphins to navigate and survive.

The commercial over fishing along the river has affected the natural feeding habit of dolphins and crocodiles and life cycle of some endemic fishes. The sand mining activities have caused habitat destruction of turtles and disturbed the nesting and basking ground for the crocodiles.

Physiological or behavioral responses of aquatic organisms exposed to pollutants serve as important indicators of the environment. These animals in polluted environment accumulate toxic substances and suffer physiological stress i.e., diminished rate of growth, impaired reproductive capacity or modified behavior. The disturbance in habitat is also a great threat to the continued survival of the animals.

There are several riverine indicator species which are threatened by human activities in the Ganga basin. However, the Ganga river dolphin, otters, gharials and the riverine turtles are few reliable indicator species to understand the health of the Ganga river ecosystem. Studying indicator species could create the basis for a sustained research programme to see how the changes of the said species can be related to the health of Indicator species in the river. This would help to implement various programmes for restoration of the river system.

Barrages on the Ganga have an impact on the habitats of all aquatic animals like turtles, crocodiles and aquatic mammals. The other threats include fishing, hunting and pollution. River dolphin population has declined significantly due to construction of barrages in the upper reaches of the river systems, local populations have been cut off and new immigrants are blocked ultimately resulting to the extinction of the isolated population.

Habitat protection remain the only viable long term means to ensure the survival of different animals. The level of impact of fishing activity on the aquatic species population still remains scientifically unknown. Since both fishermen and the higher aquatic species rely on food from the rivers for survival they interact in many ways. Synthetic twine is widely

used in the nets, this may be deadly, because it not easily detected visually or acoustically by species like dolphins in the murky run-off waters generated by annual monsoon.

At least two billion people on the earth depend upon rivers directly for provision of ecosystem services that can be characterized most simply as 'food', such as the benefits to be derived from fisheries, flood-recession agriculture, and dry-season grazing. Moreover, the value of freshwaters is bound to increase in the future, as ecosystems become more stressed and their goods and services scarcer. It will be a colossal challenge to reconcile human needs for water without compromising provision of goods and services that result from functioning ecosystems and the biodiversity that sustains them.

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