

# 3. LIFE

## *Biodiversity of the region*

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**THE CONVENTION** on Biological Diversity 1992 defined biological diversity or biodiversity as: ‘the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems’.

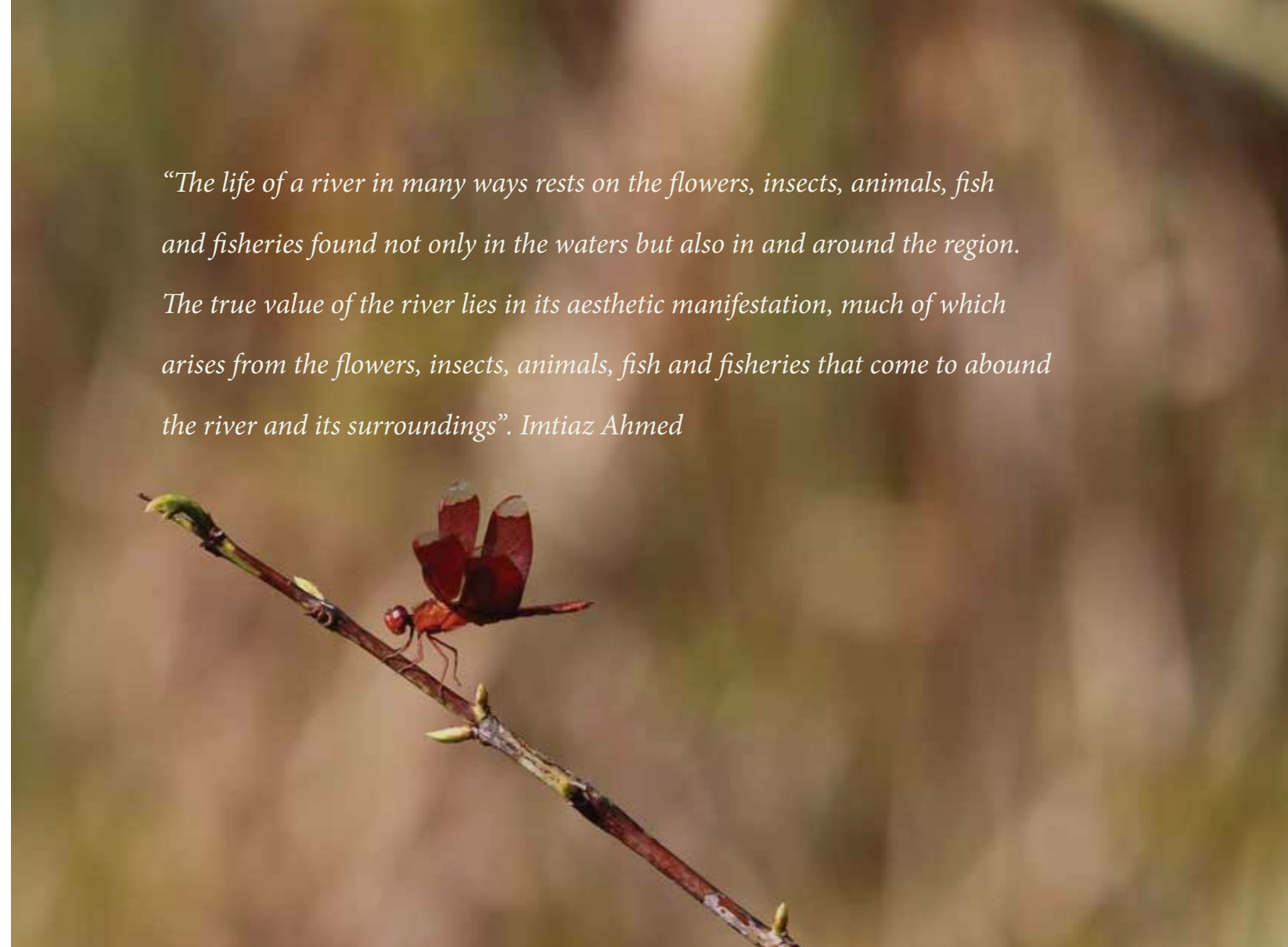
The Yarlung Tsangpo-Siang-Brahmaputra-Jamuna river system comprises unique and diverse ecosystems and habitats for a large variety of flora and fauna including many endangered species. The biodiversity of living habitats and species brings beauty and vibrancy to the river system making it one of the most fascinating river systems of the world. The aquatic and terrestrial habitats of the river system are dynamic in themselves and also change in character over short and long distances due to the changes in altitude and geographical and climatic conditions in each basin and sub-basin of the river system.

From the high altitude Tibetan plateau with its drought-resistant shrubs and grasses which is home to the yak, to the forests at lower altitudes with unique plant diversity, and the tall reed jungles, grasslands, and wetlands of the floodplains, home to three of Asia’s largest herbivores-the greater one-horned rhino, the wild water buffalo and the Asian elephant, and the largest carnivore, the Bengal tiger, this river system showcases diverse environments and ecosystems.

**Blue pitta** (*Hydrornis cyaneus*) This chapter provides an overview of the biodiversity of the Yarlung Tangpo-Siang-Brahmaputra-Jamuna river system.



*“The life of a river in many ways rests on the flowers, insects, animals, fish and fisheries found not only in the waters but also in and around the region. The true value of the river lies in its aesthetic manifestation, much of which arises from the flowers, insects, animals, fish and fisheries that come to abound the river and its surroundings”. Imtiaz Ahmed*



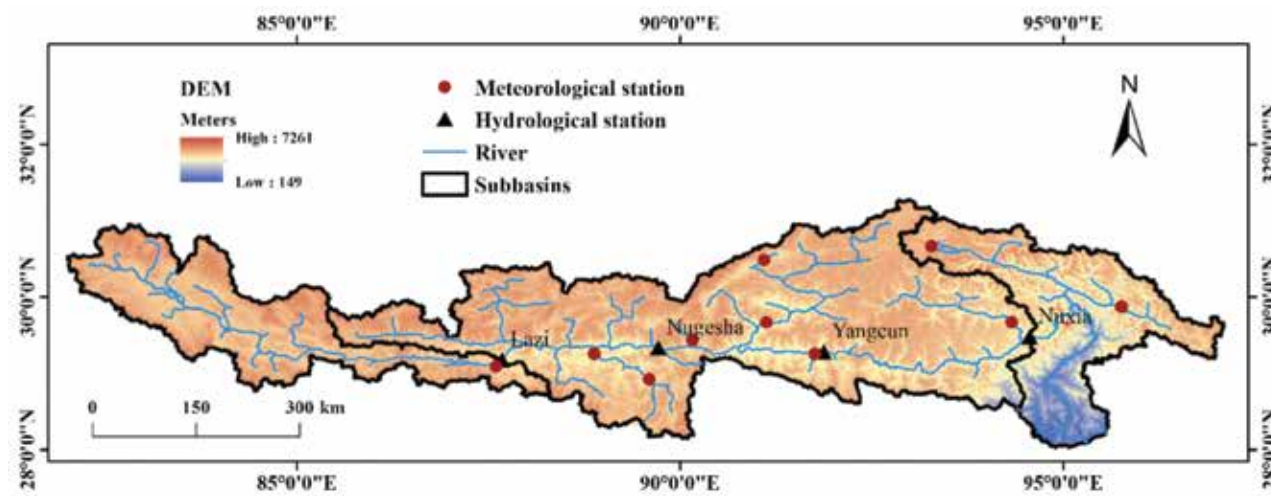
## YARLUNG TSANGPO BASIN

### *Biodiversity*

*Marc Foggin*

**THE YARLUNG TSANGPO** is an international river that flows more than 2,000 kilometers from west to east across the southern part of the Tibetan plateau, just north of the Himalayan range, at an average elevation over 4,600 metres above sea level. In total, its watershed encompasses approximately 242,000 square kilometers and it is divided in three main sub-basins (see Map 1 and Table 1). Based on the physical geography, including average altitude, topography, precipitation, and main land cover types, each of the sub-basins has relatively unique ecological characteristics, both in terms of biodiversity and of their socio-ecological features (traditional livelihoods) based on the areas’ long-term environmental constraints and opportunities, including human-nature interactions and pressures.

**Map 1: The Yarlung Tsangpo and its sub-basins, including visualisation of altitude as well as spatial distribution of meteorological and hydrological stations in Tibet Autonomous Region, China<sup>1</sup>**



**Table 1. Basic information about the Yarlung Tsangpo and its sub-basins<sup>2</sup>**

Yarlung Tsangpo	Area (km <sup>2</sup> )	Length (km)	Precipitation (mm)	Average annual temp. (°C)	Main types of land cover	Population
Upper sub-basin	26,000	268	< 300 (arid area)	- 0.3	Alpine steppe, alpine meadow, alpine bushes	153,400
Middle sub-basin	166,000	1,293	300 – 600 (semi-arid area)	5.2	Semi-arid herbs, broad leaf shrubs	1,297,000
Lower sub-basin	50,000	500	> 4,000 (humid area)	7.0	Alpine forest, tropical forest	82,000

Within the Yarlung Tsangpo's vast watershed, its westernmost headwaters, the upper basin, are most similar to the Tibetan Plateau as a whole. As high altitude arid and semiarid rangelands, this ecological region is particularly noteworthy for its unique suite of large ungulate (hoofed mammal) species including the migratory Tibetan antelope (or *chiru*; *Pantholops hodgsonii*), Tibetan gazelle (*Procapra picticaudata*), blue sheep (or *bharal*; *Pseudois nayaur*), argali (*Ovis ammon*), and wild yak (*Bos grunniens*); large carnivores such as Tibetan wolf (*Canis lupus chanco*), Eurasian lynx (*Lynx lynx*), snow leopard (*Panthera uncia*) and Pallas' cat (*Otocolobus manul*); and other native wildlife including Tibetan bear (*Ursus arctos*) as well as the black-lipped or plateau pika (*Ochotona curzoniae*). Plateau pika is itself a keystone species<sup>3</sup>, that is, a species that enables the survival of many others including many mid-size terrestrial and aerial predators that depend on the plateau pika as prey in winter, a wide range of birds

(including a suite of snow finches, e.g. *Montifringilla* species, as well as Hume's ground-tit, *Pseudopodoces humilis*) and lizards (*Phrynocephalus erythrurus*) that co-utilize the pikas' burrows, and a unique and rich plant diversity enabled by the pikas' burrowing activities.

The middle section of the Yarlung Tsangpo watershed is its most populated sub-basin. This region of southern Tibet is agriculturally the most productive, often referred to as the 'bread-basket' of Tibet due to its long history of crop production. Even here, however, cultivation is limited due to the cold and semiarid environment and is dependent on cropping systems characterised by relatively heavy tillage, frequent irrigation, high seeding rates and fertiliser applications<sup>4</sup> and there remain land use conflicts for production of food for human consumption versus forage<sup>5</sup>. Yet, along all the waterways and in lakes and wetlands of south-central Tibet, there is also a rich biodiversity. In the Lhasa urban area, the Lahu wetlands are recognized internationally under the Ramsar Convention for their global significance, providing critical habitat for endemic, rare and/or representative Tibetan avifauna including ruddy shelduck (*Tadorna ferruginea*), bar-headed goose (*Anser indicus*), brown-headed gull (*Larus brunnicephalus*), white stork (*Ciconia ciconia*), common redshank (*Tringa totanus*) and many other local and migratory species. In these wetlands as elsewhere across the middle stretch of the Yarlung Tsangpo, the black-necked crane (*Grus nigricollis*) is particularly noteworthy, being of great cultural significance to Tibetan people.

Moving further eastward and downstream along this world river, finally the most extraordinary of sections in this unique and diverse watershed is encountered: the Yarlung Tsangpo Grand Canyon. Wrapping around Namche Barwa mountain (7,782 meters) in eastern Tibet Autonomous Region, China, the river makes its "great bend", cutting through the Eastern Himalayas, in the process dropping from around 2,900 meters on the Tibetan plateau to around 600 meters when it flows into India, where it is then known as the Brahmaputra River. Flowing around 250 kilometers between Namche Barwa and Gyala Peri mountain (7,294 meters), with an average depth of 5,000 meters, this is indisputably the deepest canyon in the world. At its extreme, a single slope rises from the river all the way to the snow-capped peak with an elevational difference over 6,000 meters – thus presenting a multitude of ecosystems across all altitude zones, with climatic conditions ranging from subtropical to Arctic in just a few kilometres. Around two-thirds of all vascular plants, half of the mammals and four-fifths of the insects that are known in Tibet are found in this unique land, one of China's most exceptional biodiversity hotspots. Though largely unexplored (with no permanent road access until 2014), recent camera trap surveys in subtropical Metog county have confirmed the presence of 23 medium and large terrestrial mammal species and six pheasant species, including the very rare Bengal tiger (*Panthera tigris tigris*) as well as the dhole (*Cuon alpinus*), golden cat (*Catopuma temminckii*), marbled cat (*Pardofelis marmorata*) and clouded leopard (*Neofelis nebulosa*)<sup>6</sup>, highlighting the exceptional conservation value of this spectacular lower sub-basin of the Yarlung Tsangpo river.

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## Plant diversity

Liu Jiang

### Overview of the vegetation and species diversity<sup>7</sup>

The vertical distribution of vegetation in the Yarlung Tsangpo River Basin shows significant zonal characteristics, including coniferous forests, broad-leaved forests, thickets, deserts, grasslands, grasses, and meadows. From the perspective of a diversity index, its value gradually increased as the elevation declined from the upper reaches to the lower reaches of the Yarlung Tsangpo River.



There are more than 3,700 species of vascular plants in the Yarlung Tsangpo River valley belonging to 210 families and 1,106 genera<sup>8</sup>, ranging from vines and epiphytes in tropical forests to alpine cushion vegetation in alpine subnival belt. There are 11 cover types and 21 cover types in alpine vegetation<sup>9</sup>. More than 150 species are endemic to Tibet. Some dominant species, such as *Ericaceae* in alpine shrubs, has a total number of 154, accounting for 26 percent of the global population. Also, there are more than 50 genera and 150 species of orchids, and some of them are almost impossible to find elsewhere in China.

The water-vapor passageway along the Yarlung Tsangpo River has resulted in a complete vertical distribution of natural zones in the Yarlung Tsangpo canyon. Due to the special landform and climate conditions, the canyon has become the high and north limitation for tropical plants and also the low and the south limitation for temperate

plants distribution. Often in this region tropical and temperate plants meet to form a floristic junction and a strange geographical distribution in a small area at the same time, presenting a significant flora transition from tropical to temperate zones.

According to a survey on middle reaches of the Yarlung Tsangpo River Basin<sup>10</sup>, almost 60 percent species belong to the families of *Compositae*, *Rosaceae*, *Ranunculaceae*, *Papilionaceae*, *Labiatae*, *Liliaceae*, *Scrophulariaceae*, *Polygonaceae*, *Umbelliferae*, *Gramineae*, *Cruciferae* and *Saxifragaceae*. Families with tropical flora and temperate flora account for 50 percent respectively, indicating the seed flora in the middle reaches of the Yarlung Tsangpo River is the transitional type from tropical to temperate zone.

In the riparian zone of the Yarlung Tsangpo River, the top three families are *Compositae*, *Gramineae* and *Leguminosae*<sup>11</sup>. Species of high occurrence include *Heteropappus gouldii*, *Artemisia wellbyi*, *Sophor moorcroftiana*, *Astragalus strictus*, *Oxytropis sericopetala*, *Eragrostis mino*, *Pennisetum flaccidum*, *Orinus thoroldii*, and *Microula sikkimensis*.

On the basis of the different climatic and geographic conditions, the Yarlung Tsangpo River Basin can be divided into three main regions based on the typical vegetation in upstream, middle and downstream basin areas.

### Headwater and upstream region

Headwater region is located at an altitude of 4,000 meters to 6,000 meters. The river in the upper valley is composed of many bays, center bar, swamps and lakes, under the climate of arid and semi-arid zone. The landforms on both sides of the river are dominated by barchan dunes. This region has Alpine grassland, Alpine meadow, Alpine shrub, Alpine cushion vegetation, Alpine scree vegetation.

### Middle reach

The middle reaches of the river are like a string of beads, wide or narrow, with broad valley, providing the main farming areas in Tibet. Altitude of this region is from 3,000 meters to 4,000 meters. This reach has Subalpine dark coniferous forest which includes tree moss and lichen in abundance, in addition to Alpine pine forest and sand dune vegetation.

### Downstream region

The downstream, flowing in the grand mountain valley, is the area with abundant vegetation types and plant species. It is the most complete vertical mountain ecosystem in the world. The reach has Alpine shrub meadow with a good quality grass layer which is suitable for grazing cattle, sheep and other herds in the summer season. The Alpine shrub meadow, Alpine and Subalpine coniferous forest, is the forest group with widest distribution, largest area, strongest stability and highest productivity. In the vertical zone with an elevation from 2,700 meters to 4,300 meters, mountain semi-evergreen broad-leaved forest, evergreen broad-leaved forest and the valley monsoon rainforest can be found.

*The downstream region of the Yarlung Tsangpo River Basin is the most complete vertical mountain ecosystem in the world*





## Black-necked cranes

*Xiawei Liao*

THE BLACK-NECKED crane (*Grus nigricollis*) belongs to the *Grus* genus, *Gruidae* family and *Gruiformes* order. It is the latest crane discovered among the 15 kinds of cranes worldwide by the Russian naturalist, Przhewalski, near the Qinghai Lake in 1876. It is also the only kind that inhabits high-altitude plateau areas between 2,500 and 5,000 meters above the sea level. There are estimated 10,000 to 10,200 black-necked cranes in the world and Tibet is home to 7,000 to 8,000, making up about 70 to 80 percent of the global population<sup>12</sup>.

The black-necked cranes are featured with red head, black neck and white body. An adult crane is around 110 to 120 centimeters tall and weighs 4 to 6 kilograms. The breeding areas of black-necked cranes in China are located in the rivers and wetlands in the northern and western parts of the Qinghai-Tibet plateau, and scattered in the swamps in the southwest of the Qinghai-Tibet plateau as well as in Gansu and Northern Sichuan. They arrive at the breeding areas in March and build their nests that are about 10 centimeters tall and 90 centimeters in diameter in swamps or wetlands which cannot be easily accessed by humans and other animals. From early May, female and male black-necked cranes start to mate. They are known to usually mate in the mornings. They begin laying eggs in late May. Nestlings start to hatch after 30 to 33 days.

Attracted by the warmer climate and abundant food, including barley, wheat and grassroots, black-necked cranes migrate to the middle reach of the Yarlung Tsangpo River and its two tributaries, Lhasa River and Nyang Chu River from middle-October to March to spend the winter<sup>13</sup>.

The black-necked crane is endangered because of habitat losses and illegal hunting. Due to the development of lakes and construction of infrastructure, such as fishing ponds and roads, the habitats of black-necked cranes are being gradually threatened. In southern Tibet, black-necked cranes are also affected by the changing farming practices. Due to technology improvement, many farmers started to grow winter wheat. When the black-necked cranes arrive, the winter wheat has not yet started to germinate and therefore cranes cannot find food. Black-necked cranes are now on China's first-class protection list, along with other 90 endangered species including the giant panda and golden monkeys. The National Black-necked Crane Natural Reserve in the middle reach of the Yarlung Tsangpo River (28°39'-30°00'N, 87°34'-91°54'E) was established in 1993 and elevated to a National Natural Reserve in 2003 with a total area of 6,143.5 square kilometers.

*Frescoe in a monastery in Tibet (left)*

*There are estimated 10,000 to 10,200 black-necked cranes in the world and Tibet is home to 7,000 to 8,000, making up about 70 to 80 percent of the global population*



## Fish diversity

Xiawei Liao

**THERE IS** a long history of fishery in Tibet. Fish bones and fishing gears were found in the Qugong ancestor village ruins in Lhasa that date back to four to five thousand years. Fishery in Tibet took off from the early nineteen eighties, with the total catches tripling from 450 to 1,291 tons in ten years from 1985 to 1995.

There are 71 species<sup>14</sup> or subspecies of fish in Tibet, many of which are unique to the Qinghai-Tibet Plateau, including *Schizothoracinae*, *Triplophysa*, and *Sisoridae*. In the downstream, besides the species mentioned above, there are also other typical oriental region fish species, including *Barbodes hexagonlepis*, *Sinilabeo dero*, *Garra Kempi*, *Nemacheilus subfuscus*, and *Aborichthys kempfi*. There are 13 alien species found in Tibetan water bodies, including rivers, wetlands and reservoirs. *Cyprinus carpio* and *Carassius auratus* are the most widely seen.

According to the Chinese Fishery Statistics, in 2017, fishery GDP amounted to RMB 32.7 million (approximately USD 4.7 million), making up 0.2 percent of the provincial agricultural GDP. The total fishery output in Tibet in 2017 was 454 tons, including 383 tons of catches from the rivers and 71 tons of aquaculture production. In recent years, the total aquaculture production in Tibet ranges from 60 to 100 tons. The main aquaculture species include *Hypophthalmichthys molitrix*, *Oreochromis spp*, and *Silurus asotus*.



Lulu wetlands, Lhasa Town







*Red Pandas are members of Ailuridae family and are endemic to the Himalayan and Hengduan mountain ranges. Red panda population has probably declined by 50 percent over the last three generations and is likely to continue to decline in future*

### ***Fire cat: red panda***

*Partha Sarathi Ghose, Shalini Thapa, Megha Moktan  
and Abhishek V. Shukla*

**RED PANDAS** are members of *Ailuridae* family and are endemic to the Himalayan and Hengduan mountain ranges. They occur in the mountainous regions of Nepal, India, Bhutan, Myanmar and China. Red pandas have recently been classified into two distinct species, the Himalayan red panda (*Ailurus fulgens*), distributed across Nepal, India, Bhutan, parts of southern China and northern Myanmar, and the Chinese red panda (*Ailurus styani*), which is endemic to China. The *A. fulgens* is distributed across the Yarlung Tsangpo and the Siang-Brahmaputra basin.

Red pandas essentially indicate the health of temperate forests that ranges from 1,500 to 4,800 meters above sea level. The species shows high preference for mixed temperate and conifer forests in different landscapes across its range. Red pandas prefer dense forest with healthy bamboo understory and proximity to water sources. Potential red panda habitats across the range countries range between 47,100 and 134,975 square kilometers. Red panda is a member of the Order *Carnivora*. However, its principal food is bamboo. The species of bamboo preferred by red pandas vary considerably across its range. Across the Himalayan range countries red pandas prefer *Yushania maling* and *Thamnocalamus aristatus* for food. Red panda population has probably declined by 50 percent over the last three generations and is likely to continue to decline in future. Negative impact of human related causes on red panda population and its habitat are undeniable. International Union for Conservation of Nature has categorised the red panda as an Endangered species and receives protection as a critically threatened species across all the range countries.



## SIANG BRAHMAPUTRA BASIN

### *Biodiversity*

*Ravindra Kumar Sinha*

**THE RIVER** Brahmaputra is the abode of rich biological diversity with over 300 species of fish and other megafauna, including the endangered Gangetic Dolphin, *Platanista gangetica gangetica*. The International Union for Conservation of Nature (IUCN) has found four species of fish to be critically endangered, 11 endangered and 25 vulnerable in the Ganges-Brahmaputra-Meghna basin. There is not enough data available for 27 percent of the species, some of which might turn out to be in the “threatened” category as well, after obtaining more data.

Among zooplankton 220 rotifer species (21 families and 46 genera), and *Cladocera*, termed as “water fleas” (74 species belonging to 41 genera) have been recorded from

the Brahmaputra floodplains of Assam. It is the richest diversity of rotifer recorded from any part of the Indian sub-region and one of the richest known globally. The Brahmaputra also has the richest diversity of *Cladocera* in India as well as South and Southeast Asia.

Deepor *beel*, a Ramsar designated wetland in the Brahmaputra valley is recognized globally as a rich rotifer ecosystem with its 171 species of rotifer and 58 species of *Cladocera*. Majuli, the largest riverine island which is located in the floodplains has a rich micro-metazoan diversity with 131 species of rotifer and 55 species of *Cladocera*.

The *beels*, streams and rivers provide ideal habitats for turtles and amphibians. Out of 24 species of freshwater turtles in India, 21 are present in the Brahmaputra river. More than 250 species of birds have been recorded in the river basin.

The floodplains also harbor a total of 76 species of macrophytes or aquatic plants belonging to 36 families and 55 genera. A detailed checklist of Angiosperms and Gymnosperms of Assam state prepared in 2014, lists 3,854 taxa (including infra-specific taxa) under 1,394 genera and 236 families. Out of these, 2,752 taxa are dicotyledons, 1,080 taxa are monocotyledons, and 22 taxa are gymnosperms.

The flora of Assam represents 18 percent of the total species of flora in India. However, the figures are provisional as many areas of the state are still unexplored or underexplored. The flora of Umananda island (having an area of only 4.7 hectares) on the Brahmaputra near Guwahati includes 146 species of plants belonging to Macro-Fungi, *Bryophytes*, *Pteridophytes*, *Gymnosperms* and *Angiosperms*. Macro-fungi are represented by 4 species belonging to 4 genera and 3 families; Bryophytes are represented by 4 species belonging to 3 genera and 3 families; Pteridophytes are represented by 11 species belonging to 8 genera and 6 families; Gymnosperms are represented by 2 species belonging to 2 genera and 2 families; Dicots are represented by 100 species belonging to 88 genera and 42 families and, finally, Monocots are represented by 25 species belonging to 22 genera and 11 families.



*Changeable hawk eagle (Nisaetus cirrhatus)*



*Bar-headed geese (Anser indicus)*

## Linked Ecosystems of the Siang-Brahmaputra River Basin

Sanchita Boruah and S.P. Biswas

THE NORTHEASTERN region of India is blessed with high endemism due to its highly assorted and complex habitat which includes the numerous floodplain lakes scattered throughout the valley covering an estimated area of 0.1 million hectares<sup>15</sup>. The Brahmaputra, aptly considered as the 'lifeline' of Assam, boasts some unique flora and fauna, which makes it a paradise for nature and wildlife lovers. The diverse types of aquatic habitat scattered throughout the river basin are the abode of a variety of edible and ornamental fish species as well.

The five critical components of the flow regime which regulate river ecosystems are: magnitude, frequency, duration, timing and rate of change of hydrologic conditions<sup>16</sup>. In maintaining river health, the water quality and quantity is the master variable, which includes natural flow regimes, physio-chemical properties, sediment transport and drainage basin runoff. These collectively give rise to diverse habitats which comprise "linked ecosystems" within a particular river ecosystem. The Brahmaputra river system comprises such linked ecosystems.

### Wetlands (Floodplain lakes)

The Brahmaputra basin is blessed with innumerable wetlands variously named as *beel*, *anua* and *haor* depending on the size and origin of the wetland in question. The marshes and swamps are locally known by different names such as *jalah*, *doloni*, *pitoni*, *doba*. These water bodies with diverse aquatic macrophytes are home to many aquatic faunas and a major source of capture fisheries which provide livelihood support to the local population. Deepor *beel*, Maguri *beel*, Mer *beel*, Chatla *haor*, Bakri *haor*, Sone *beel* are among the prominent wetlands in Assam. The *beels* and *anuas* are repositories of a wide array of riverine species including Indian Major Carps while *hoars* are abode of food as well as ornamental fish species. Over 100 species of commercially important fish have so far been recorded from the wetlands of Assam. Fishing is conducted in the wetlands almost round the year except in the season when fishing is banned. Fish production from these wetlands is far below their potential production of about 1,000 kilograms per hectare per year. Siltation of wetlands, wanton killing of brood and juveniles and lack of management plans are identified as major contributory factors for the poor fish production in the wetlands. However, proper management can turn these wetlands into fish granaries of the region.

### Man-made tanks

The upper Brahmaputra basin has large excavated tanks which are centuries old and



Lesser  
whistling teal  
(*Dendrocygna  
javanica*)



*White-winged wood duck (Asarconis scutulata)*  
Highly endangered, only about 800 survive in the wild

are perennial tanks being fed by underground streams. The tanks provide shelter for a variety of flora and fauna and provide drinking water to thousands of people residing in their periphery. During the *Ahom* rule in Assam, many large tanks were constructed which are still in their full splendor. The *Ahoms* adopted a special technique to construct these tanks. One such tank is the Joysagar tank which is one of the largest man-made tanks in south Asia having an area of 4,50,000 square meters. The tank holds about 22,02,240 cubic meters of water during winter. Maximum depth of the tank ranges from about 8.85 meters in winter to about 9.67 meters in the monsoon season. Twenty-three species of aquatic macrophytes belonging to 18 families have been recorded from the tank. The faunal composition comprises of insects (19 genera), fish (21 species), and birds (22 species) including many migratory forms. Between December and February, thousands of migratory birds throng into Joysagar and other historical tanks of upper Assam which could be developed as ecotourism destinations.

### Paddy fields

In the eastern and southern states of India, paddy fields are often flooded with small wild fishes during monsoon months which are retained within for varying periods of time; but production is low as many of the traditional systems of rearing are inefficient<sup>17</sup>. In Assam, people trap varieties of wild fish, mostly murrel and other air-breathing forms in seasonal water bodies like ditches, road-side canals, and deeper areas of paddy fields by making 'shelter' or traps for the fishes during the rainy season. The fishes are harvested during post-monsoon/winter months. However, the method of trapping fish is still 'primitive' and therefore the yield is very erratic and usually low. In the Siang Basin, composite rice-fish culture has been adopted by the Apatani tribe in their paddy fields, mostly for common carps<sup>18</sup>. In agriculture dominated areas, expansion of paddy cum fish culture may be an alternative livelihood option for the farmers.

### Ephemeral streams

In the northeastern Himalayan region, most of the rivers are perennial, as these are

fed by both snowmelt and rainwater alternatively during summer and monsoon seasons respectively. However, a special type of lotic system known as ephemeral or seasonal streams emerge during monsoon. Ephemeral streams represent a semi-arid existence which harbour fish diversity uniquely adapted to survive in those adverse micro habitats. These are locally known as *Jiadhal* and create havoc due to flooding particularly in Dhemaji and Lakhimpur districts of upper Assam. The small sized fish like *Danionella*, *Pseudolaguvia*, and other biota living in this type of biome have specific adaptive capability to cope with harsh and fluctuating abiotic parameters of seasonal streams.

### Threats/Issues

Aquatic biodiversity especially is in critical crisis due to human exploitation, pollution and developmental activities<sup>19</sup>. The depletion of biodiversity is accelerated by various anthropogenic activities such as (a) release of toxic waste elements from the factories/industries and agricultural fields into open water sources; (b) felling of trees in catchment areas for setting up of industries and large scale construction works which also have an adverse impact on aquatic life; (c) leakage of crude oil into water sources from the nearby oil reservoir; (d) injudicious fishing, high rate of siltation in river bed and above all, non- implementation of the existing fishing policies which are the root causes of declining aquatic diversity in the basin; (e) climate change is inevitably a major challenge for fishermen and riparian communities.

### Eco restoration, Sustainable development, Livelihood & Flood mitigation plan

Local ecological knowledge constitutes a potentially useful source of information for conservation of ephemeral fish, some of which are very rare and endemic. Although there are limitations and biases of this type of untested traditional knowledge, the local information from fishing communities is likely to help in monitoring the population status of target species.

The following suggestions have been put forward for maintaining a balance between economic activities and ecological resilience.

- » Minimize environmental stresses such as pollution, habitat alteration, and exotic species introduction in the aquatic system
- » Retain riparian forests that shade streams and rivers for maintenance of existing habitat quality
- » Reduce nutrient loading to rivers and wetlands by maintaining natural flow
- » Maintain flow of water and sediments critical to riverine ecosystems
- » Restore aquatic and wetland ecosystems to the maximum extent possible to promote ecosystem resilience to climate change and other stressors
- » Use groundwater judiciously for irrigation and human consumption in the rain shadow areas of the region
- » Conduct a comprehensive study on impacts, mitigation and adaptation in the vulnerable areas, combined with practical actions involving resource users.

*Local ecological knowledge constitutes a potentially useful source of information for conservation of ephemeral fish, some of which are very rare and endemic*

## Brahmaputra Grasslands

Girish Jathar

THE GRASSLANDS of the Brahmaputra floodplains are a suitable habitat for many threatened species such as the Indian rhinoceros *Rhinoceros unicornis*, Bengal tiger *Panthera tigris tigris*, Asian elephant *Elephas maximus*, wild water buffalo *Bubalus arnee*, hog deer *Axis porcinus* and the swamp deer *Rucervus duvaucelii*. Most of the important grassland bird species of the Indian subcontinent<sup>20</sup> are found in the Brahmaputra floodplains. The Assam Plains Endemic Bird Area which includes the floodplains, has three restricted range species namely Manipur bush-quail *Perdicula manipurensis*, black-breasted parrotbill *Paradoxornis flavirostris* and marsh babbler *Pellorneum palustre*<sup>21</sup>. Other threatened bird species found in the grasslands of the Brahmaputra are listed in Table 2<sup>22</sup>.

**Table 2: Threatened grassland birds found in the Brahmaputra Floodplains**

S.No	Common Name	Scientific Name	IUCN Status
1	Bengal Florican	<i>Houbaropsis bengalensis</i>	CR
2	Swamp Grass Babbler	<i>Laticilla cinerascens</i>	EN
3	Swamp Francolin	<i>Francolinus gularis</i>	VU
4	White-throated Bushchat	<i>Saxicola insignis</i>	VU
5	Jerdon's Babbler	<i>Chrysomma altirostre</i>	VU
6	Slender-billed Babbler	<i>Turdoides longirostris</i>	VU
7	Marsh Babbler	<i>Pellorneum palustre</i>	VU
8	Black-breasted Parrotbill	<i>Paradoxornis flavirostris</i>	VU
9	Bristled Grassbird	<i>Chaetornis striata</i>	VU
10	Yellow-breasted Bunting	<i>Emberiza aureola</i>	VU
11	Finn's Weaver	<i>Ploceus megarhynchus</i>	VU

Encroachment is one of the major threats to the Brahmaputra floodplains<sup>23</sup>. Grasslands outside protected areas are currently under great threat owing to rise in human population throughout the Brahmaputra floodplains. Protected areas such as Dibru-Saikhowa National Park are heavily disturbed by humans and overgrazing by livestock<sup>24</sup>.

In most of the non-protected areas, various anthropogenic activities and natural events have changed the habitats leading to their degradation and transformation. Land use has changed due to expansion of agriculture, human settlements, developmental projects, and breaking up of the grasslands into smaller and patchy fragments. Over the last 45 years, the mosaic of grasslands, wetlands, agriculture patches have been converted to either tea gardens or contiguous agriculture areas in most of the districts of Assam.

These grassland floodplains are of great importance to both wildlife and human beings. The ecosystem services they provide are invaluable in terms of water recycling, arresting soil erosion, controlling floods, providing habitats for threatened wildlife, carbon storage, and most importantly livelihood to local communities. Conservation of these grasslands are of great importance in view of the changing climate and needs to be integrated into the policy and action plans of the government.

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## Avifaunal diversity

Utpal Singha Roy

MORE THAN 900 different bird species including birds of global conservation concern and restricted-range bird species have been recorded from North-east India the majority of which are found in the Brahmaputra valley ecoregion<sup>25</sup>. Wide geographic areas under this region have been designated as Important Bird Areas (IBAs). These include National Parks such Dibru-Saikhowa, Kaziranga and Orang; Sanctuaries such as D'Ering, Panidihing and Chakrashila; and Reserved/Protected Areas such as Dibang and Majuli island. On the basis of the large number of endemic birds found in these areas, two Endemic Bird Areas have been designated from this region; the Eastern Himalayas (EBA 130) and the Assam Plains (EBA 131)<sup>26</sup>.

Several important studies on avifaunal diversity of Brahmaputra valley have been conducted. However, most of the studies have been limited to areas with easier access. Studies from remote areas covering different seasons throughout the year are likely to result in newer interesting findings.

Among the numerous residential and migratory birds recorded from the Brahmaputra Valley, many belong to the threatened category. Most notable among these threatened birds are the critically endangered Bengal florican (*Houbaropsis bengalensis*), white-bellied heron (*Ardea insignis*), Baer's pochard (*Aythya baeri*), spoon-billed sandpiper (*Eurynorhynchus pygmeus*), Indian vulture (*Gyps indicus*), slender-billed vulture (*Gyps tenuirostris*) and white-rumped vulture (*Gyps bengalensis*). Among the Endangered category most notable are white-winged duck (*Asarcornis scutulata*), oriental white stork (*Ciconia boyciana*), greater adjutant-stork (*Leptoptilos dubius*) and masked

*The ecosystem services they provide are invaluable in terms of water recycling, arresting soil erosion, controlling floods, providing habitats for threatened wildlife, carbon storage, and most importantly livelihood to local communities*



From left to right:  
**Long-tailed broadbill**  
*(Psarisomus dalhousiae);*  
**Crimson sunbird**  
*(Aethopyga siparaja);*  
**Red-billed leiothrix**  
*(Leiothrix lutea)*



finfoot (*Heliopais personatus*). Vulnerable birds from this region include Dalmatian pelican (*Pelecanus crispus*), lesser adjutant stork (*Leptoptilos javanicus*) and great knot (*Calidris tenuirostris*). Apart from these, black-bellied tern (*Sterna acuticauda*), black-headed ibis (*Threskiornis melanocephalus*), black-necked stork (*Ephippiorhynchus asiaticus*), Blyth's kingfisher (*Alcedo Hercules*) and ferruginous pochard (*Aythya nyroca*) all belong to the Near Threatened category.

Deforestation in the Brahmaputra watershed has resulted in higher siltation and soil erosion often leading to flash floods in downstream habitats causing huge loss to biota (including birds) thriving therein. Hunting and poisoning of birds are other major threats for both migratory and resident avifauna of this area. Thus, habitat loss, habitat alteration, restricted geographic range, pollution, climate change, hunting and various diseases are affecting the birds of this region negatively<sup>27</sup>.

The Wild Life (Protection) Act 1972 of India prohibits hunting of water-birds under Schedule IV. Also, birds like white-bellied heron, oriental white stork, pink-headed duck, white-winged wood duck are protected under Schedule I under the same act that prohibits killing or capturing them. However, these laws need to be enforced without prejudice to save the bird population. Habitat protection is another excellent approach to conserve wildlife and the Brahmaputra valley semi-evergreen forests ecoregion has been included in the 200 global priority ecoregions identified by WWF in the year 2000. To conserve the rich biodiversity of this region a number of protected areas have been designated of which Kaziranga National Park is also a 'World Heritage Site'. Brahmaputra valley with its enormous avian diversity can be easily considered a birds paradise, however, it is obvious that this region needs proper scientific management strategies including conservation education and awareness for long-term sustenance.

## Fisheries and aquatic biodiversity

S.P. Biswas

### Riverine Biota

Brahmaputra basin is made up of alluvial soil, with high percentages of sand and silt. The riverbank is almost perpendicular in most of the 640 kilometer stretches and highly prone to erosion. Based on the topography of the Brahmaputra river basin, fish habitats and their faunal types are as follows: - (I) *Bedrock reaches* (fast flowing river): Rapid streams having relatively steep gradient and rocky bed that harbour small fish genera like *Amblyceps*, *Barilius*, *Danio*, *Garra*, *Glyptothorax* and *Hara*; (II) *Step-pool* (upstream pools): Sluggish and deeper parts of upland streams. Fishes like *Bangana dero*, *Labeo pangusia*, *Neolissocheilus hexagonolepis*, *Raiamas bola*, *Tor* spp., are dominant here. (III) *Regime reaches* (river meandering & confluence): The eddy counter-current system at the junction of two rivers is an ideal place for fish assemblages. The confluences are also the passageways for upstream fish migration. Similarly, the channel meanderings offer suitable home for a large variety of fish species; (IV) *Braided reaches* (adjoining floodplain lakes): *Beels* are weed infested shallow water bodies temporarily or permanently connected with the main river. (V) *Plane-bed reaches* (open river): Large sized species such as *Sperata*, *Bagarius*, *Chitala*, *Pangasius*, *Silonia* and other giant aquatic fauna like *Platanista* and *Nilssonina* (*Trionix*) are mainly encountered in the open river; (VI) *Ephemeral streams*: These streams are 'alive' during rainy months. Varieties of small and medium sized fish are encountered; (VII) *Seasonal water bodies*: Low lying paddy fields, derelict ponds, swamps and road-side *nallahs* (depressions) are also 'temporary homes' for a variety of small

fish species. The Brahmaputra system shares its fish resources with the Indo-Gangetic plain gene pool and to a lesser extent with the Myanmar and south Chinese fauna.

### Biota of Riparian Ecotones

Over 3,500 floodplain lakes or *beels*, including both tectonic (closed type) and ox-bow lakes (open type) scattered throughout the Brahmaputra valley receive regular flood pulses during monsoon. Almost all types of riverine fish including Indian major carps depend on riparian ecotones for spawning. This lateral migration of spawning fish alters the species composition of floodplain lakes during rainy months. Trophic structure is typically present from surface dwelling to typical substrate dwelling species



*The beels constitute a major fishery resource of Assam and have provided livelihood support to thousands of riparian fisher folks for centuries*

like *Glossogobius giuris* to mud-dwellers like *Monopterus albus* or burrower like *Channa barca*. Fish species may be grouped into five habitat guilds, such as surface water guilds, column dwellers, bottom dwellers, marginal dwellers and mud dwellers. Further, wetland fish may also be categorized as: (a) food fish; (b) ornamental; (c) larvicidal and (d) medicinal. Flood water rejuvenates the *beel* by providing fresh water and nutrients, auto stocking of fish as well as flushing out of floating macrophytes mainly water hyacinth. The common fish biota of *beels* and seasonal water bodies are *Amblypharyngodon*, *Botia*, *Esomus*, *Channa*, *Crossocheilus*, *Danio*, *Glossogobius*, *Leiodon*, *Macrogonathus*, *Pethia*, *Puntius*, *Rasbora*, *Salmophasia*, *Trichogaster* and *Xenentodon*. The *beels* constitute a major fishery resource of Assam and have provided livelihood support to thousands of riparian fisher folks for centuries.

Maguri *beel* is one of the largest floodplain lakes in upper Brahmaputra basin located in the periphery of Dibru-Saikhowa National Park in Tinsukia district, Assam. Maguri, an important source of capture fisheries, covers an area of 167.4 hectares at full storage level. The ecology and faunal assemblage of the wetland is almost entirely regulated by rainfall and combined discharge of rivers Dibru and Lohit. Altogether 110 fish species, mostly dominated by air breathing forms and also a good number of ornamental and endemic species like *Badis assamensis*, *Channa aurantimaculata*, *C. barca*, *C. bleheri*, *C. stewartii* and *Mystus dibrugarensis* have been recorded from this wetland. It is also a rich habitat for chelonians and avian fauna. Over 500 avian species including a large number of migratory birds in the locality attracts a large number of tourists every year.



Wetlands are also rich in benthic fauna found attached with aquatic macrophytes or sediments as nymphs or larvae. Two insect species (*Cybister tri punctatus* and *Lethocerus indicus*) and several ubiquitous mollusc species like *Lamellidens corrianus*, *L. marginalis*, *Corbicula assamensis*, *C. striatal*, *Brotia costula*, *Bellamyia bengalensis*, *Tarebia lineate* are used as non-conventional food as well as for medicinal purposes by indigenous people. Further, rare and endemic mollusc species such as *Solenaia soleniformis*, *Parreysia* spp. and *Pseudodon* spp., have also been recorded from wetlands and slow moving streams of upper Brahmaputra basin.

### Conclusion

About 200 fish species reported in the mid-twentieth century from the Brahmaputra

valley have now disappeared especially between Saikhowaghat and Dhansirimukh. High fishing pressure and wanton killing of gravid and juveniles by using explosives and chemicals as well as the *jeng* fishing (a local destructive fishing technique) have been identified as major threats to the fish biodiversity. Deforestation in the catchment area, construction of roads and embankments and blockade of feeder channels of floodplain lakes have contributed to the reduction of habitat complexity. Excessive boulder and sand excavation from the riverbed also alter the micro-habitats of many hill-stream fish species. A comprehensive study on the entire Brahmaputra basin must be carried out to assess anthropogenic and environmental stresses on instream and also riparian biota so that effective policies for river management can be formulated to maintain environmental flow for sustenance of existing riverine biota as well as dependent economy and livelihoods of riparian people.

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## Gangetic dolphin

S.P. Biswas

**OUT OF** the four freshwater dolphins found around the globe, the one which is found in the Ganga-Brahmaputra-Meghna system is known by a plethora of names: *Sus*, *Shushuk*, *Xihu* in Hindi, Bengali and Assamese respectively. To the scientific community this rare cetacean mammal is- *Platanista gangetica gangetica*.

The Gangetic dolphin is the national aquatic animal of India. It has a robust fish-like body and may attain 2 meters length and weigh about 100 kilograms or more. Calves and young dolphins are dark colored but as they grow, the body colour changes and the adults are mostly slate grey. Gangetic dolphins are virtually blind but are champion swimmers and movement even in highly turbid water is possible with the help of a sonar system (echolocation) located on the forehead (melon). Gangetic dolphins prefer sandy riverbeds, moderate water currents, and are often encountered in small groups of 3 or 4 in relatively deeper portions of the river (depth of more than 3 meters), usually at a river confluence and also at river meanders during dry months. The long, pointed rostrum bears a series of homodont teeth meant for grasping the prey, mostly fish.

Dolphins perform all their metabolic activities under water, except breathing. The mean time between two surfacing has been recorded as 38 to 45 seconds for adults. They roll over rather quietly exposing the forehead and part of the back for a second or so. The infants are very playful, surface more frequently (15 to 20 seconds between two intervals) and often jump over the water.



Sanjay Das

The dolphin is the keystone species in a riverine ecosystem. It maintains the ecosystem equilibrium by controlling the population of secondary consumers. In fact, the presence of dolphins is a clear indication of the 'good health' of a river. Dolphins were once abundant in the Brahmaputra river but the population came down drastically in the eighties primarily due to intentional killing of dolphins for their oil which is believed to be a master drug against various ailments. Dolphin oil was also used for catching cat fishes especially *Clupisoma garua*. People were ignorant about the importance of dolphins in a riverine ecosystem. In one particular instance, more than 50 dolphins were killed, and their body oil extracted by some professional killers at Narain Dahr, upstream of the Barak (Meghna river system) in 1985-86. This led to a virtual extinction of dolphins from the Barak River in southern Assam. At present only 'fragmented populations' of dolphins can be sighted in certain pockets in protected areas like Dibru-Saikhowa National Park, river Subansiri, Kaziranga National Park and River Kulsi in the Brahmaputra valley.

Continuous widening and aggradations of the river due to bank erosion, high rate of siltation and loss of prey base in the habitat are major threats for the survival of dolphins. High rate of siltation has reduced the depth of the river especially 'deep pools' by 30 percent in the last four decades and this is the prime reason for the shrinkage of dolphin habitats in the upper reaches of the Brahmaputra. Fortunately, the number of Gangetic dolphins in the central and lower reaches of the Brahmaputra has shown an increasing trend due to continuous efforts by conservation groups in the last two decades.

*The Gangetic dolphin is the national aquatic animal of India. The presence of dolphins is a clear indication of the 'good health' of a river*



## Hoolock gibbon

Dilip Chetry

**WESTERN HOOLOCK** gibbon (*Hoolock hoolock*) and Eastern Hoolock gibbon (*Hoolock leuconedys*) are two charismatic primates that represent the ape group in India. Their distribution in India is restricted to the southern bank of the Dibang–Brahmaputra river system in the northeastern states of India excluding Sikkim. The Eastern Hoolock gibbon occurs only in the Siang basin and in Assam. Extremely elusive, the gibbons inhabit tropical wet evergreen, tropical semi-evergreen and sub-tropical moist deciduous forests. Being exclusively arboreal, Hoolock gibbons depend on the high canopy coverage in their habitats. They are diurnal and exhibit extreme form of brachiating skill. Fruit is the staple food of frugivore Hoolock gibbons. They live in monogamous families and an ideal Hoolock gibbon family has one adult male, one adult female and one to four offspring. The average group size is three. Each gibbon family maintains its own territory through their trademark duet song. Adult males are

black in colour with white eyebrows and adult females are copper tanned in colour. Neonates are milky white in colour. Juveniles of both the sexes are black with white eyebrows. Females turn gray to tan colour in sub-adult stage, but males retain the black colour till adulthood. There is no marked size variation between males and females. Some morphological differences are there between the two species. Females attain sexual maturity at the age of 6 to 8 years and the age for sexual maturity in males is 7 years. Estimated gestation period is 183 to 225 days and inter-birth interval is 2 to 3 years. The gibbon is our close living relative and wild gibbons share 95 percent of their genetic material with us. Gibbons play a vital role in the regeneration of forests as active seed dispersers.

The principal threats to gibbons in Assam are massive habitat loss, intensive habitat fragmentation, *jhum* cultivation and hunting. Loss of habitat is a result of wanton destruction of forests, encroachment, agro-expansion, and development projects. Along with habitat loss, fragmentation of habitats is becoming another major threat to gibbons. Reducing cycles of traditional *jhum* cultivation has also threatened gibbons by creating secondary forests. Hunting of gibbons as food, for traditional medicine, sports, and ornaments is also a common custom among many tribes.

In the Indian Wildlife Protection Act, 1972, both species of Hoolock gibbons are listed as Schedule I species. According to the IUCN red list of 2019, Western Hoolock gibbon is endangered and Eastern Hoolock gibbon is vulnerable. The Gibbon Wildlife Sanctuary in Jorhat district of Assam is the only protected habitat in the country to be named after a primate species. Thirteen protected habitats in Assam support the Western Hoolock gibbon. Only three reserve forests in Sadiya harbour protect the eastern Hoolock gibbon in Assam. Implementation of the slogan “Save Forest, Save Gibbon” in its true sense can only ensure long-term conservation of gibbons and their habitats in Assam.

*Hunting of gibbons as food, for traditional medicine, sports, and ornaments is also a common custom among many tribes*

## Golden langur

Rekha Chetry

**THE GOLDEN** langur (*Trachypithecus geei*) is a highly attractive arboreal primate discovered in 1953. It is endemic to northwest Assam in India and neighbouring Bhutan. In India, its distribution is limited to an area bounded by the river Manas in the east, Sankosh in the west and the Brahmaputra in the south. In India they are primarily inhabitants of wet evergreen forests and semi-evergreen forests. Sal (*Shorea robusta*) dominated forests and secondary forests also support them. The diurnal golden langurs spend 99 percent of their active time in trees exploring the top and middle strata of forests, though in degraded habitats they descend to the ground.

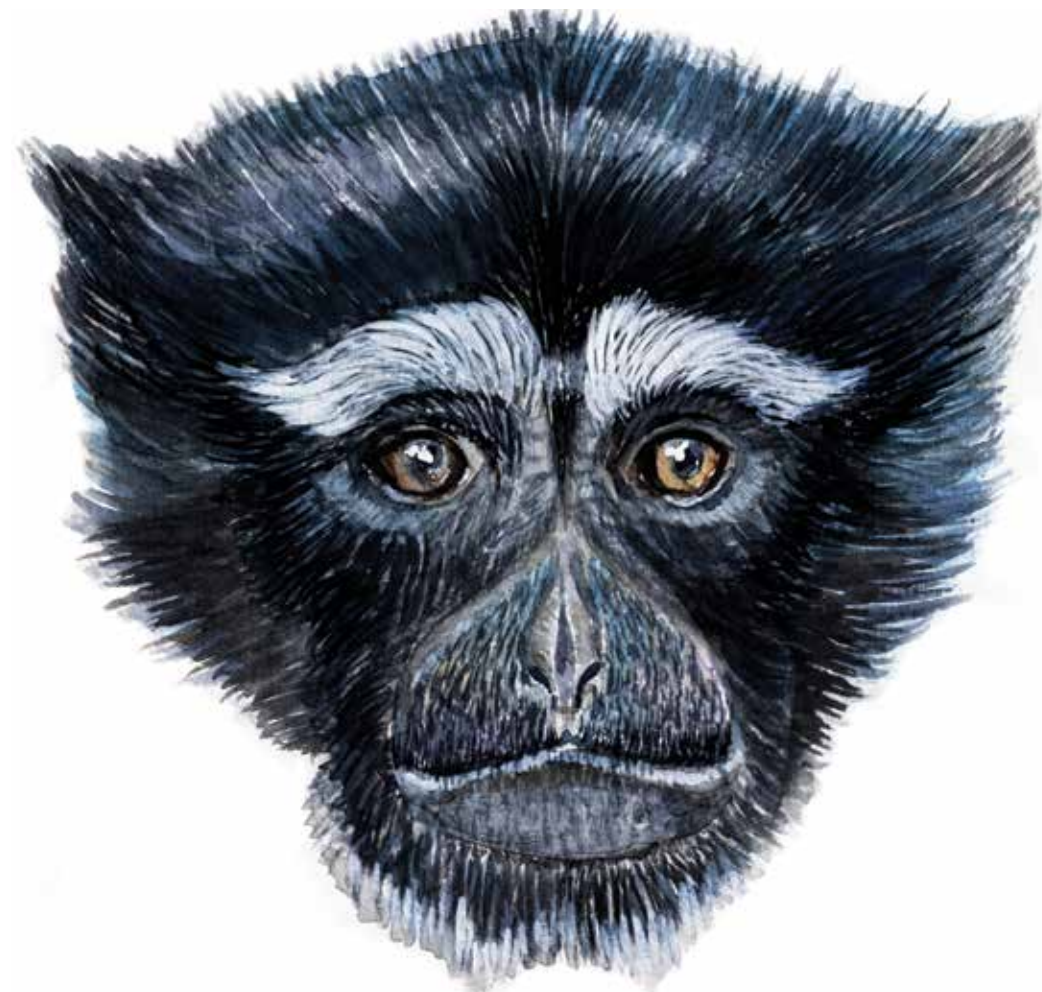


Illustration by Tania Zakir

*Gibbons play a vital role in the regeneration of forests as active seed dispersers*

Highly social golden langurs live in diverse social frameworks such as uni male–multi female troop or society, bi male-multi female troop, multi male-multi female society, all male bands or societies and lone males. Uni male–multi female troops are more common and stable. Average troop size varies in different habitats and generally ranges from 2 to 12 individuals. Inter-individual bonding between the troop members is very strong which is the key to their peaceful societies.

The major activities of golden langurs are locomotion, resting, feeding, and monitoring. Other activities include grooming and playing. Golden langurs are folivorous and leaves contribute 60 percent or more of their daily diet. Fruits, seeds, flowers and flower buds, stem cortex, twigs, bamboo shoots are other food items. Gum feeding, soil feeding, algae feeding, insect feeding, snail feeding have also been observed. More than 200 species of food plants have been identified from different habitats in Assam. Langurs spend their nights on selective tall trees to avoid predators.

*From 2016 to 2020, it has been in the IUCN list of top 25 most endangered primate species of the globe*



Illustration by Tania Zakir

Golden langurs are seasonal breeders and June to January is the breeding season. The typical golden coat colour of the species can be observed only during the breeding season. The estimated gestation period is 168 to 180 days, and inter-birth interval is two years. January to June is the birthing season. Male golden langurs attain sexual maturity at 5 to 7 years, while the age of sexual maturity for the female is four years. The golden langur is a Schedule-I species in the Indian Wildlife (protection) act, 1972, and an endangered species in the IUCN Red list (2020). From 2016 to 2020, it has been in the IUCN list of top 25 most endangered primate species of the globe. Chakrashila Wildlife Sanctuary and Manas National Park are the only protected habitats for golden langur in India. Habitat destruction and fragmentation are the most severe threats to golden langurs in Assam. Fatalities due to electrocution, dog predation and vehicular accidents are emerging threats. We the people of Assam should do our best for the conservation of golden langur which is a part of our rich natural heritage.

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## *Greater one-horned rhino*

*Bibhab Kumar Talukdar*

EVERY RIVER in this world carries stories of culture and biodiversity of which humans are an integral part. The alluvial floodplain grassland ecosystems of the Brahmaputra provide an excellent habitat for the greater one horned rhino (*Rhinoceros unicornis*). The rhino represents the floodplain ecosystem of the Brahmaputra. For Assamese people, the rhino is the epitome of the conservation movement in Assam, reflecting the success of the conservation efforts which began early in the nineteenth century, when it was assumed that the Kaziranga area in Assam had only about a dozen rhinos left.

The rhino has been a conservation dependent species since early nineteenth century because of the threats from poaching and destruction of grassland habitats. The conservation of rhinos in early nineteenth century got a boon through the declaration of key rhino habitats in Assam as protected areas. The first sincere efforts to protect the estimated population of a dozen rhinos in Kaziranga was initiated in the year 1905. Kaziranga, Manas and Laokhowa were finally declared as Game Reserves in the year 1908. In the year 1968, the Assam Government realized the need to convert the Kaziranga Wildlife Sanctuary into a national park and began making efforts to enact the Assam National Park Act, which came into effect in 1969. In January 1974, in pursuance of the Assam National Park Act 1968, the Kaziranga was declared as the first National Park covering an area of about 430 square kilometers.

Due to proactive conservation initiatives, Assam currently (in year 2020) has about 2,650 rhinos. This conservation success has been achieved due to the dedicated work of the forest officials, including frontline wildlife staff working hard to conserve and protect

*The alluvial floodplain grassland ecosystems of the Brahmaputra provide an excellent habitat for the greater one horned rhino*



*The rhino conservation effort is one of the biggest conservation success stories of India. From just a dozen rhinos left in the wild in early nineteenth century, today there are more 2650 rhinos!*

the rhino and their habitats despite diverse challenges. Support and cooperation is being rendered by local communities, complimentary support is being rendered by district administration and Assam police and also by various non-government organisations. The media also proactively assisted in spreading conservation awareness to reach out to diverse audiences with regards to rhino conservation. The rhino conservation success is the pride of Assam.

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**Asian elephant**  
(*Elephas maximus indicus*)  
**Red jungle fowl**  
(*Gallus gallus*)  
**Wild water buffalo**  
(*Bubalus arnee*)

## Amphibian and reptile diversity

M Firoz Ahmed

**THE AMPHIBIANS** and reptiles are one of the poorly understood groups of vertebrates across the globe. Our understanding about these groups in many areas, bestowed with high biological diversity has just got momentum. The hills of northeast India and the eastern Himalayas represent a complex of ecosystems of extraordinarily rich biodiversity, resulting from the meeting of three biogeographic regions of the world: Indian, Indo-Chinese, and Indo-Malayan. The Brahmaputra river traversing through the hills and plains of the region for millions of years, continues to influence all forms of life. The unique position, climate and physiography have laid the foundation for proliferation of a variety of ecosystems that raised a diverse biota with high level of endemism.

The Himalayas, the topography, the monsoon, the forests, and the river systems, all together, contributed to the evolution of the region as a hotspot for amphibians and reptiles: 146 species of amphibians and 180 species of reptiles are recorded in this region. This number is only going to increase as explorers and scientists have started to take more effort to understand their diversity only recently. Positioned next to the Tropic of Cancer, with an altitudinal range from 20 meters to 5,000 meters above sea level, the region houses a striking range of habitats, from tropical floodplains and forests to alpine meadows and forests, through vast subtropical humid forests as altitude rises from south to north. This unique mix of ecosystems is intricately complex.

Northeast India is characterized by a hot, wet summer, and a cool, usually dry winter. Temperature varies from subzero to maximum 38 degrees centigrade. Annual average rainfall is above 2,000 millimeters which varies from less than 1,000 millimeters in parts of central Assam to more than 12,000 millimeters in parts of the southern Meghalaya plateau such as in Cherrapunjee and Mawsynram.

Understanding reasons for the high diversity of herpetofauna in the northeast region of India can be complex but not impossible. As the Ganges drains into Bangladesh territory and shares the same floodplains as the Brahmaputra, northeast India receives several mainland Indian species such as gharial *Gavialis gangeticus*, Gangetic softshell turtle *Nilssonia gangeticus*, Indian bull frog *Hoplobatrachus tigerinus* and *Polypedates taeniatus*. Even further, the floodplain connects the region to an African genera of tree frog, *Chiromantis sp.* found in the east and northeast of India.

As we move upstream of the Brahmaputra, the diversity of species of herpetofauna also starts going up. There are as many as 25 species of amphibians and 95 species of reptiles found in the floodplains itself. Once thought extinct in the wild, the black softshell turtle *Nilssonia nigricans* lives in the lakes and networked channel systems of the Brahmaputra and its major tributaries.

*Once thought extinct in the wild, the black softshell turtle lives in the lakes and networked channel systems of the Brahmaputra and its major tributaries*



**Indian bullfrog**  
(*Hoplobatrachus tigerinus*)

Just above the floodplains up to the base of the hills, a number of unique and endemic species of amphibians are found in the region, such as Orang sticky frog *Kalophrynus orangensis* and Assamese balloon frog *Kaloula assamensis*. This is the transition zone from floodplains to the hills, where the endemic Assam roof turtle *Pangshura sylhetensis*, inhabits. Further up, in the lower hills, two species of turtles and tortoises, Asian brown tortoise *Manouria emys* and Malayan box turtle *Cuora mouhotii*, indicative of their names, connects the region to the Malaya and the rest of Southeast Asia, bringing in more complexity to its diversity.

The herpetological diversity in the northeast hills increases with increasing altitudes up to the mid elevation before it goes down near the snow line. The hills thus also connect to several species of Malayan origin that occur in Southeast Asia, the reason being the similarity in habitats and ecosystems extending to Southeast Asia over Myanmar and Thailand to peninsular Malaysia.

A unique species of amphibia, Jerdon's tree frog *Nasutixalus jerdonii* occurs in the subtropical broadleaf forests in the hills of northeast India and southeast Asia that lives in the holes of trees that contain small quantities of water. As life is hard in such an uncommon habitat, particularly for a tadpole confined to such a narrow space without mobility and food resources, the mother comes to their rescue. The female visits such breeding tree holes regularly and deposits unfertilized eggs for



**Diamond-backed lizard**  
(*Sitana*)



**Asian roofed turtle**  
(*Pangshura sylhetensis*)

**King cobra**  
(*Ophiophagus hannah*)



*The largest and longest venomous snake in the world, the King Cobra is the unique snake species where the females lay eggs in nests made with fallen leaves and guard them until the eggs hatch*

her tadpoles on which they feed and grow to miniature frogs one day to explore the vibrant world outside.

Similarly, the forest floors of the tropical forests of northeast India, often with thick leaf litter, is home to many species of herpetofauna. The largest and longest venomous snake in the world, the King Cobra *Ophiophagus hannah* occurs widely in the moist evergreen forests. This is the unique snake species where the females lay eggs in nests made with fallen leaves and guard them until the eggs hatch.

Further upstream of the Brahmaputra river, as it becomes narrower and powerful, it is known by the name of Siang, and creates a unique topography in the Himalayas. It is where the Himalayas are cut deep by the Tsangpo and Siang at an altitude of 550 meters at the Xizang-India border with a sharp fall from 2,950 meters near Nyingchi in Xizang. This transition of Tsangpo through the 'Great Bends' creates a pass for several species from Tibet and south China into India using the Himalayan foothills as a conduit. Medo pit viper *Trimerusurus medoensis*, and Cross barred treefrog *Rhacophorus translineatus* are two best examples of Indo-Chinese cross over.

While the Himalayas act as a barrier for most terrestrial species between India and the Tibetan plateau, some amphibians (*Scutigera sp.*) still exist across the Himalayas.

The amphibian *Scutigera* genera are found to occur in the high Himalayas that may seem inhospitable for them, between 3,000 and 4,000 meters above sea level. It might be possible that they were separated by the rising Himalayas millions of years ago or they speciated on both the north and south flank of the Himalayas using the Yarlung-Tsangpo-Siang as a biological corridor after the rise of the Himalayas.

The Brahmaputra basin in northeast India has witnessed human induced local extinctions of at least two species of reptiles in recent times: the mugger *Crocodylus palustris* and the gharial *Gavialis gangeticus*. The mugger was extirpated much earlier, the gharial followed more recently in the nineteen seventies. Human intolerance towards 'dangerous' crocodilians was the primary reason for extirpation of these giant reptiles since human occupation of the river basins began overlapping their habitats in the mid-twentieth century.

Many species of amphibians and reptiles are endemic to this region or with restricted range. Such species face high threat to extinction than those widely distributed. However, limited information on distribution of such species hampers diligent evaluation of their conservation status. Among the known species of the northeast region of India, nine species of amphibians, about 6 percent of known species, and 29 species of reptiles, about 16 percent of known species are threatened as per the IUCN red list.

The amphibians and reptiles are known indicators of environmental changes in an ecosystem given their high sensitivity to their surrounding environment. Humans have always benefited by their presence. For example, reptiles control the rodent population. However, herpetofauna are threatened today due to our own actions leading to diminishing the ecosystem services over generations. This is very prominent, particularly, where habitats have been converted into agriculture and monocropping by removing many species living there. Pollution of air, water, and soil through negative human actions on ecosystems is another major threat to the herpetofauna. More importantly, unplanned, and overoptimistic river valley development projects in the Brahmaputra basin is a serious conservation concern to amphibians and reptiles.



The critically endangered  
Elongated  
tortoise  
(*Indotestudo  
elongata*)

While superior technology has brought down cost of solar power production globally, hydropower is still being promoted with misinformation as profitable and ecofriendly in the upper Brahmaputra basin areas in northeast India. Ecological disaster is inevitable from such hydropower dams and reservoirs, with far reaching consequences. A dam on a river not only kills the living river, but it also inundates a large area which includes habitats for endemic, rare, and threatened species of herpetofauna or displacement of individuals living there, causing stress in the ecosystem.

Policies and planning must be aggressively changed to make the world more livable and sustainable for our future generations. This is more so in the light of climate change events. Value of ecosystem and nature needs to be part of our economic and development agenda to ensure that we grow sustainably.

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## MANAS BASIN

### *Wetlands of Bhutan*

*Karma Chopel Ghongsar*

**BHUTAN HAS** a number of wetlands in the form of glacial lakes, marshes, swamps, and ponds which also have particular biological, spiritual and socio-cultural functions. Wetlands in Bhutan are under increasing pressure from unplanned development, disturbances and lack of awareness among the general public leading to the loss of integrity of the wetland ecosystem. Even though there is no aggregated data to make an unambiguous demonstration, there is a strong perception, backed by informal reporting, that Bhutan is experiencing a drying up of streams and creeks with the disappearance of their associated marshes and swamps.

Wetlands support high biological diversity including migratory birds and other flora and fauna. They are also important for water storage and release which sustains the perpetual flow in our rivers that is crucial for our hydropower generation. Culturally these wetlands and lakes are revered as sacred sites and are associated strongly with the traditional belief systems and lifestyles. It is reported that 104 bird species inhabit these freshwater ecosystems in Bhutan and many other aquatic plant and animal species such as *Rununculus trichophyllus*, *Hydrilla verticillate*, *Potamogeton crispus*, *R. Tricuspis*, *Acorus calamus*, *Acorus gramineus*, *Shoenoplectus juncooides*, *Typhus spp.*, *Phragmites spp.*, *Equisetum spp.*, *Aconogonum alpinum*, *Carex spp.*, *Juncus spp.* and *Salix sp.* Similarly, large predators such as *Panthera tigris tigris*, *Panthera pardus*, *Panthera uncia*, and smaller predators such as *Neofelis nebulosa*, *Cuon alpinus*, and *Felis bengalensis* come to drink water and stalk prey species at water sources. Other mammals associated with wetland ecosystems include *Platanista gangetica* *Lutra lutra*, *Lutrogale perspicillata*, *Bubalus arnee*, *Felis viverrinus*, *Herpestes urva*, *Nectogale elegans*, *Chimarrogale himalayica*.

*Culturally these wetlands and lakes are revered as sacred sites and are associated strongly with the traditional belief systems and lifestyles*

The Coleoptera species *Hydraena karmai* was discovered from a puddle in a place called Zomyuethang behind Punakha Dzong. This species was never known to science before. Several new species of Ephemeroptera (may flies), Plecoptera (stone flies) and Trichoptera (caddis flies) EPT taxa were also discovered from the water bodies in Bhutan in a few weeks of sampling and assessment from Paro, Thimphu, Tsirang and Sarpang Dzongkhags (EU funded Assessment System to Evaluate the Ecological Status of Rivers in the Hindu Kush-Himalayan Region (ASSESS HKH) project led by the author). The impacts of climate change compounded by the ad hoc developmental activities will wipe these newly discovered species and others even before they are discovered, signaling the importance and the need to address the impacts of climate change and ad hoc developmental activities with great urgency.

The relict species of dragon fly larvae, *Epiophlebia laidlawi* was found in the headwater of *Drey Chhu* stream above Dechencholing, Thimphu and in *Lamchela Chhu* stream in Chendebji, Trongsa. This species is categorized as rare and highly threatened and the only other places where it is ever found to this day is in eastern Japan and Nepal. This species is an indicator of the pristine water quality.

Karma Chopel Ghongsar



*Hydraena Karmai* (left picture) found only in Bhutan; *Epiophlebia laidlawi* (right) indicator of pristine water quality.

Bhutan acceded to the Ramsar Convention on Wetlands on 7 May 2012.

Currently Bhutan has three Ramsar sites:

1. **Bumdeling Wildlife Sanctuary**, Tashiyangtse; 142 ha; 27°40'23"N 091°26'29"E. This glacial valley in the northeast Bhutan was a rice producing area. At least 74 bird species including the endangered black necked cranes (*Grus nigricollis*) inhabit this site. Other endangered species recorded at the site include the snow leopard (*Panthera unica*), tiger (*Panthera tigris tigris*), Asiatic wild dog (*Cuon alpinus primaevus*) and Himalayan musk deer (*Moschus leucogaster*).
2. **Khotokha** in Wangdue District with an area 114 ha; 27°25'55"N 89°59'33"E, is located west of the Black Mountain range. Khotokha wetland is one of the sources for the tributaries of the Punatsang Chhu, and also provides drinking water and irrigation water for potato farms. The subalpine shrub marsh, consisting of peat bogs and fens, is one of the last remaining places in Bhutan where summer-winter migrations of farmers are practiced. The black necked crane along with other endangered species such as the Himalayan musk deer (*Moschus leucogaster*) and the Asiatic wild dog (*Cuon alpinus primaevus*) inhabit this site.
3. The **Gangtey-Phobji** is the third and largest wetland in Bhutan of international importance. This site lies in a wide glacial valley with scenic beauty and clear streams in the valley such as Nakey Chhu, and Khewang Chhu. This site comprises of rich ecosystems and provides prime winter habitat for up to 300 black necked cranes (*Grus nigricollis*), and other globally threatened species such as the endangered red panda (*Ailurus fulgens*) and tiger (*Panthera tigris tigris*), and the vulnerable sambar (*Cervus unicolor*).

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## White-bellied heron

Indra P Acharja

THE WHITE-BELLIED heron (*Ardea insignis*) is a large wader species of family *Ardeidae*, order *Pelecaniformes*, found in freshwater ecosystems of the Himalayas. Historically known to be found across South Asia, it is now one of the rarest birds in the world, having disappeared from most of its historical range including Nepal and Bangladesh. The global estimated population is between 49 and 250 adults according to IUCN data, however fewer than 60 individuals are known to live in the wilds of Bhutan, Northeast India, China, and Myanmar. There are five actively breeding pairs in Bhutan and are the only currently known breeding population in the world. The heron is categorized as critically endangered under the IUCN Red List of threatened species since 2007 and the species is also protected under respective laws in all the range countries.

*The White-bellied heron is now one of the rarest birds in the world*





The white-bellied heron is the second largest heron standing up to 130 centimeters tall with a wingspan of nearly 2 meters and weighs up to 5 kilograms. The heron has a dark greyish body with contrasting white belly and vent, white-streaked scapulars, fore neck, and upper breast with prominent crest and long sharply pointed black bill with slight serration on the tip of the lower mandible. Juveniles are darker than adults, with browner-tinged vent, the neck is more streaked, the plumes are smaller, and the bill is shorter and greyish in colour. White-bellied herons are sexually monomorphic and differentiating sexes visually is almost impossible. During breeding seasons, the plumage turns light grey with a whitish neck and crest.

The white-bellied heron is a rare, elusive, and highly sensitive piscivore species, inhabiting freshwater rivers, streams, lakes, and wetlands up to 2000 meters altitude. The herons forage in silent open waters by walking along the shallow banks of up to 60 centimeters depth with low to medium riffle. They are non-migratory but move up to 200 kilometers from one feeding locale to another looking for food during seasons when food is scarce. Generally, they are solitary, but groups of up to 4 are seen during breeding seasons and up to 6 are seen before juveniles attain independence. They are very silent and only make loud croaking calls; *auk auk auk urrrrrr*, during courtship or when alerted.

*There are only five actively breeding pairs in Bhutan and are the only currently known breeding population in the world*

Unlike many other heron species which breed in colonies, the white-bellied heron breeds in solitude. Generally, the breeding season begins from January and juveniles fledge by end of June, but sometimes it prolongs through July or August. They build simple platform nests of dried twigs and small branches without foliage on tall trees with open canopy at a height of 10 to 30 meters, both on conifer and broadleaved species, within 10 to 100 meters from the nearest waterbodies, preferably on slopes with ample open space and good exposure to sun, at an altitude of 200 to 1,500 meters. The average clutch size is three, the incubation period is 30 to 33 days, the average brood size is of two and nestlings fledge 70 to 75 days after hatching. Juveniles reach independence and leave their parents after 2 to 3 months of fledging.

The distribution range of the white-bellied heron has shrunk by 90 percent over the century. The extremely low and shrinking population across the region is attributed to human exploitation of river systems and disturbance in core foraging and breeding habitats. The small gene pool with a few breeding pairs restricted to small geographical range is of immediate concern. The conversion of sections of rivers or tributaries or entire rivers to hydroelectric dam regimes is the single biggest threat to the white-bellied heron and its habitat across the range. Most of the habitats are very susceptible to disturbances both man-made and natural, making the species highly vulnerable to extinction. The call to save this species from extinction is urgent and the only way is to save our rivers.

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## Fish diversity

*D B Gurung*

### Ichthyology in Bhutan

Bhutan is rich in freshwater biodiversity. Bhutan has four major river systems viz. Amochhu (Toorsa), Wangchhu (Raidak), Punatsangchhu (Sankosh), and Drangmechhu-Mangdechhu (Manas)<sup>28</sup>. There are 2,674 glacial lakes in Bhutan and the largest glacier has an area of 36 square kilometers and is located in the Punatsangchhu basin<sup>29</sup>. Besides rivers, lakes and glaciers, Bhutan also has 3,027 high altitude wetlands including supra-snow lakes<sup>30</sup>.

The National Research Centre for Riverine and Lake Fisheries of the Department of Livestock of the Ministry of Agriculture and Forests has prepared a checklist of 104 species from the Amochhu, Wangchhu and Punatsangchhu river basins of western Bhutan<sup>31</sup>. However, since ichthyology is a new science in Bhutan, many of these species are identified up to the genus taxa only.

### Threats to Water Resources and Fish Conservation

About 51.44 percent of the country's geographical area has been declared as Protected Areas which include National Parks, Wildlife Sanctuaries, Strict Nature Reserve, and Biological Corridors<sup>32</sup>. It is perhaps assumed that the protected area system takes care of the aquatic biodiversity and aquatic ecosystems per se, but this is not the case. Climate change, hydropower dams, farm road construction, mining, and introduced and invasive species are some of the major conservation threats for native fish species.

### Hydropower projects

The construction of hydropower projects results in blocking fish migration, habitat fragmentation, river-bed siltation and other environmental degradation around the dam construction site. Construction of fish ladder and lifts may not be the best options when the minimum flow of the river is not maintained below the dams for most part of the year once the power plants start operating.

### Introduced and invasive species

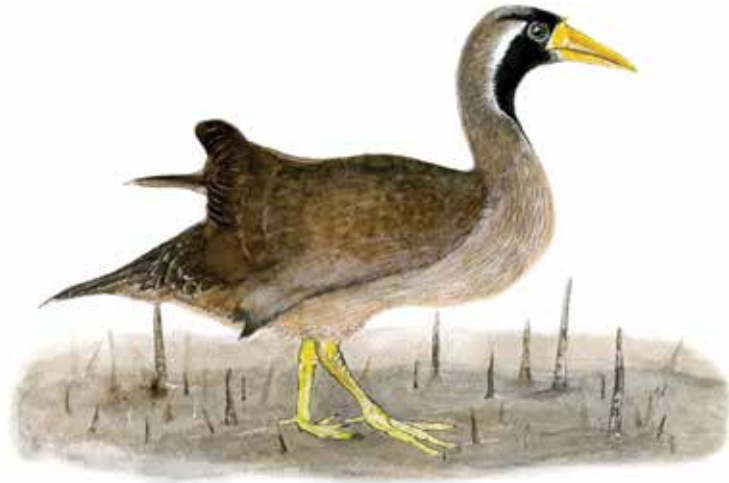
In 1940, the Scottish origin Brown trout ova were transported to Darjeeling from Kashmir, from which some developing fry were transported to Bhutan, reared in Haa hatchery and the fingerlings released in Haachhu river in 1941<sup>33</sup>. In Bhutan, so far there is no assessment on the impact of introduced species on the native species. However, field observations indicate that the fingerlings of native species are rarely found in areas where Brown trout has established successfully.

Besides Brown trout, many species of fish are introduced through aquaculture, fish market, aquarium trade and socio-religious practice called *Tsethar* – live release<sup>34,35</sup>. *Clarias gariepinus* Burchell is one such species which has established in Amochhu

*Bhutan is rich in freshwater biodiversity. About 51.44 percent of the country's geographical area has been declared as Protected Areas*

### Endangered fauna of the River basin

Illustrations by Tania Zakir



*Masked Finfoot (Heliopais personatus)*



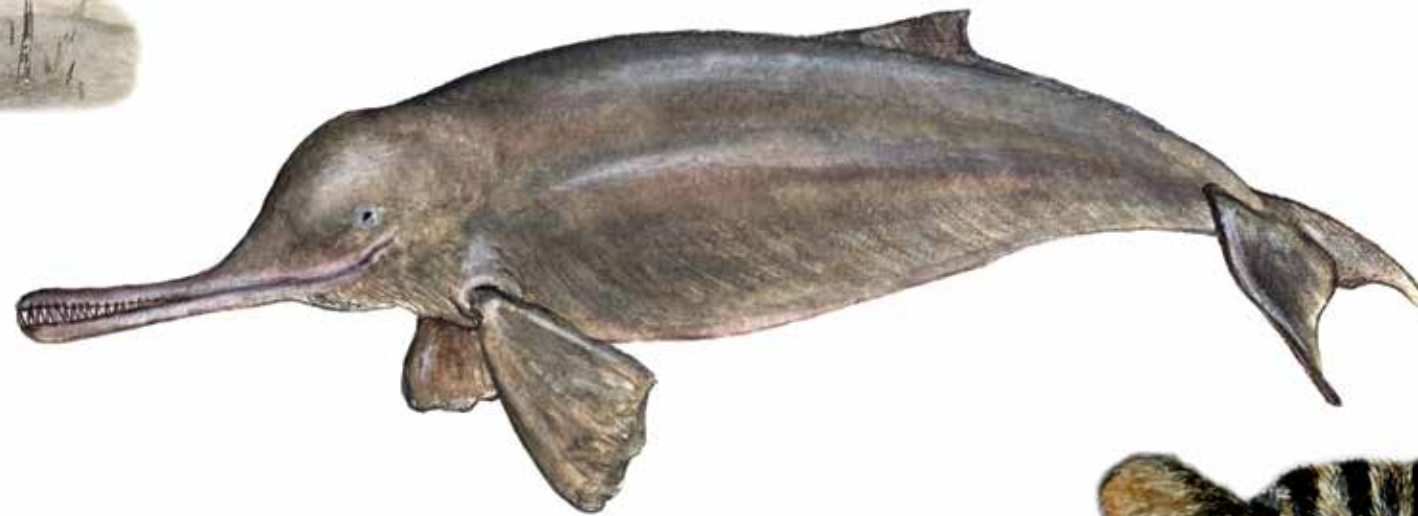
*Western Hoolock Gibbon (Hoolock hoolock)*



*Golden Langur (Trachypithecus geei)*



*Greater Adjutant (Leptoptilos dubius)*



*Gangetic River Dolphin (Platanista gangetica)*



*Golden Mahseer (Tor putitora)*



*Fishing Cat (Prionailurus viverrinus)*



*Clouded Leopard (Neofelis nebulosa)*

River, bordering the Indian state of West Bengal<sup>36</sup>. This fish primarily feeds on the fingerlings of native species. *Oreochromis niloticus* (Linnaeus), *Cyprinus carpio* Linnaeus, *Hypophthalmichthys molitrix* (Valenciennes), *Hypophthalmichthys nobilis* (Richardson), *Ctenopharyngodon idella* (Valenciennes), *Cirrhinus mrigala* (Hamilton), *Catla catla* (Hamilton), *Labeo rohita* (Hamilton), and *Oncorhynchus mykiss* (Walbaum) are other species introduced in aquaculture in Bhutan. Among these species, the Rainbow trout (*O. mykiss*) has the potential to become an invasive species. Additionally, there are also some aquarium species appearing in the country for which there is no account.

### Road construction and mining

Sub-standard farm road construction has resulted in downstream sedimentation, soil erosion, changes in hydrological characteristics, increased surface runoff, deforestation, and loss of biodiversity<sup>37</sup>. Careless disposal of excavated road materials often results in muddy river water causing considerable damage to aquatic biodiversity.

The environmental costs of mining include mud slides, sedimentation downstream, soil erosion, and water pollution besides noise and air pollution<sup>38</sup>. In southern Bhutan, during monsoon, few overburden slips from the mines have been noted in blocking of river and stream courses temporarily. Therefore, priority should be given to maintaining certain environmental standards in the construction of farm roads and mining operations.

### Low priority species

While Bhutan is recognised for its conservation efforts, its priorities are on protection of charismatic megafauna such as the Royal Bengal tiger, snow leopard, and golden mahseer. In the process, some Near Threatened, Threatened or Endemic species such as the *Anguilla bengalensis* (Gray), *Bagarius bagarius* (Hamilton), *Clarias magur* (Hamilton) and *Parachiloganis drukyulensis*<sup>39</sup> are overlooked. Species such as *P. drukyulensis* have a very narrow distributional range, occurring in few streams of southern Bhutan which are under anthropogenic pressure. Therefore, such species may need to be given conservation priority as well and assessed for IUCN Red List.

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## TEESTA BASIN

### Taxonomic diversity of birds

Bishal Thakuri and Bhoj Kumar Acharya

THE INDIAN state of Sikkim located in the Teesta basin in eastern Himalaya, forms a part of the Himalayan Biodiversity Hotspot, and is one of the 36 globally significant biodiversity regions<sup>40</sup>. The variation in elevations in the Teesta basin ranging from 300 meters to 8,586 meters, resulting in distinct gradation of vegetation, climate and other

topographical features, combined with high humidity have created diverse habitats and novel niches conducive for various species of flora and fauna<sup>41</sup>.

A total of 579 bird species belonging to 57 families and 17 orders have been recorded in Sikkim, which is about 44 percent of all the birds found in India<sup>42</sup>. Although there are records of collection of birds dating back to the middle of the eighteenth century during British expeditions, the first systematic study on birds of Sikkim was undertaken by Salim Ali which led to the publication in 1962 of the book "Birds of Sikkim"<sup>43</sup>. Sikkim has a number of wetlands and, hence, bird species dependent on water bodies (either aquatic or depending on water for some activities) are well represented. A majority of the aquatic birds are migratory species, and some species use Sikkim as stop-over during migration.

There are 22 species of birds restricted to Eastern Himalaya Endemic Bird Area out of which 12 species are found in Sikkim. The endemic species are *Tragopan blythii*, *Arborophila mandellii*, *Harpactes wardii*, *Sphenocichla humei*, *Spelaornis caudatus*, *Babax waddellii*, *Certhia discolor*, *Brachypteryx hyperythra*, *Actinodura nipalensis*, *Tickellia hodgsoni*, *Phylloscopus cantator* and *Yuhina bakeri*. Similarly, 38 bird species are listed in the IUCN red list of threatened species of which fourteen are Vulnerable, two are Endangered (*Falco cherrug* and *Aquila nipalensis*), six are Critically Endangered (*Aythya baeri*, *Gyps indicus*, *Sarcogyps calvus*, *Gyps bengalensis*, *Emberiza aureola* and *Ketupa zeylonensis*) and sixteen are Near Threatened<sup>44</sup>. Seven species of birds found are listed in Appendix I and five species are listed in Appendix II of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). Similarly, four species of birds (*Lophura leucomelanos*, *Gyps bengalensis*, *Gyps indicus* and *Gracula religiosa*) are included in the Schedule-I category of Wildlife Protection Act of India, 1972.

Recent studies have highlighted the importance of indigenous farming systems for conservation of birds in the region

The Government of Sikkim has designated 11 Important Bird Areas (IBAs) in Sikkim and notified one bird sanctuary (Kitam Bird Sanctuary) for the conservation of birds. Additionally, there are one biosphere reserve and national park and seven wildlife sanctuaries (including Kitam) in Sikkim which protect the habitats of birds as well as other flora and fauna. Our recent studies have highlighted the importance of indigenous farming systems for conservation of birds in the region, but policy intervention is necessary in order to protect these biodiversity rich ecosystems.

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## JAMUNA BASIN

### Wetlands

S M Sadik Tanveer

THE FORMATION of beels and other wetlands on the left and right banks of Jamuna River depend both on geomorphological processes as well as environmental changes.

Environmental changes are not necessarily natural, rather such a change may take place as a result of human interference at various levels. Broadly, the formation processes of all category wetlands are divided into two (i) autogenic and (ii) allogenic<sup>45</sup>. The autogenic process is related to the river regime, such as channel migration, cutoff, loop formation, and allogenic processes include various types of human intercessions. On the right bank of the Jamuna, wetlands were formed as a result of the shifting of the course of Teesta river in 1787 and reduction in the flows of tributaries such as Atrai, Karatoya and Punarbhaba rivers. On the left bank of the Jamuna, wetlands were formed by the shifting of the old course of the river<sup>46</sup>.

The allogenic changes that take place mainly as a result of human activities are responsible for formation of many *beels* and ox-bow lakes in the left bank of Jamuna river. Major changes are observed in the river regime after the commissioning of regulatory works on rivers. Construction of structures such as embankments and bunds for flood control and irrigation has caused drastic changes in the river course and altered the wetland environment. In addition, human encroachment across the river and impeding the natural flow of the river significantly changed the flow regime and the denudation pattern of rivers, accelerating the siltation rate of the river as well as of *beels* and large ponds.

*The beels and other water bodies on riverbanks provide ideal habitats for feeding, resting and breeding of a large number of fishes, birds and various aquatic animals*

*Beels* are of different shapes, sizes and depth. Some of them are partly or fully infested with floating mats of aquatic plants. Reeds, grasses and bushes comprise the common natural vegetation in the shore areas of *beels*. The swampy and marshy areas, such as *jalah*, *pitoni*, and *doloni*, are shallower than the *beels*. They are normally developed close to riverbanks and on ageing shallow *beels*. In general, the *beels* and other water bodies on riverbanks provide ideal habitats for feeding, resting and breeding of a large number of fishes, birds and various aquatic animals.

### **Chalan Beel**

Chalan *beel*, a seasonal water body, is the largest *beel* and constitutes one of the largest, most important watersheds in north central Bangladesh. It consists of a series of depressions, interconnected by numerous channels that form more or less one continuous sheet of water during inundation (following the monsoon), covering an area of about 375 square kilometers<sup>47</sup>. The water area then shrinks to a 52 to 78 square kilometers residual cluster of smaller *beels* of varying sizes during the dry season<sup>48</sup>. Chalan *beel* is rapidly silting up and shrinking down.

Chalan *Beel* has a unique natural beauty and provides habitat for diverse wildlife including a variety of fish, aquatic invertebrates, birds and others aquatic animals upon which the local economy and livelihoods of people of surrounding area depends<sup>49</sup>. At least twenty-seven species of mammals, and thirty-four species of reptiles, with amphibians including seven species of frogs and toads can be found on the banks of the *beel*. A total of 81 fish species including 72 indigenous and 9 exotic species under 12 fish orders, 27 families and 59 genera have been recorded

from different studies and surveys<sup>50</sup>. Flora found along the banks of the *beel* includes a perennial grass known as *kans* or *kash* (wild sugarcane). Date palms, *dhol kolmi* (pink morning glory) and *simul* (cotton tree) are also found in and around Chalan *beel*. The fruit from the date palm is used to make jelly, while the sap is boiled to make a sugary product called “*jaggery*”<sup>51</sup>.

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## **Riverine birds**

Sayam U. Chowdhury

**RIVERINE HABITATS** are possibly one of the most neglected ecosystems in terms of conservation efforts in Bangladesh<sup>52</sup>. However, the sandbars, waters, pools and floodplain grasslands of Padma and Jamuna river systems support a wide range of globally important wildlife. The alluvial channels and adjacent floodplains of these two rivers are highly productive, as they are sustained by dynamic hydrologic and



sediment transport regimes, as well as nutrient mobilization and transport through annual flood cycle and water supply<sup>53</sup>. These extremely productive floodplains support early successional tall grasses dominated by wild sugarcane (*Kash*) *Saccharum spontaneum*<sup>54</sup> and several other grass species. These grasslands support 22 avian species of global concern including the Critically Endangered yellow-breasted bunting *Emberiza aureola*<sup>55</sup> and Vulnerable bristled grassbird *Chaetornis striata*, both of which are grassland specialists that inhabit tall grasslands particularly in riverine or swampy areas.

Waterbirds such as the black-bellied tern *Sterna acuticauda* and river tern *Sterna aurantia* were once common along the large river systems of Bangladesh. However due to large-scale destruction of riverine habitats, these species have become extremely rare in Bangladesh and elsewhere. The black-bellied tern has been uplisted in 2012 from Near Threatened to Endangered due to a rapid and continuous decline over the last 27 years, leading to almost becoming extinct in a large part of its range<sup>56</sup>.

The population of resident birds that nest on sandbanks such as little tern *Sterna albifrons*, small pratincole *Glareola lacteal*, river lapwing *Vanellus duvaucelii*, great

thick-knee *Esacus recurvirostris* and Indian thick-knee *Burhinus indicus* appeared to have declined in Bangladesh.

However, recent surveys along the major rivers of Bangladesh indicate that the Padma and Jamuna river systems still provide breeding and wintering habitats to substantial populations of resident and migratory birds<sup>57</sup>. These include the Critically Endangered Baer's pochard *Aythya baeri* (known to stopover in large rivers during migration), Endangered steppe eagle *Aquila nipalensis*, Vulnerable common pochard *Aythya ferina*, Asian woollyneck *Ciconia episcopus*, Indian skimmer *Rynchops albicollis*, Indian spotted eagle *Clanga hastata*, greater spotted eagle *Clanga clanga*, eastern imperial eagle *Aquila heliaca* and 11 other Near Threatened birds<sup>58</sup>.

Large rivers of Bangladesh also support of the Critically Endangered gharial *Gavialis gangeticus* (possibly only migratory population), the Endangered Ganges river dolphin *Platanista gangetica*, crowned river turtle *Hardella thurjii* and Indian narrow-headed softshell turtle *Chitra indica*<sup>59</sup>.

Human impact on riverine biodiversity is more apparent in Asia than any other part of

**From left to right:**  
**Black-headed ibis**  
*(Threskiornis melanocephalus);*  
**Little egret**  
*(Egretta garzetta);*  
**Black-winged stilt**  
*(Himantopus himantopus)*



the world. Flow regulation, construction of large dams, flood control, over-harvesting of fish, pollution and conversion of riverine wetlands to agriculture are common threats to many Asian rivers<sup>60</sup>. Sand and gravel extraction for development is common in Padma and Jamuna rivers, especially around large towns<sup>61</sup>. As a result of this ongoing degradation of riverine ecosystems, some taxa have been gravely affected, especially riverine birds<sup>62</sup>.

These stresses on the overall riverine ecosystems reduces potential roosting and nesting habitats of riverine bird species and other resident wildlife. However, even where the habitat remains suitable, hunting in winter by local or visiting sport-hunters, collection of eggs and chicks of sand-nesting birds in late-winter are frequent along the Padma and Jamuna rivers. These practices pose a common threat to riverine birds and reduce their overall population. Due to the reduced level of fisheries resources, competition between riverine birds and local fishermen may also be expected, although no evidence of this has been observed so far<sup>63</sup>.

For the protection of these dwindling riverine species, several steps could be undertaken including establishing riverine protected areas. The sandbanks, grasslands and islands (which remain in state ownership) are not leased out and hence any change in management will not be resisted by leaseholders unlike other wetland sites in Bangladesh. Hence, designating riverine sanctuaries/protected areas would be relatively straightforward,<sup>64</sup> and further surveys are recommended to identify breeding sites of all waterbirds that nest on riverbanks.

Once identified, these sites can be declared as sanctuaries in addition to the sites that are already proposed to Bangladesh Forest Department under Ministry of Environment and Forests. There also needs to be a comprehensive conservation strategy for the Padma and Jamuna rivers, including sustainable management plans for both fisheries and wildlife. In order to understand the overall health of the riverine ecosystem, an indicator bird monitoring approach could be established targeting species that are still widespread such as the little pratincole, Indian spot-billed duck and plain martin.

The Bangladesh Wildlife Preservation Act protects all water-bird species that occur in these rivers. Therefore, enforcement by the government and support by local NGOs are needed to tackle bird hunting and prevent illegal habitat encroachment. In addition, awareness-raising activities in villages along these rivers should be carried out to educate local people, especially fishermen and other natural resource harvesters, of the importance of birds and other wildlife to maintain a healthy riverine ecosystem.

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## Wildlife of Jamuna basin

Sheikh Muhammad Abdur Rashid

**THE GHARIAL** is a flagship species of the Jamuna Basin and critically endangered in Bangladesh. Gharial nesting records in the river Jamuna at Pechakhola, Bera Upazilla, Pabna date back to the nineteen seventies. In the nineteen eighties and in the early nineteen nineties, gharial nests were recorded from Char Khidirpur, Padma River (in Rajshahi District) and Baladuba Char (Kurigram District) in the Jamuna River. During later surveys by Centre for Advanced Research in Natural Resources and Management (CARINAM) in the Padma and Jamuna rivers during 2009 to 2011 only juveniles (between 1 to 2 meters) were found, and no nests could be detected, even though several suitable nesting sites were observed.

The Asian freshwater dolphin (*Platanista gangeticus*) is another flagship species of the Jamuna river. Based on the results of a study conducted by CARINAM, three dolphin sanctuaries were designated by the government; one in the Jamuna River and the second in one of the tributaries (Selunda-Hurasagar) of the Jamuna River, while the third is in the Padma River.

The Jamuna basin overlaps the Central Asian and East-Asian-Australasian migratory bird flyways and many migratory birds particularly ducks and waders use this route during migration. Among the raptors, kites, shikra, peregrine falcon, buzzards, and winter visitors like ospreys, harriers, and others can be regularly seen. Unfortunately, the vultures are not seen anymore, however, Eurasian griffon and cinereous vulture occasionally visit the Jamuna basin area.

The sandy riverbanks in the Jamuna basin provide nesting and basking habitat for freshwater turtles, gharials, smooth-coated otters, several species of kingfishers, bee-eaters, sand larks, and bank mynas. The grass cover of the sand bars, mainly *Saccharum spontaneum*, *Typha domingensis*, and *Phragmites karka* support and provide nesting habitats for a variety of small grassland bird species mainly prinias, larks, lapwings, lesser whistling teals, spotbill ducks, baya weaver, streaked weaver, black-breasted weaver, buntings, munias and many more. Rare bird species like the black stork, common merganser also visit the sand bars.

The shallow inundated *chars*, cultivated land and the adjacent human settlements along the river bank support several species of amphibians which include the common toad (*Duttaphrynus melanostictus*), marbled toad (*D. stomaticus*), bull frog (*Hoplobatrachus tigerinus*), skipper frog (*Euphlyctis* sp.), green frog (*E. hexadactylus*), several species of cricket frogs (*Fejervarya* sp.), *Polypedetes* sp., *Hylarana tytleri*, *Kulaula* sp., the recently recorded *Microhyla nilphamariensis*, and the unusual *Humerana humeralis*.

*The Jamuna basin overlaps the Central Asian and East-Asian-Australasian migratory bird flyways and many migratory birds particularly ducks and waders use this route during migration*

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*The gharial or the fish-eating crocodile is amongst the longest of all the crocodilians. Once found in freshwater river systems from Pakistan to Myanmar, the critically endangered gharial is on the brink of extinction and is found today only in a few locations in India and Nepal.*



Freshwater turtles are threatened by the conversion of wetlands, demand for trade and consumption by some as food. The commercial trade from early nineteen seventies till late nineteen nineties has almost exterminated many of the populations and once common species have become rare and some are critically endangered. The species encountered within the basin include *Batagur kachuga*, *Pangshura tecta*, *P. tentoria*, *P. smithii*, *Hardella thurjii*, *Morenia petersi*, *Lissemys punctata*, *Nilssonina gangetica*, *N. hurum*, and recently *Nilssonina nigricans* has also been found within the basin.

Reptiles include Burmese pythons (*Python bivittatus*), python, venomous snakes such as *Naja kaouthia*, *N. naja*, *Bungarus caeruleus*, *B. walii*, *B. niger* are found, and in recent years *Daboia russelli* is often reported from the villages in the vicinity of the riverbank and also from the chars. Other nonvenomous snakes include *Enhydris enhydris*, *Eryx conicus*, *Ahaetulla nasuta*, *Coelognathus radiatus*, *Dendrelaphis pictus*, *Lycodon aulicus*, *Oligodon arnensis*, *Ptyas mucosa*, *Sibynophis sagittarius*, *Amphiesma stolatum*, *Xenochrophis cerasogaster*, *X. piscator*, *Ferania sieboldi*, *Indotyphlops braminus*, and many more.

Although small reptiles are hard to find and are often left unrecorded, some common lizards have been observed and recorded by CARINAM. These include *Calotes versicolor*, *Gekko gekko*, *Hemidactylus brookii*, *H. flaviviridis*, *H. frenatus*, *Eutropis carinata*, *E. dissimilis*, *Lygosoma bowringii*, *L. punctata*, *Varanus bengalensis*, and *V. flavescens*.

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## Hilsa fisheries

M Niamul Naser and Anisur Rahman

*The river shad, hilsa is the national fish of Bangladesh. This fish received the Geographical Indicator registration in 2017*

THE JAMUNA river system is important for migratory fishes and as nursing grounds for natural spawned carp fishes. The river shad, hilsa (*Tenualosa ilisha*) is the national fish of Bangladesh and the most important single species for fishery in the country. The hilsa (*Tenualosa ilisha*) holds a special place in the hearts and in the diets of people living in this region. Locally known as the “Macher Raja Ilish”, or the “king of the fishes”, this fish received the Geographical Indicator registration in 2017.

The hilsa accounts for nearly half of the total marine catch, and about 12 percent of total fish production of the country contributing about 1 percent to GDP. About 450,000 fishers are directly employed in hilsa fishing with an indirect employment of about 2.6 million people in the wider hilsa sector (trading, processing etc.). In 2017-18, a total 541 metric tons of hilsa was caught from this river system, out of which 320 metric tons were caught from the Jamuna river.



*The Ilish represents a shared history, a common ecosystem, and close economic ties between Bangladesh and India. The fish contributes to one percent of the total GDP of Bangladesh*





The distribution of hilsa mainly depends on water flow and flooding of the rivers. In years of heavy flooding, they are caught in the small channels and floodplains. Considerable quantities of hilsa are also caught in the lower Arial Khan, Madhumati, and Padma rivers, with lower quantities in the Jamuna and Brahmaputra rivers. The hilsa in breeding season migrates from the Jamuna towards upper Brahmaputra river basin of Assam, India. The hilsa lives and breeds in the Jamuna river due to its unique water quality and habitats; particularly the plankton (both phytoplankton and zooplankton) available in this area are suitable as food for hilsa.

During last few decades over-fishing and indiscriminate catching of *jatka* (juvenile hilsa) had reduced the hilsa population in the river. To sustain as well as to increase hilsa production, several management measures have been undertaken by Department of Fisheries under the Ministry of Fisheries and Livestock. Conservation of *jatka* through declaring six fish sanctuaries in the major nursery and spawning grounds of riverine and estuarine system and prevention of hilsa fishing for 22 days during the peak breeding season are the most important initiatives. Due to conservation of *jatka*, the abundance of grown up/sub-adult hilsa has increased considerably. Overall, there has been a gradual revival of hilsa population, but the threats still remain, as these fish are often caught before they reach maturity of the first spawning stage.

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## Madhupur National Park<sup>56</sup>

M. Monirul H. Khan

**THE 80 KILOMETERS** avulsion of the river Brahmaputra by the year 1843 created two rivers in central Bangladesh: Jamuna (main Brahmaputra) and Old Brahmaputra. Between these two rivers lie a fertile highland called the Madhupur Tract. Even a hundred years ago a major part of the Madhupur Tract was covered by moist deciduous forest dominated by sal (*Shorea robusta*) trees. The sal forest used to be teeming with wildlife including some charismatic megafauna like the Indian rhinoceros (*Rhinoceros unicornis*), tiger (*Panthera tigris tigris*), leopard (*Panthera pardus*), Asian elephant (*Elephas maximus*) and Asiatic black bear (*Ursus thibetanus*), but none of them currently survive in the Madhupur Tract. Both the forest and the wildlife were destroyed mercilessly by humans.

During the Mughal and the British colonial era, the local landlords or *zaminders* preserved some wilderness areas of the Madhupur Tract in order to facilitate game hunting for the elites. Two pockets of these areas in Madhupur and Bhawal eventually got legal protection and became the first legally designated protected areas in Bangladesh. Having an area of 84.36 square kilometers, the Madhupur National Park was formally

*The Madhupur National Park holds one of the last remaining natural sal forest patches in Bangladesh*



Top left:  
Grey heron (*Ardea cinerea*)

Top right:  
Lesser coucal  
(*Centropus bengalensis*)

Bottom:  
Oriental magpie robin (*Copsychus saularis*), the national bird of Bangladesh

established in 1982. It is situated about 125 kilometers north of Dhaka City, in Tangail District, beside the Tangail-Mymensingh Highway. The Park is historical not only because it is the first of its kind, but also because it was the training and sheltering ground of the freedom fighters during the Liberation War in 1971. The Dokhola Rest House in the park is also historical because the drafting of the Bangladesh Wildlife Order, 1973, was done here under which the park was formally established in 1982.

The topography of the Madhupur National Park and its surrounding areas mainly consist of flat-topped highlands or *chalias* intersected by many lowlands or *baidis*. The highest altitude of topped ridges is 15 meters above the mean sea level. The climate is moderate, with the temperature rising up to 37°C in May and dropping down to minimum 10°C in January. The depressions or *chalias* are flooded every year during the tropical monsoon from June to September. The soil is loamy, clay and sandy loam, and mostly looks reddish due to rich iron content.

*The Park is historical not only because it is the first of its kind, but also because it was the training and sheltering ground of the freedom fighters during the Liberation War in 1971*

The Madhupur National Park holds one of the last remaining natural sal forest patches in Bangladesh where about 40 percent of the area is covered with sal trees. It represents an important and treasured part of Bangladesh due to its rich biological and cultural diversity that still prevails despite considerable deforestation in the last few decades. In Tangail District alone the sal forest has shrunk to 10 square kilometers in 1990 from 200 square kilometers in 1970. The ethnic Garo community, together with the local Bengali community, live in scattered villages in and around the park. According to an estimate in 1989, about 100,000 Garo people live in Bangladesh, of which about 14,000 live in the Madhupur forest area. They have been living there for the last few centuries. They cultivate paddy in the lowlands, and pineapple and cassava in the highlands. The Government of Bangladesh has permitted about 4,500 Garo people to reside in the park area since 1968.

There are at least 176 vascular plant species in the park, including 73 tree, 22 shrub, 27 climber, 45 medicinal plants, 8 grass and 1 palm species. The sal trees grow in association with *Dillenia pentagyna*, *Lagerstroemia parviflora*, *Adina cordifolia*, *Miliusa velutina*, *Lannea grandis*, *Albizia* spp., *Bauhinia variegata*, *Spondias mangifera*, *Butea frondosa* and *Barringtonia acutangula*. The undergrowth is shrubby and includes *Eupatorium odoratum*, *Pennisetum setosum*, *Asparagus racemosus* and *Rauwolfia serpentina*. Plantations of *Acacia* spp., *Tectona grandis*, *Cassia siamea*, *Morus* spp., *Terminalia arjuna* and *Syzygium cumini* are seen in buffer areas around the park.

About 21 species of mammal, 140 bird, 32 reptile and 21 amphibian species occur in the Madhupur National Park. It is a major stronghold of the globally threatened capped langur (*Trachypithecus pileatus*), which occurs in groups headed by an alpha male. Another globally threatened mammal, the fishing cat (*Prionailurus viverrinus*), rarely occurs in the park. Among other notable wildlife there are rhesus macaque (*Macaca mulatta*), golden jackal (*Canis aureus*), barking deer (*Muntiacus muntjak*), Irrawaddy squirrel (*Callosciurus pygerythrus*), crested serpent eagle (*Spilornis cheela*), red junglefowl (*Gallus gallus*), Indian pitta (*Pitta brachyura*), yellow-footed green-



pigeon (*Treron phoenicopterus*), red-breasted parakeet (*Psittacula alexandri*), small minivet (*Pericrocotus cinnamomeus*), spotted flapshell turtle (*Lissemys punctata*), Tokay gecko (*Gekko gecko*), Bengal monitor (*Varanus bengalensis*), painted bronzeback tree snake (*Dendrelaphis pictus*), banded krait (*Bungarus fasciatus*), Indian balloon frog (*Uperodon globulosus*), Indian bull frog (*Hoplobatrachus tigerinus*) and stripe sticky frog (*Kalophrynus interlineatus*). The Madhupur National Park is the only known area in Bangladesh where the rare stripe sticky frog is found.

**Brown fish owl** (*Ketupa zeylonensis*)

The Madhupur National Park remains open for visitors throughout the year and is easily accessible by road. It is a popular tourist attraction due to its diversity, scenic beauty and proximity to Dhaka. The Park can be visited even in a day trip from Dhaka City.

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