

Rapid Assessment of Freshwater Turtles & their Habitats along middle Yamuna, Agra, Uttar Pradesh

**A Study by:
Agra Forest Division & TSA Foundation India
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 - ❖ Frontline Forest staffs and local communities along the Yamuna River
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EXECUTIVE SUMMARY

To evaluate habitat suitability and freshwater turtle status in the Yamuna River within Agra's jurisdiction, a rapid survey was conducted during mid October, 2023. Spanning a 250-kilometer stretch from *Jugsan* village at the Agra-Mathura district junction to the Agra-Etawah district border, the survey focused on recording turtle diversity, habitat characteristics, and human-induced pressures.

Six species of freshwater turtles—Three-striped Roofed Turtle (*Batagur dhongoka*), Crowned River Turtle (*Hardella thurjii*), Indian Tent Turtle (*Pangshura tentoria*), Indian Softshell Turtle (*Nissonia gangetica*), Narrow-headed Softshell Turtle (*Chitra indica*), and Indian Flap-shell Turtle (*Lissemys punctata*)—were directly encountered during the survey.

P. tentoria emerged as the dominant turtle species, constituting an impressive 98.93% of the encountered turtle population. Followed by *N. gangetica*, *B. dhongoka*, *H. thurjii*, *C. indica*, and *L. punctata*. Notably, the survey unveiled a significant female-to-male ratio of 3:1 among *P. tentoria* individuals.

The survey highlighted three dominant types of shoreline—sandy shoreline, hard mud, and vegetated shoreline. Nesting sites of two turtle species, *C. indica* near villages *Baripura*, *Sunsar* and *Pura Dasu Khilawali*, and *P. tentoria* on various recorded sand banks, were observed within the survey area.

Based on habitat variables, anthropogenic pressure, species richness, turtle population records, and nesting areas, the *Bamruli-Bateshwar* section emerged as a high-priority conservation area, followed by *Kundol-Bamrauli* and *Bateshwar-Lakheepura Kalna* as areas of moderate priority. Sections like *Jugsana-Babarpur Mustkil* and *Babarpur Mustkil* were considered low conservation priorities. These areas are recommended for enhanced protection, potential turtle replenishment sites, and community awareness programs.

Throughout the surveyed region, fishing activities and riverbed agriculture were identified as predominant pressures affecting the river's ecological balance. Furthermore, discernible impacts from sand collection, sewage and industrial wastewater discharge, ferry Ghats, and water extraction were observed. Local interviews highlighted declining turtle populations due to local consumption and accidental drowning, emphasizing the urgent need for extensive awareness programs. The study advocates continuous monitoring of turtle populations and the implementation of long-term conservation measures, especially nest protection for endangered turtle species like *B. dhongoka* and *C. indica*.

Additionally, the survey documented 72 bird species (including 7 migratory), 12 butterfly species, 3 Odonate species, 22 fish species, 2 snake species, 3 lizard species, 5 mammal species, and 48 plant species. Sightings of two sub-adult Mugger crocodiles (*Crocodylus palustris*) were also reported.

TABLE OF CONTENTS

EXECUTIVE SUMMARY	1
INTRODUCTION	3
METHODOLOGY	5
RESULTS AND DISSCUSION	7
RECOMMENDATIONS	27
CITATIONS	29
ANNEXURE	30

INTRODUCTION



Freshwater ecosystems are vibrant havens, hosting an astonishing diversity of species, providing homes for approximately 9.5% of the world's animal species. Within rivers, this rich tapestry of biodiversity reflects the vast array of environments these waterways traverse. River habitats are dynamic, constantly shifting across short distances and timescales, blending aquatic and terrestrial areas in a mesmerizing interplay. The significance of rivers extends beyond their dynamic nature; they hold immense conservation value, evident in both international and national designations aimed at safeguarding their integrity. These waterways play an indispensable role in nurturing and preserving wetlands, nurturing breeding grounds that sustain nearly 40% of Earth's species. India, standing among the top 17 mega biodiversity nations globally, ranks 9th in terms of freshwater mega biodiversity (Mittermeier et al., 1998). Its freshwater ecosystems encompass a multitude of inland wetlands, including lakes, rivers, ponds, streams, groundwater sources, springs, floodplains, as well as bogs, marshes, and swamps. Despite India's abundance, its freshwater diversity faces a daunting decline, primarily due to human-induced habitat degradation and loss. This decline carries global consequences, impacting not just the natural world but also the economic and social fabric of societies worldwide. Following the request of the Divisional Forest Officer in Agra, on

25/9/23 vide letter no. 1266/5-1. TSA Foundation India collaborated with Agra Forest Division for a five-day survey of the Yamuna River stretch in the Agra district. The study assessed bank features, human impact, nesting habitats, threats, and the presence of freshwater turtle species. The findings from this survey pinpointed critical habitats spanning a 250 km stretch of the Yamuna River, providing a foundational cornerstone for the conservation of these delicate ecosystems. The data collected through this survey will provide a fundamental starting point for conservationists and government bodies, aiding in the formulation of long-term projects, policy management, and the restoration of ecological equilibrium for endangered aquatic life and natural resources in the area.

OBJECTIVES

- To document the freshwater turtle species diversity and distribution along Yamuna river in Agra district
- To document and map the important turtle habitats in the Yamuna river for future conservation actions.
- Collecting additional data on sympatric taxa and compare the notes with previous surveys
- To document various threats to aquatic biodiversity in said stretch.

STUDY AREA

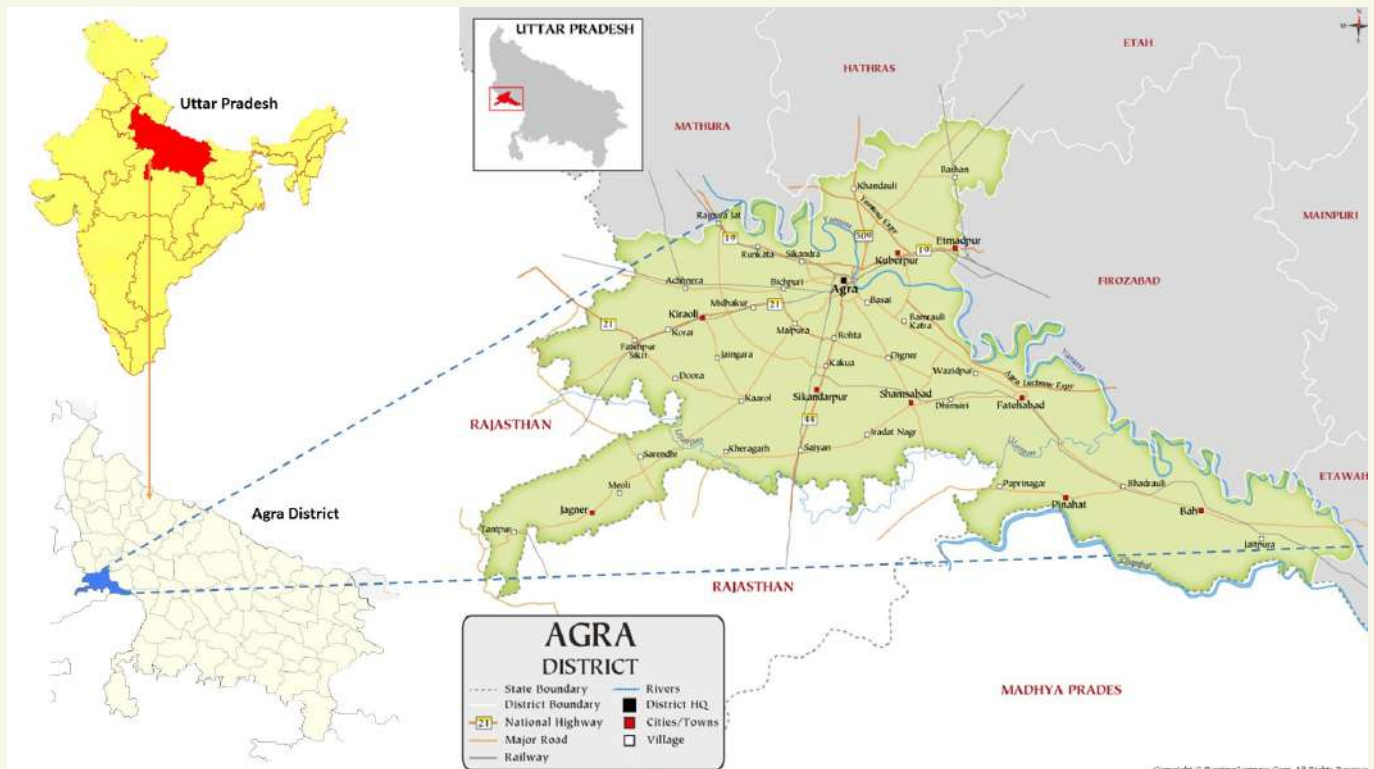


Figure 1 . Map representing the study area in Agra district

A total of 250 km was covered from *Jugsana* (Agra-Mathura border) till *Lakheepura Kalna* (Agra-Etawah border)

A 250 km, Yamuna River stretch between *Jugsana* (N27.295786 E77.851424) to *Lakheepura Kalna* (N26.808663 E78.852461) lying in Agra district of Uttar Pradesh (figure 1) was surveyed. This stretch shares the starting boundary with the Mathura and end boundary with Etawah district of Uttar Pradesh. The Yamuna River in this particular stretch flows through alluvial plains and helps to create the highly fertile alluvial Ganges-Yamuna Doab region between itself and the Ganges in the Indo-Gangetic plain. The hydrodynamics of the study area give rise to different platform such as mid-river islands, sand bars and scroll bars, which are formed at the edge of the flood plain by deposition. Other morphological features include natural levees, high ravines and Badlands. Majorly river flows through the villages and big cities like Agra, Fatehabad and Bateshwar or their adjoining agricultural land while some bank are connected with reserves forest area of *Prosopis juliflora* forest. Survey area falls under the Indo-Gangetic plain with tropical monsoon climate with the mean annual rainfall ranges between 600 and 650 mm. In Hindu culture, Yamuna River is highly honoured as a sacred river, considered the goddess Yamuna, and depicted as a river of heaven. In the region it has tourism importance as well, as it flows just beside the Taj Mahal. In and around the Agra city there are some famous temples situated on the bank of Yamuna which attract lakhs of devotees in different religious gathering.

METHODOLOGY

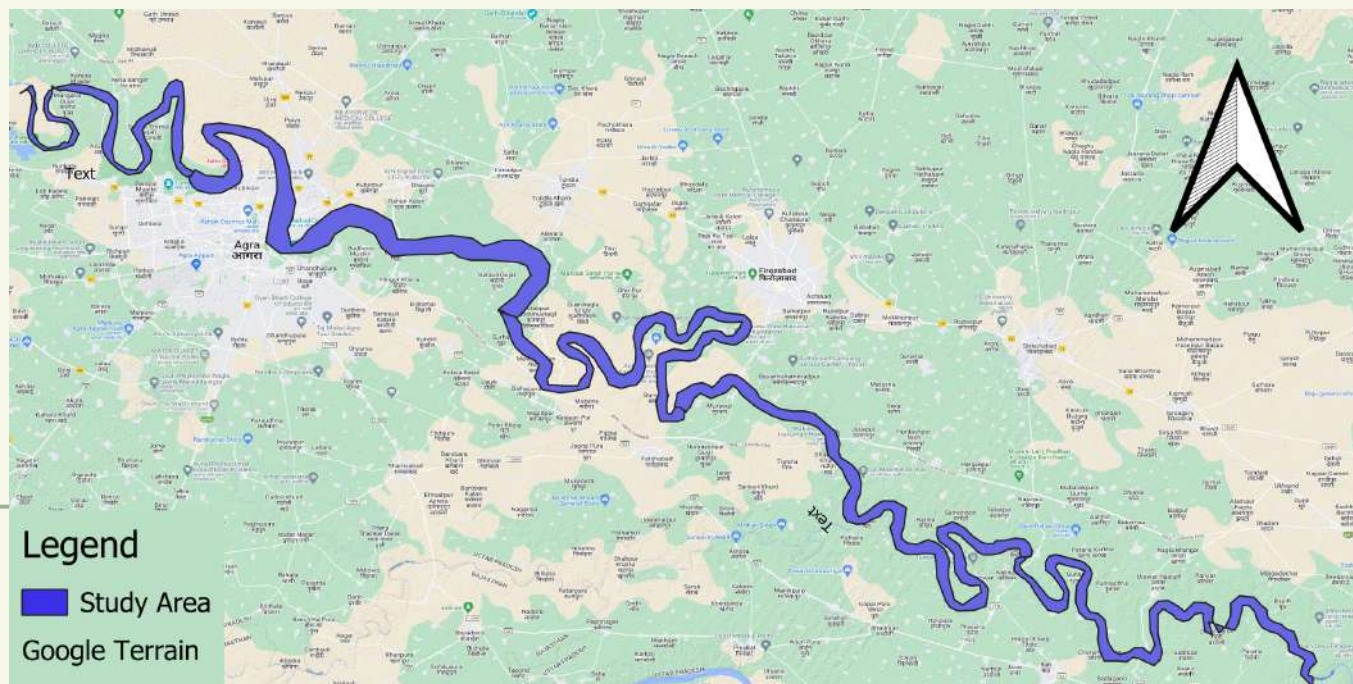


Figure 2. Map showing the Yamuna stretch surveyed in this study

To collect data on turtle species occurrence and mapping of feasible habitats of Yamuna River, a visual survey of entire stretch come under the Agra district 250 kms was conducted using engine boat and foot survey during the second and third week of October 2023. Indirect sign of turtle presence were also recorded alongside secondary information through fishermen interview, nesting signs and concave pits of turtle basking. Turtle nests were observed, if any by walking on sand bank or the island and any sign including soil disturbance, sign of nest predation such as dug out hole with scattered broken eggs found was recorded.

SPECIES OCCURENCE AND DISTRIBUTION

The present survey was conducted in October assuming the chances of post monsoonal observations for indirect signs of turtle presence such as nests and nesting crawls along with higher chances of detectability (basking). As October is the month with onset of monsoon, there are relatively higher chances to encounter basking and migrating turtles. Also, the post-monsoon, such surveys help in detecting fresh turtle crawls, nesting as well as body signs when sand banks are exposed by receding water level of the river. To achieve larger and more informative data on species sightings two methods point count and visual count survey methods were used for the turtle observation (Mifsud, 2014) using boat. The observations were taken during day time between 09:00 to 16:00 hr.

POINT COUNT METHOD

The investigation employed a point count technique, Castello et al. (2009), for monitoring the presence of turtles. This method involves enumerating individuals as they surface for arial respiration. The point count methodology is a logically sound practice, not only for detecting turtles but also for observing other aquatic species. Throughout the surveyed stretch, a total of 250 sites were strategically selected at intervals of 1 to 2 kilometers (refer to figure 2). At each designated point, a minimum observation period of 5 minutes was dedicated to scrutinize turtle activities or any indirect signs of their presence, facilitated by the use of Nikon Image Stabilizer Binoculars (20*50). The point count method was applied within an imaginary plot area with a radius of approximately 100 meters. The data pertaining to the presence or

absence of turtles, along with information on other coexisting species and the respective timings, were meticulously recorded. To enhance spatial representation, all observation points were georeferenced using a hand-held GPS device (Garmin eTrex 20x), and representative maps were subsequently developed in-house using GIS software. Additionally, bird species observed during the survey was systematically recorded.

BOAT SURVEY

The research utilized a boat-based transect approach, grounded in the assumption that the highest likelihood of turtle observation occurred during basking, with some potentially submerged or swimming in the river. Boat surveys were carried out under optimal weather conditions—specifically, during sunny periods with minimal wind—within the time window from 09:00 to 16:00 hours, aligning with favorable conditions for turtle basking activities.

HABITAT SURVEY & THREAT ASSESSMENT

Habitat survey and threat assessment of freshwater turtles –To document the habitat attributes, boat survey was conducted along the entire stretch. The boat traversed with a low speed of 20 to 30 km/hr to document the habitat parameters as well as to ensure the encounter of basking/surfacing turtles and other aquatic wildlife. One observer recorded the pre-defined habitat parameters of turtles such as area of sand banks, midriver rocky islands, midriver sandy island, hard mud banks, muddy shoreline, grassland, shrubland etc. Observation included threat parameter such as fishing area, pontoon bridge, ferry ghats, sand mining, settlements, lift irrigation, riverbed agriculture were also recorded. Habitat and threat data were recorded on each 1 km distance.

FISHERMEN INTERVIEWS

Random fisherman interviews were conducted with the men encountered during the survey period. The interviewer tried to assess the fisherman's perceptions regarding turtles, encounters in their by catch and the species they commonly observe in the area or get as a bycatch. A coloured turtle identification guide was used while interviewing the fishermen.

The interview questions were asked in the local language, consisting of a series of questions relating to the fisherman's profile, fishing equipment (types of fishing boat and gears), the local ecological knowledge of fishermen about freshwater turtles (feeding areas/basking area/nesting area), turtle bycatch managements and their attitudes towards turtles. Species of fishes catches and encountered were also recorded for the documentation.



RESULTS AND DISCUSSION

ABUNDANCE AND DISTRIBUTION OF FRESHWATER TURTLES

We documented a total of 2620 individuals of turtles in the study area representing six species directly via visual encounter with a total effort of 40 hrs. Most encountered species was Indian tent turtle (n=2592) followed by Indian Softshell Turtle (n=19), Crowned River turtle (n=3), Three striped roofed turtle (n=3), Narrow Headed softshell turtle (n=2) Indian flap-shell turtle (n=1) through visual encounter. However, among these we had encountered only dead Narrow headed softshell turtle, 1 dead crowned river turtle, 1 dead Three striped roofed turtle.

Table 1: Species list as encountered in Yamuna survey

#	COMMON NAME	SCIENTIFIC NAME	IUCN STATUS
1.	Three striped Roofed Turtle	<i>Batagur dhongoka</i>	Critically Endangered
2.	Crowned River Turtle	<i>Hardella thurjii</i>	Engangered
3.	Narrow Headed Softshell Turtle	<i>Chitra indica</i>	Endangered
4.	Indian Softshell Turtle	<i>Nilssononia gangetica</i>	Endangered
5.	Indian Flapshell Turtle	<i>Lissemys punctata</i>	Vulnerable
6	Indian Tent Turtle	<i>Pangshura tentoria</i>	Least Concern



Figure 3. *P. tentoria* basking on mud rocks

Rank Abundance Plot

The following Whittaker plot depicts both freshwater turtle species richness and species evenness. Species richness can be viewed as the number of different species on the chart i.e., six species were ranked. Species evenness is reflected in the slope of the line that fits the graph (assuming here a logarithmic series, relationship). A steep gradient in the following graph indicates low evenness as the high-ranking species like *P.tentoria* (Ranked 1) and *N.gangetica* (Ranked 2) have much higher abundances than the low-ranking species like *C.indica* and *L.punctata* (ranked 4 and 5 respectively)

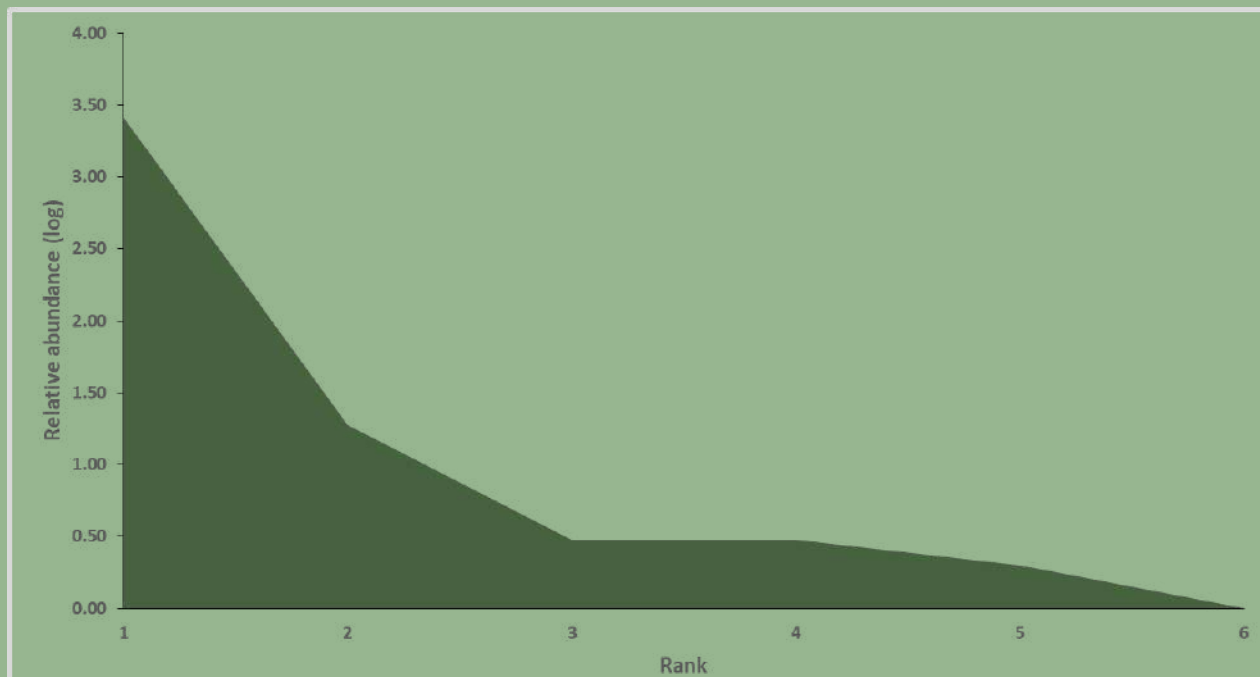


Figure 4. Rank abundance plot of freshwater turtles seen in Yamuna River

P. tentoria, a species prominently identified in the Yamuna River, constituted an impressive 98.93% of the entire turtle population encountered during the comprehensive survey. Delving into the intricacies of *P. tentoria* demographics, the investigation extended to record the sex ratio within the species. Among the myriad encounters, the careful documentation revealed a notable 3:1 ratio of females to males among *P. tentoria* individuals (Fig. 5). This detailed examination provides valuable insights into the population dynamics and composition of *P. tentoria* in the Yamuna River.

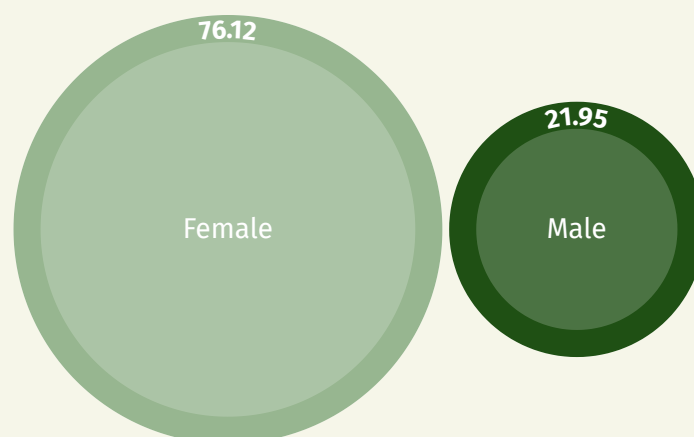


Figure 5. Male female sex ratio of *P. tentoria* observed in Yamuna River

To facilitate data analysis and devise targeted conservation strategies, the study area was meticulously divided into five distinct sections. The diversity of turtle species encountered in each section is succinctly summarized in Table 2. Notably, the *Bamruli-Bateshwar* section, holding the top rank, emerged as the habitat hosting the highest number of species, closely followed by the *Kundol-Bamrauli* section, ranked second. These sections stand out for their exceptional species richness, encompassing the entire spectrum of turtle species, including the presence of critically threatened species like *B.dhongoka* and *C.indica* of which carcass was only sighted. In these two sections Mugger crocodile (*Crocodylus palustris*) was also sighted. Figure 6 visually presents the abundance of turtle species across these sections. This graphical depiction offers a comprehensive view of the distribution of turtle species within each segment of the river.

Table 2: Ranking of section according to species richness

Sections (Upstream to downstream)	<i>P.tentoria</i>	<i>N.gangetica</i>	<i>B.dhongoka</i>	<i>H.thurjii</i>	<i>C.indica</i>	<i>L.punctata</i>	Rank
<i>Jugsana - Babarpur Mustkil</i>	++++	++++	0	0	0	0	4
<i>Babarpur Mustkil - Kundol</i>	++++	++++	0	0	0	0	4
<i>Kundol - Bamrauli</i>	++++	++++	++++	++++	++++	0	2
<i>Bamruli - Bateshwar</i>	+++	++++	++++	++++	++++	++++	1
<i>Bateshwar -Lakheepura Kalna</i>	++++	++++	0	0	++++	0	3

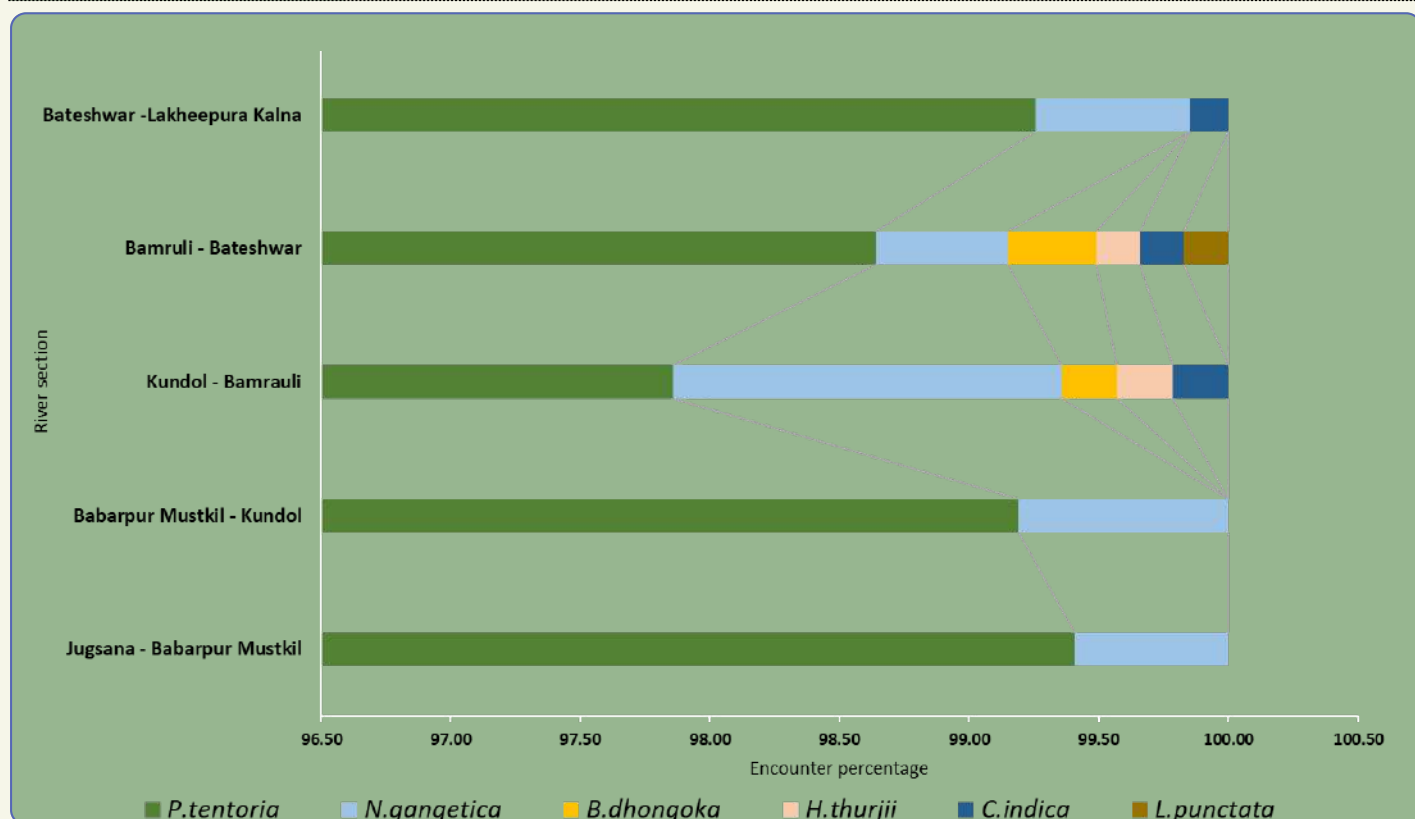


Figure 6. Section wise percentage of turtle individual encountered

HABITAT CHARACTERISTICS

The surveyed stretch of the river exhibited a predominant landscape characterized by a combination of sandy shorelines and areas adorned with vegetative cover. Notably, an observation highlighted a distinct pattern where one bank of the river featured sandy shores while the opposite bank predominantly comprised hard mud terrain. Detailed analysis revealed that approximately 78.6% of the shoreline was veiled by vegetation, primarily agricultural land, while sandy banks constituted about 13.0% of the total shoreline. A smaller proportion, approximately 2.9%, comprised hard mud terrain. A limited number of mid-river sandy islands were identified, playing a crucial role in facilitating nesting activities and providing basking sites for turtles and various aquatic fauna. These islands accounted for around 5.5% of the studied area, contributing significant ecological niches within the river ecosystem.

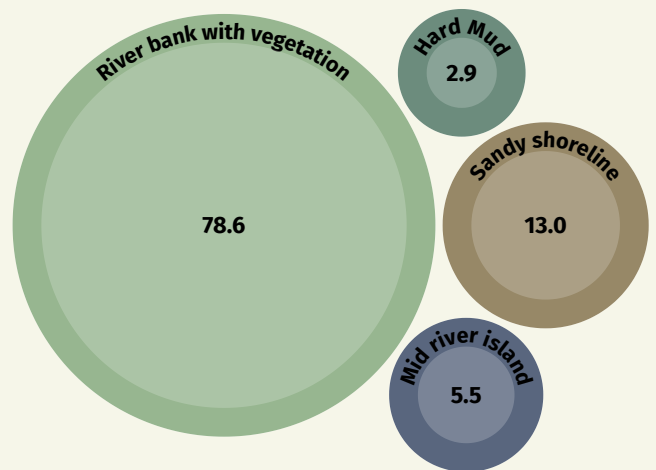


Figure 7. Habitat type recorded along Yamuna River



Figure 8. Habitat shoreline observed along Yamuna River study stretch a) Sandy shoreline b) River shoreline with vegetation c) River shoreline with hard mud

IMPORTANT NESTING AREAS

During the survey we documented nesting sites of the following two species:

C.indica - Normally nest from August through mid september in high river bank constituting mostly of sand particles which emerges just after the flood. In the study stretch along Yamuna three sites were documented with nests of *C. indica* which were *Baripura* (27.11258 78.24302), *Sunsar* (26.94898 78.59613) and *Pura Dasu Khilawali* (26.78741 78.8707). Nests were identified following the tracks of nesting turtles, by claw marks. The *Sunsar* and *Pura Dasu Khilawali* site all the nests were seen to be predated (jackal, feral dogs etc.). However, in *Baripura* sight we recorded crawl mark of hatchlings from nest site to the river signifying that these nest site couldn't be predated as this was a mid river island with no access for jackals or feral dogs to predate in. However, we assessed that after nesting of *C.indica* the *Sunsar* and *Pura Dasu Khilawali* site became accessible as it got connected to the mainland as flood water resided.

P. tentoria- During the survey period, which coincided with the nesting phase of *P. tentoria*, observations revealed widespread utilization of available habitats by this species for nesting purposes. Notably, flat sand banks devoid of vegetation emerged as the preferred nesting grounds for *P. tentoria*. Despite this preference, a concerning trend surfaced as the survey data indicated that a staggering 60-65% of nests belonging to this species fell victim to predation.



Figure 9. a) Typical nesting bank of *C.indica* observed in Yamuna River b) Hatched nest of *C.indica*

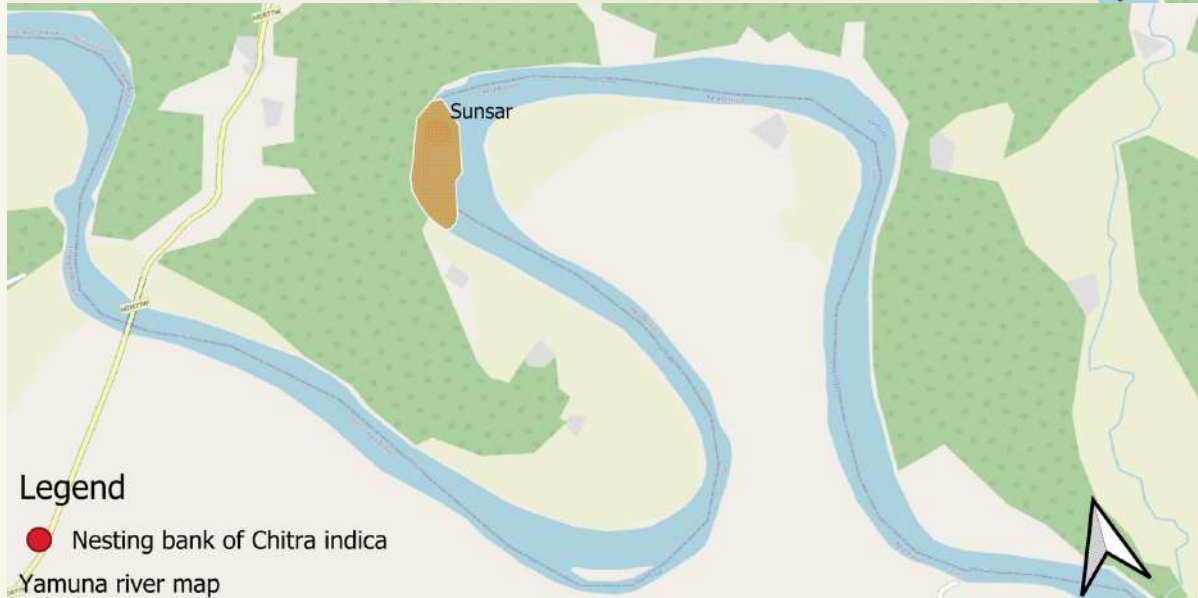


Figure 10. a) *Baripura* nesting sand bank b) *Sunsar* nesting sand bank c) *Pura dasu khilawali* nesting sand bank

ANTHROPOGENIC STRESSORS

Across the expansive 250-kilometer stretch of the surveyed Yamuna River, a meticulous inventory revealed six major threats significantly impacting its ecosystem. Fishing activities and riverbed agriculture emerged as dominant anthropogenic pressures affecting the river's ecological equilibrium. Additionally, discernible impacts from sand mining, sewage and industrial wastewater discharge, ferry Ghats, and water extraction, including pump and lift systems, were evident throughout this vast expanse. Specifically, irrigation pumps (84 in total) were prevalent along the entire stretch, while 13 discharge points for sewage and industrial waste (nalahs) and active sand mining in two areas were observed.

The river's course passing through Uttar Pradesh's significant cities, Agra and Mathura, attracted dense human settlements along its banks. These communities heavily rely on the Yamuna for sustenance, engaging in agricultural, fishing, and industrial activities, collectively contributing to the multifaceted degradation of the river's ecosystem.

Moreover, the revered temples lining the Yamuna's banks compound its environmental challenges. Notably, Kailash Temple and Bateshwar Dham were identified as major sites contributing the highest volume of religious waste along the study stretch. During religious festivals and significant events, these temples become centers for waste accumulation, intensifying the strain on the river's health and exacerbating its ecological vulnerability.

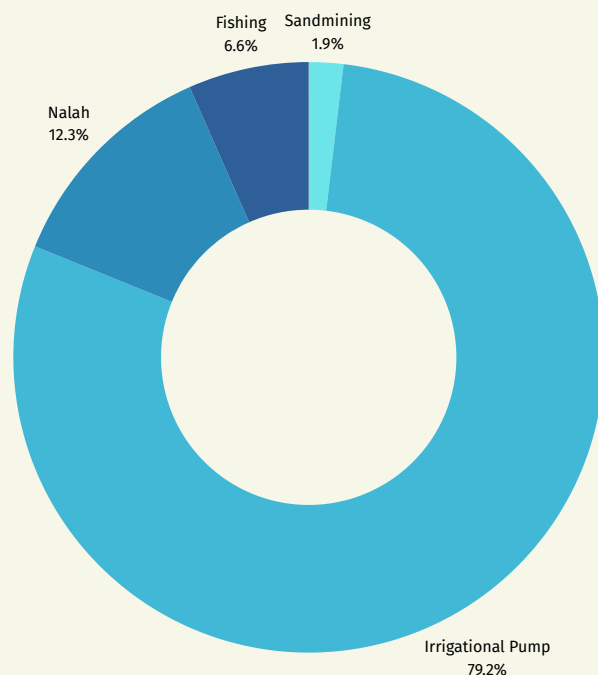


Figure 11. Anthropogenic disturbances recorded along Yamuna river



Figure 12. Fishing practices recorded along Yamuna River

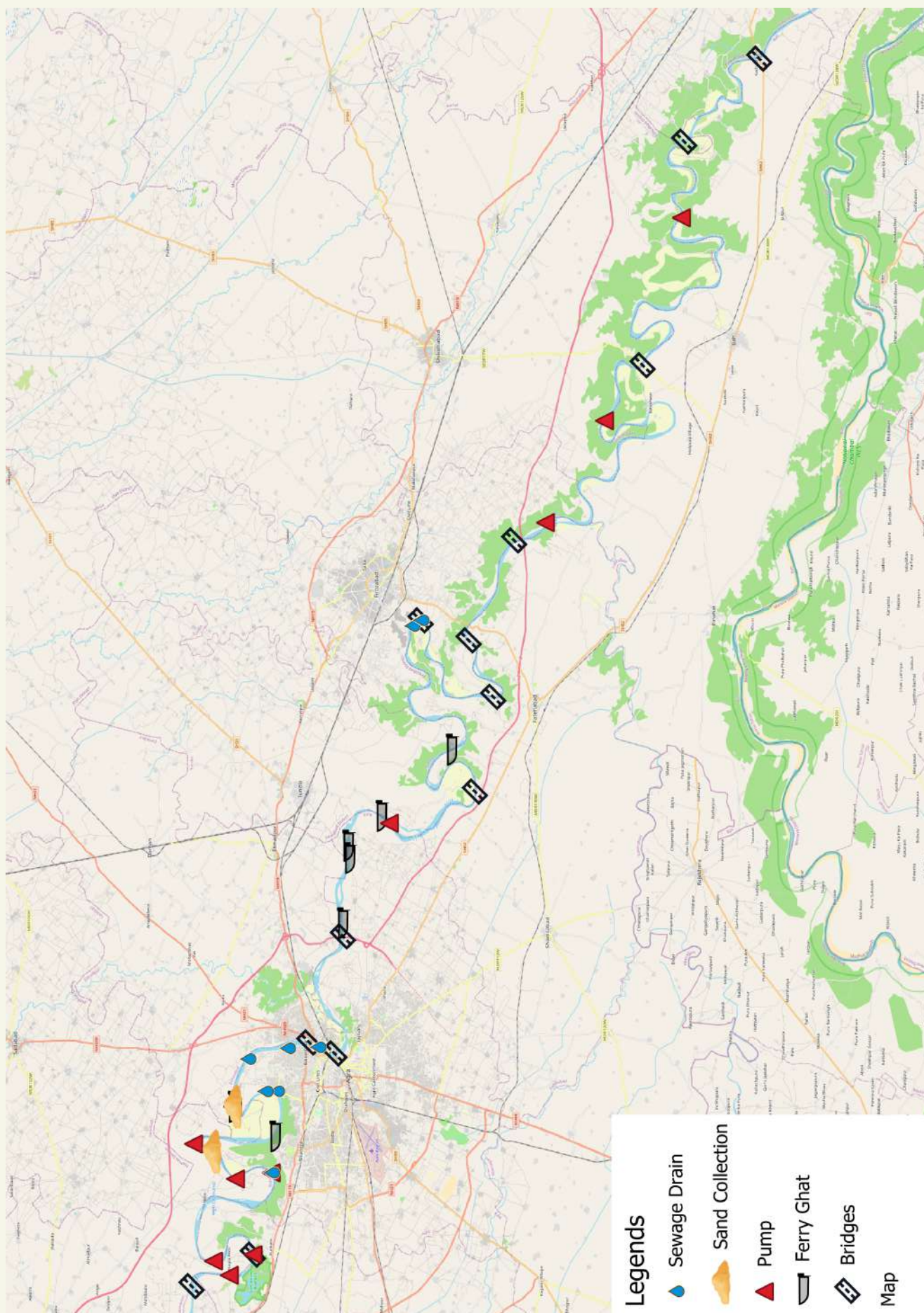


Figure 13. Anthropogenic stressors recorded along Yamuna river

FISHERMEN INTERVIEWS

A total of 19 fishermen were interviewed with their consent and human ethics guidelines were followed. These were mainly dependent on fishing for their livelihood. Majority of the respondents could identify soft-shell turtles like *N. gangetica* and *C. indica* and confirmed their presence in the area. 1-2 respondents identified and confirmed the Indian roofed turtle (*Pangshura smithii*) and Indian tent turtle (*P.tentoria*) and mentioned that it was found in the stretch long back but is now rarely seen. Fishermen also reported they get turtle eggs during the summer in the sand banks. All the respondents claimed that when they find turtles in their nests or in fishing hook they release them back to the river. The major threat identified through the interview was the accidental entanglement of turtles in fishing gears, riverbed agriculture and sand mining along the potential nesting sand banks.



Figure 14. Interview among fishermen and local communities

100%

HARVESTING

Most fishermen informed that turtle poaching is prevalent in the area.

70%

BYCATCH

Turtle gets entangled in their nets however they release the turtles

50%

INDIGENOUS KNOWLEDGE

Fishermen were aware about species of turtles, their nesting time and sites.

65%

AWARENESS

Fishermen were aware about turtle's legal protection and hunting is prohibited.

Table 3: Habitat for conservation priority along Yamuna River, Agra

Sections	Turtles		Potential Habitat				Nesting area		Threats				Conservation Priority
	Individual turtle sightings	Species richness	Sand bank	River bank with vegetation	Mid river island	Hard Mud	<i>P.tentoria</i>	<i>C.indica</i>	Sand mining	Pump	Sewage	Fishing	
I	13.9	33.3	82.4	10.6	5.9	1.2	5	0	3.0	97.0	0.0	0.0	Low
II	15.2	33.3	38.9	22.2	22.2	16.7	8	0	3.0	66.7	30.3	0.0	Moderate
III	19.2	83.3	17.4	56.5	13.0	13.0	18	8	0.0	80.0	13.3	6.7	High
IV	24.2	100.0	30.8	26.9	34.6	7.7	15	5	0.0	76.9	7.7	15.4	Very High
V	27.5	66.7	26.3	57.9	15.8	0.0	27	4	0.0	66.7	0.0	33.3	High

Section I- Jugsana - Babarpur Mustkil; Section II- Babarpur Mustkil - Kundol; Section III- Kundol - Bamrauli; Section IV- Bamrauli - Bateshwar;
Section V- Bateshwar -Lakheepura Kalna

Considering the habitat variables, anthropogenic pressure, species richness, number of turtle individual records and nesting areas, certain areas were prioritised that can be considered for further protection, turtle replenishment site and community awareness program:

Section IV- The section between *Bamruli- Bateshwar* have the highest species richness critically threatened species like *Batagur dhongoka*, *Chitra indica* and *Hardella thurjii* were observed here with 24.2% of turtle individuals. Nests of *C.indica* and *P.tentoria* were observed in this section, This site has presence of important habitat features like sand bank, mid river island and hardmud critical for nesting and basking of aquatic fauna. Nests of *C.indica* and *P.tentoria* were also observed in this section. Basking of *N.gangetica* were also recorded from this section. This stretch can be considered as area with **very high** conservation priority but warrant further conservation intervention like nest protection, and regular and regular community awareness program in associated fishing villages.

Section III & V- The section between *Kundol-Bamrauli* and *Bateshwar-Lakheepura Kalna* was listed as **high** priority area on the basis of turtle presence compared to Section IV (species richness Section III- 83.3 and Section V- 66.7). Nest of *C.indica* and *P.tentoria* were also observed in these section with presence of sand banks and basking areas. However both the section warrant conservation intervention, compared to other section maximum level of fishing pressure was observed in Section V thus dedicated community awareness and programs is required in this areas.

Section I and II- The sections *Jugsana - Babarpur Mustkil* and *Babarpur Mustkil - Kundol* were ranked as **low** and **moderate** priority areas respectively due to less species richness and turtle presence compared to other sites. Except for *P. tentoria* no other species nests were recorded from these area although these sections had larger sand bank areas however those were highly disturbed due to anthropogenic disturbances. Large scale sand mining were observed in these areas. 97% of water extraction for irrigation was observed in Section I.

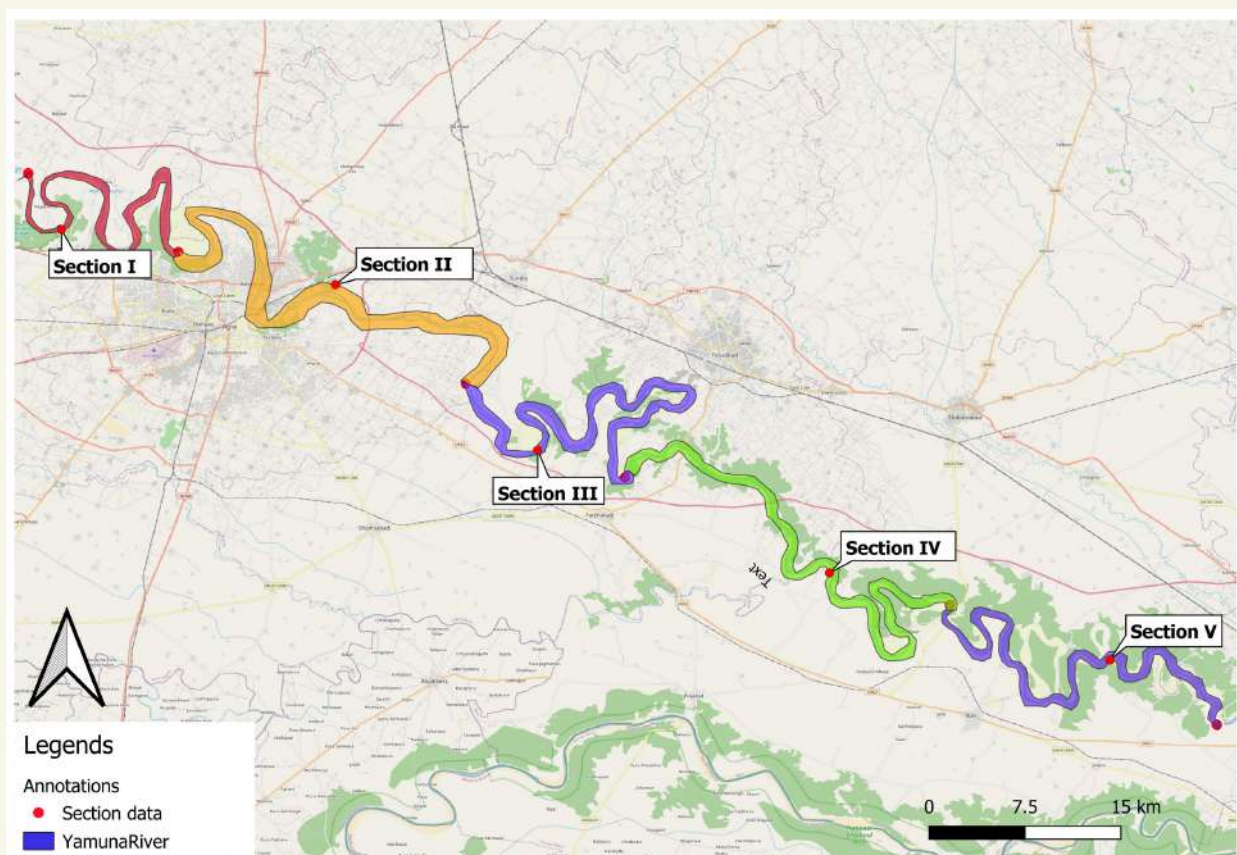


Figure 15. Map showing the identified section of Yamuna River based on the conservation priority.

AVIFAUNAL DIVERSITY

72 species of birds were recorded in the 250 km stretch of Yamuna River and its floodplain. Out of this we had recorded 7 migratory species including Pelican, Domicile crane, Spot-billed, Spoon bill, Ruddy Shelduck and Ruff. Large number of single species and mixed species flock of ducks were also observed such as Lesser Whistling duck, Spot-billed duck. Four large flocks (of 40-45 number) of Pied avocet were sighted. Interestingly it was observed that most bird species were sighted in human dominated areas. Birds like Pied avocet were not sighted downstream of Taj Mahal may be due to high sewage contamination from city areas. It is recommended that regular survey should be conducted to understand the year around avian species diversity of resident and migratory birds arriving in the Yamuna floodplain.

Table 4: Checklist of birds observed during the survey, R= Resident (n=65); M= Migratory (n=7)

Sr.no.	Common Name	Scientific Name	Status
1	Red-naped Ibis	<i>Pseudibis papillosa</i>	R
2	Black-headed Ibis	<i>Threskiornis melanocephalus</i>	R
3	Gray Heron	<i>Ardea cinerea</i>	R
4	Indian Pond Heron	<i>Ardeola grayii</i>	R
5	Black-crowned Night Heron	<i>Nycticorax nycticorax</i>	R
6	Purple Heron	<i>Ardea purpurea</i>	R
7	Little Cormorant	<i>Microcarbo niger</i>	R
8	Indian Cormorant	<i>Phalacrocorax fuscicollis</i>	R
9	Cattle Egret	<i>Bubulcus ibis</i>	R
10	Intermediate Egret	<i>Ardea intermedia</i>	R
11	Little Egret	<i>Egretta garzetta</i>	R
12	Pied Avocet	<i>Recurvirostra avosetta</i>	R
13	Oriental Darter	<i>Anhinga melanogaster</i>	R
14	Great White Pelican	<i>Pelecanus onocrotalus</i>	M
15	Asian Openbill Stork	<i>Anastomus oscitans</i>	R
16	Black-necked Stork	<i>Ephippiorhynchus asiaticus</i>	R
17	Painted Stork	<i>Mycteria leucocephala</i>	R
18	Woolly-necked Stork	<i>Ciconia episcopus</i>	R
19	Pied Kingfisher	<i>Ceryle rudis</i>	R
20	White-throated Kingfisher	<i>Halcyon smyrnensis</i>	R
21	Eurasian Curlew	<i>Numenius arquata</i>	R
22	Great Thick-knee	<i>Esacus recurvirostris</i>	R
23	Spot-billed Duck	<i>Anas poecilorhyncha</i>	M
24	Lesser Whistling Duck	<i>Dendrocygna javanica</i>	R
25	Ruddy Shelduck	<i>Tadorna ferruginea</i>	M
26	Black-winged Stilt	<i>Himantopus himantopus</i>	R
27	Bronze-winged Jacana	<i>Metopidius indicus</i>	R

Sr.no.	Common Name	Scientific Name	Status
28	Demoiselles Crane	<i>Anthropoides virgo</i>	M
29	Common Green Shank	<i>Tringa nebularia</i>	R
30	Common Redshank	<i>Tringa totanus</i>	R
31	Common Sandpiper	<i>Actitis hypoleucos</i>	R
32	Eurasian Spoonbill	<i>Platalea leucorodia</i>	R
33	Red-watteld Lapwing	<i>Vanellus indicus</i>	R
34	River Lapwing	<i>Vanellus duvaucelii</i>	R
35	Common Moorhen	<i>Gallinula chloropus</i>	R
36	Grey-headed Swamphen	<i>Porphyrio porphyrio</i>	R
37	Ashy Prinia	<i>Prinia socialis</i>	R
38	Asian Koel	<i>Eudynamys scolopaceus</i>	R
39	Asian Palm Swift	<i>Cypsiurus balasiensis</i>	R
40	Black Drongo	<i>Dicrurus macrocercus</i>	R
41	Black Kite	<i>Milvus migrans</i>	R
42	Common Babbler	<i>Argya caudata</i>	R
43	Common Hoopoe	<i>Upupa epops</i>	R
44	Common Myna	<i>Acridotheres tristis</i>	R
45	Common Tailorbird	<i>Orthothomus sutorius</i>	R
46	Crow Pheasant	<i>Centropus sinensis</i>	R
47	Eurasian Collared Dove	<i>Streptopelia decaocto</i>	R
48	Green Bee-eater	<i>Merops orientalis</i>	R
49	Gray Francolin	<i>Francolinus pondicerianus</i>	R
50	Black Francolin	<i>Francolinus francolinus</i>	R
51	House Crow	<i>Corvus splendens</i>	R
52	House Sparrow	<i>Passer domesticus</i>	R
53	Indian Peafowl	<i>Pavo cristatus</i>	R
54	Indian River Tern	<i>Sterna aurantia</i>	R
55	Indian Robin	<i>Saxicoloidesfulicatus</i>	R
56	Indian Roller	<i>Coracias benghalensis</i>	R
57	Indian Silverbill	<i>Euodice malabarica</i>	R
58	Jungle Babbler	<i>Argva striata</i>	R
59	Jungle Crow	<i>Corvus macrorhynchos</i>	R

Sr.no.	Common Name	Scientific Name	Status
61	Plum Headed Parakeet	<i>Himalayapsitta cyanocephala</i>	R
62	Purple Sunbird	<i>Cinnyris asiaticus</i>	R
63	Red-wattled Lapwing	<i>Vanellus indicus</i>	R
64	Red-vented Bulbul	<i>Pyconotus cafer</i>	R
65	Rose-ringed Parakeet	<i>Alexandrinus krameri</i>	R
66	Scaly-breasted Munia	<i>Lonchura punctulata</i>	R
67	Shikra	<i>Accipiter badius</i>	R
68	Spotted Dove	<i>Spilopelia chinensis</i>	R
69	White-browed Wagtail	<i>Motacilla maderaspatensis</i>	R
70	Feral Pigeon	<i>Columba livia domestica</i>	R
71	Ruff	<i>Calidris pugnax</i>	M
72	Brown-headed Gull	<i>Chroicocephalus brunnicephalus</i>	M



Figure 16. a) Eurasian Spoon bill (PC- Kunal Jain) (b) Spot- billed duck; (c) Flock of Pied Avocet

ADDITIONAL OBSERVATIONS

During the survey we also documented 12 species of butterflies, 3 species of odonates, 22 species of fish, 2 species of snakes, 3 species of lizards, 5 species of mammals and 48 species of plants.

Table 5: Checklist of butterflies, odonates, snakes, lizards, mammals, fish & Plants observed during the survey

Sr.no.	Common Name	Scientific Name
Butterflies		
1	White Orange Tip	<i>Ixias marianne</i>
2	Rice Swift	<i>Borbo cinnara</i>
3	Lemon pansy	<i>Junonia lemonias</i>
4	Common Grass Yellow	<i>Eurema hecabe</i>
5	Plain Tiger	<i>Danaus chrysippus</i>
6	Peacock Pansy	<i>Junonia almana</i>
7	Dark Grass Blue	<i>Zizeeria karsandra</i>
8	Tiny Grass Blue	<i>Zizula hylax</i>
9	Common Emigrant	<i>Catopsilia pomona</i>
10	Striped Tiger	<i>Danaus genutia</i>
11	Pale Grass Blue	<i>Pseudozizeeria maha</i>
12	Common Castor	<i>Ariadne merione</i>
Odonates		
1	Green Marsh Hawk	<i>Orthetrum sabina</i>
2	Ditch Jewel	<i>Brachythemis contaminata</i>
3	Senegal Golden Darlet	<i>Ischnura senegalensis</i>
Snakes		
1	Indian Rock Python	<i>Python molurus</i>
2	Checkered Keelback	<i>Fowlea piscator</i>
Lizards		
1	Bengal Monitor lizard	<i>Varanus bengalensis</i>
2	Yellow Monitor Lizard	<i>Varanus flavescens</i>
3	Oriental Garden Lizard	<i>Calotes versicolor</i>

Sr. no.	Common Name	Scientific Name
Mammals		
1	Spotted Deer	<i>Axis axis</i>
2	Blue bull	<i>Boselaphus tragocamelus</i>
3	Golden Jackal	<i>Canis aureus</i>
4	Wild Boar	<i>Sus scrofa</i>
5	Rhesus Macaque	<i>Macaca mulatta</i>
Fish		
1	Rohu	<i>Labeo rohita</i>
2	Tilapia	<i>Oreochromis niloticus</i>
3	Mangar	<i>Luciobarbus esocinus</i>
4	Chitla	<i>Chitala chitala</i>
5	Goonch	<i>Bagarius bagarius</i>
6	Gangera	<i>Gogangra viridescens</i>
7	Indian gagata	<i>Gagata cenia</i>
8	Wallago	<i>Wallago attu</i>
9	Singhara	<i>Sperata seenghala</i>
10	Gangetic Mystus	<i>Mystus cavasius</i>
11	Stripped Dwarf Catfish	<i>Mystus vittatus</i>
12	Tengra	<i>Mystus tengra</i>
13	Gangetic ailia	<i>Ailia coila</i>
14	Batchwa vacha	<i>Eutropiichthys vacha</i>
15	Indian potasi	<i>Neotropius atherinoides</i>
16	Corsula	<i>Rhinomugil corsula</i>
17	Yellow tail moonlet	<i>Sicamugil cascasia</i>
18	Elongated glass perchlet	<i>Chanda nama</i>
19	Indian glassy fish	<i>Parambassis ranga</i>
20	Banded gourami	<i>Trichogaster fasciata</i>
21	Spotted snakehead	<i>Channa punctata</i>
22	Zig zag eel	<i>Mastacembelus armatus</i>

Sr.no.	Common Name	Scientific Name
Plants		
1	Bon tulsi	<i>Croton bonplandianus</i>
2	Common cocklebur	<i>Xanthium strumarium</i>
3	Wild Jute	<i>Corchorus trilocularis</i>
4	Gudrisag	<i>Alternanthera sessilis</i>
5	Bermuda grass	<i>Cynodon dactylon</i>
6	Drumstick	<i>Moringa oleifera</i>
7	Chaff Flower	<i>Achyranthes aspera</i>
8	Undho bhurat	<i>Pupalia lappacea</i>
9	Neem	<i>Azadirachta indica</i>
10	Carrot grass	<i>Parthenium hysterophorus</i>
11	Castor	<i>Ricinus communis</i>
12	Kans grass	<i>Saccharum spontaneum</i>
13	Baruwa grass	<i>Saccharum bengalense</i>
14	Desset cotton	<i>Aerva javanica</i>
15	Babool	<i>Acacia nilotica</i>
16	Water reed	<i>Phragmites karka</i>
17	Frog fruit	<i>Phyla nodiflora</i>
18	Bringaraj	<i>Eclipta prostrata</i>
19	Blue panic grass	<i>Panicum antidotale</i>
20	Wild tobacco	<i>Nicotina plumbaginifolia</i>
21	Cluster fig	<i>Ficus recemosa</i>
22	Peepal	<i>Ficus religiosa</i>
23	Banyan	<i>Ficus benghalensis</i>
24	Khas khas	<i>Vetiver zizionoides</i>
25	Jungle jujube	<i>Ziziphus nummularia</i>
26	Indian jujube	<i>Ziziphus mauritiana</i>
27	Bhongla	<i>Apluda mutica</i>
28	Monkey bush	<i>Abutilon indicum</i>
29	Stiky Indian Mallow	<i>Abutilon ramosum</i>

Sr.no.	Common Name	Scientific Name
30	Sacrificial grass	<i>Desmostachya bipinnata</i>
31	Karira	<i>Capparis decidua</i>
32	White Babul	<i>Acacia lucocephala</i>
34	Malabar Sesame	<i>Sesamum malabaricum</i>
35	Devils claw	<i>Martyna annua</i>
36	Date Palm	<i>Phoenix sylvestris</i>
37	Buttercup	<i>Ranunculus indicus</i>
38	Mesquite	<i>Prosopis juliflora</i>
39	Shami	<i>Prosopis cineraria</i>
40	Shankh Pushpi	<i>Convolvulus prostratus</i>
41	Sessile Joyweed	<i>Alternanthera sessilis</i>
42	Sacred Datura	<i>Datura innoxia</i>
43	Country Gooseberry	<i>Physalis angulata</i>
44	Foetid Cassia	<i>Senna tora</i>
45	Coffee-senna	<i>Senna occidentalis</i>
46	Small Knotweed	<i>Polygonum plebeium</i>
47	Nut Grass	<i>Cyperus rotundus</i>
48	Wide spikenard	<i>Mesosphaerum suaveolens</i>



Figure 17. Survey team of Yamuna River

FIGURE PLATE



a



b



c



d



e



f

Figure 18. : a) Mugger (*Crocodylus palustris*), b) Bengal Monitor Lizard (*Varanus bengalensis*) c) Ditch Jewel (*Brachythemis contaminata*) d) Indian Rock Python (*Python molurus*) e) Rohu fish (*Labeo rohita*) f) Goonch (*Bagarius bagarius*)

FIGURE PLATE



Common Castor



Striped Tiger



Plain Tiger



Lemon Pansy



Peacock Pansy



Tiny Grass Blue



Common Grass Yellow



Dark Grass Blue



White Orange-tip



Rice Swift



Pale Grass Blue



Common Emigrant

IMPORTANT FINDINGS

Previously, the Yamuna River boasted a diverse array of eight freshwater turtle species, including *Batagur kachuga*, *B. dhongoka*, *P. tentoria*, *N. gangetica*, *N. hurum*, *L. punctata*, *H. thurjii*, and *C. indica*. However, in our current comprehensive study, we documented the presence of six turtle species. Interestingly, we did not observe *N. hurum* during our fieldwork, although an earlier study conducted by Ranjana and Mohindra in 2018 documented the presence of *N. hurum* in the Agra region. Notably, our study revealed the highest abundance of *P. tentoria* among the recorded species. Conversely, species such as *B. dhongoka*, *C. indica*, and *N. gangetica* were encountered in relatively low numbers. Through interviews with local fishermen, it became evident that harvesting activities significantly impact the turtle population in the Yamuna River. Particularly alarming is the vulnerability of larger-bodied turtle species, as they face the most imminent threats from these activities. This insight underscores the pressing need for conservation efforts and effective management strategies to safeguard these vulnerable turtle populations in the Yamuna River ecosystem.

In the investigations conducted by Moll in 1983 and 1986 along the Yamuna River, species including *B. kachuga*, *B. dhongoka*, *P. tentoria*, *L. punctata*, and *N. gangetica* were conclusively documented at Bateshwar. However, our recent comprehensive study on the same stretch of the Yamuna did not yield any evidence of *B. kachuga*, strongly implying a localized disappearance of this species from the Yamuna ecosystem. Furthermore, our observations in this study revealed only a sparse population of *B. dhongoka*. Intriguingly, a separate and recent encounter documented by Bharhadiya in 2020 reported sightings of *B. dhongoka* further upstream along the Yamuna River, specifically within the vicinity of Delhi. This disparity in findings indicates a dynamic and fluctuating distribution pattern of these species within distinct sections of the Yamuna River over time. The contrast between historical data and current observations underscores the necessity for continued monitoring and in-depth research to comprehend the changing dynamics of these turtle populations within the Yamuna ecosystem.

Over the years, turtles confiscated from Manpuri, Etawah, and Agra have been systematically released into the Yamuna River. According to records from 2019, a total of 273 individuals belonging to the *P. tentoria* species, rescued from illegal trade, were reintroduced into the Yamuna River near Bateshwar Dham. Along the expanse of the Yamuna River adjacent to Bateshwar Dham, numerous turtles can often be observed basking in close proximity to human presence. This area not only provides a suitable habitat for turtles but also benefits from the inadvertent protection offered by the region's religious sanctity. In alignment with recent habitat prioritization studies, this specific area falls within Section IV, acknowledged as a high-priority zone for turtle conservation efforts. Considering this designation, it stands as a prospective candidate for future turtle release initiatives and subsequent monitoring programs. In the future, focusing on this area could significantly contribute to future efforts aimed at the conservation and preservation of turtle populations.



RECOMMENDATIONS

#	Recommendations	Priority
1.	Prioritization and increased protection of key areas to identify key populations areas of turtles and categorize the river stretch into different habitats as per the utilization by freshwater turtles inhabiting, and to use this data for formulating stringent monitoring policy for habitat level protection of at least in three priority sites comes in (section 3, 4 and 5). Absence of which can embolden poaching and illegal fishing activities within the study area.	● High
2.	Annual and seasonal species surveys to collect baseline information on the actual species diversity, population status and potential habitat of freshwater turtle population in the area - identifying different species composition and microhabitats will help to understand the current and changing population dynamics of the turtles and the river system for informed management policies and decisions.	● High
3.	Focussed community awareness and outreach with a targeted message about the plight and conservation of threatened turtles in the area through signboards, regular events etc. are highly recommended with various members of the fishing and agrarian community, and riverside schools.	● High
4.	Scientific conservation interventions like habitat monitoring, nest protection program, head starting, post-release survival dispersal monitoring of freshwater turtles like Chitra indica and Batagur dhongoka and sympatric species using telemetry shall be included as a part of scientific interventions in conservation management plans to allow for better decision-making concerning future habitat and species restoration programs in Yamuna.	● High
5.	Population estimation techniques should be introduced slowly through Capture – Mark – Recapture (CMR) method. This will help us to understand turtle demography, movement ecology and a rough species wise numbers that is found in the area.	● High
6.	An education kiosk or interpretation centre on aquatic wildlife of Yamuna may be built at the strategic location in major religious sites identified Kailash Mandir and Btaeshwar Dham with the installation of important awareness signages to aware local community.	● High
7.	Physico-chemical characterization study of water is required to establish a Water Quality Index (WQI) and its relationship with the turtle assemblage in different area. This will help to determine the ecological condition of the river and develop a baseline data that can be used to discern long term hydro chemical changes (if any) and its impact on habitat use by different aquatic animals. Devising and operating regulatory guidelines for sewage disposal and industrial wastewater discharge in the Yamuna.	● High

Recommendations

Priority

8 Capacity building of frontline staff for basics identification, rescue and rehabilitation of endangered aquatic wildlife. Additional use of motor boats for patrolling, and establishment of base camps at areas identified as potential nesting sites of endangered turtle species (Baripura, Sunsar and Pura Dasu Khilawali) and high threat prone area can be considered to check any illicit activities.

● Medium

9. Alternative livelihood and turtle friendly fishing programs for the fishing settlements along the Yamuna are needed. Formal training can be held to scope and implement alternative livelihood earnings for the community members and to address the unsustainable, ecologically harmful and even certain illegal activities. Additionally, fishermen are to be made aware about unsustainable fishing practices, promote use of turtle-friendly gears through training, print materials such as informative posters, leaflet and brochures.

● Medium

10. Participatory conservation management planning via a multifarious approach should be adopted to comprehensively integrate the local community. A separate conservation plan for the conservation of endangered aquatic wildlife of the Yamuna should also align conservation objectives with community benefits via mainstreaming of the fishing community. Conservation awareness alongside skill development programs and setting-up government schemes and urban marketing linkages will improve community resilience and reduce river dependency.

● Medium



Figure 19. Three striped roofed turtle (*B. dhongoka*) as sighted in Yamuna River

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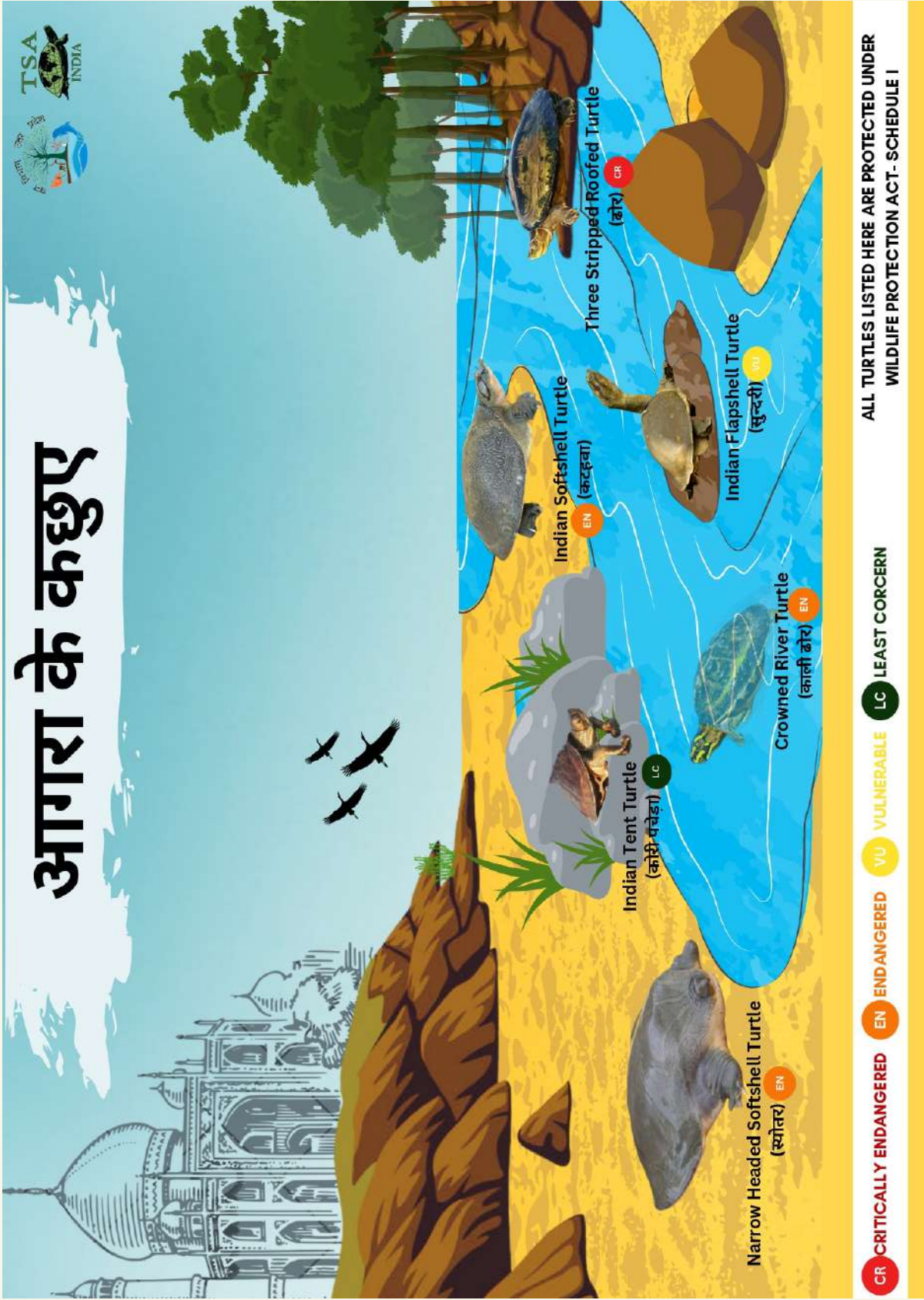
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Figure 20. One of the major religious temple situated on the bank of Yamuna - Bateashwar Shiv Temple.

ANNEXURE- I



ANNEXURE -II

Fishing Threat Assessment	
1. Name of the Interviewer -	Date -
2. Detail of fisherman -	
Name -	Gram Panchayat -
Tehsil -	District -
3. Fishing information -	
A. Frequency of fishing - Daily/ Weekly/ Monthly/Occasionally	
B. Area used for fishing - Main channel/ Back flow/ Edges	
C. Nets use for fishing - Nylon / Wool or Silk	
D. Time of net deployment - Morning/ Afternoon/Night	
E. Duration of net deployment - Hourly basis/ Full day/ Over night	
F. Any other method use for fishing - Hook/ Poison/ Spear	
G. Mode of fishing - Fixed / Moving	
H. Other -	
4. Turtle Information -	
A. Frequency of turtle trapped -	
B. Species of Turtle -	
C. No. of individual at a time -	
D. Condition of Turtle - Live /Dead/ Injured	
E. Action taken for trapped turtle -	
F. Any other -	
5. Any prevention measure used -	

ANNEXURE -III

[illegible]

ANNEXURE -IV

[illegible]



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