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## **Biodiversity of riparian zone of haora river stretch along urban centres, Agartala, Tripura**

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### **Abstract**

River ecosystem supports a large number of plant and animal species comparing to other ecosystems (Ward, J. et.al. 1999). River biodiversity consist of aquatic and terrestrial components which varies along the distance of river and its dynamics. Rivers stretch passing along the urban centres are subject to various pressures including point and non-point pollution, water extraction, sand mining, invasive species, loss of riparian flora due to anthropogenic pressure and other physical alterations. Present study is conducted to understand biodiversity of the river stretch of the Haora river along Agartala city for about 2-kilometer stretch. The Primary objective for this study is to evaluate the biodiversity of the river and riparian zone at its current state. Data is compiled and interpreted to understand the possible improvement in biodiversity of river area after interventions like cleaning, landscaping, plantation etc. Quadrante and transect method were used for assessment of flora and fauna of the locations. Studies have revealed 28 species of plants and 36 species of birds. The study also reveals that the river stretch is highly modified with anthropogenic activities. Interventions like shore line cleaning, plantation, preventing pollution will enhance good biodiversity.

**Keywords:** urban biodiversity, river, aquatic ecosystem

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### **Introduction**

Rivers have played most important role in supporting the evolution process of many species. Thus, the biodiversity in river system is diverse and complex. (LWG Higler). Large cities have been established on the deltas considering plentiful availability of resources. This has resulted into alteration of river physically, chemically as well as biologically. Anthropogenic activities have impacted original flora and fauna of the river (LWG Higler). One of the major impacts is on riparian zones which acts as a interlink between terrestrial and aquatic ecosystem (S. Gregory et.al. 1991). Riparian zone benefits by providing area of transfer for Resources and by serving in ecosystem by the means of improvement of water quality (natural attenuation of pollutants), flood control, recreation, support animal population, improvement of fish habitat, nutrient cycle balance, microclimate regulation, seed dispersion, biodiversity conservation (V. Iakovoglou et.al. 2012; R.C. Schultz et.al. 2000; McDonell & Picket, 1990). Patten 1998 has proved that riparian areas provide large number of ecosystem services compared to the small area it covers. Services provided by freshwater ecosystem are depleting due to degradation in health of freshwater resources which necessitates restoration and management of freshwater ecosystem. The study is designed to assess the biodiversity of riparian zone, identify the threats and suggest interventions to improvise the conditions of the river stretch of about 2-Km along Agartala city.

### **Study area**

Haora flows from East to West direction in Tripura and pours down in the Bay of Bengal by passing through Bangladesh. Haora is benefitting thousands of individuals for daily needs before crossing the border. The river Haora has originated from Baramura hills of West Tripura district. After flowing through the places like Chandrasadhubari, Champak Nagar, Debendranagar, Jirania, Ranirbazar, Pratapgarh the river has entered Agartala city and ultimately met with river Titas in Bangladesh. During its course to Bangladesh, it passes through the jurisdiction of Agartala Municipal Corporation. It is considered as lifeline of Agartala by contributing directly or indirectly to 60% of the population.

The river span under reference (2 km) has disturbed riparian area due to human establishments. Northern bank of the stretch has an embankment which was built to secure Agartala city from floods of the river. Haora river is polluted due to point (Sewage from human settlements, solid waste dumping along the bank etc.) and non-point sources (runoff from the open sewerage systems during flood, agriculture etc).

The river has been listed by NGT in one of the polluted rivers of the India.

The water of the river is observed to be very turbid, large quantities of solid waste was seen floating on the river water along the entire stretch. Entire 2 km of river front stretch is surrounded by residential properties, commercial establishments and public utilities like water pumping jack well, gardens, Children Park and green areas on both the sides of the bank.

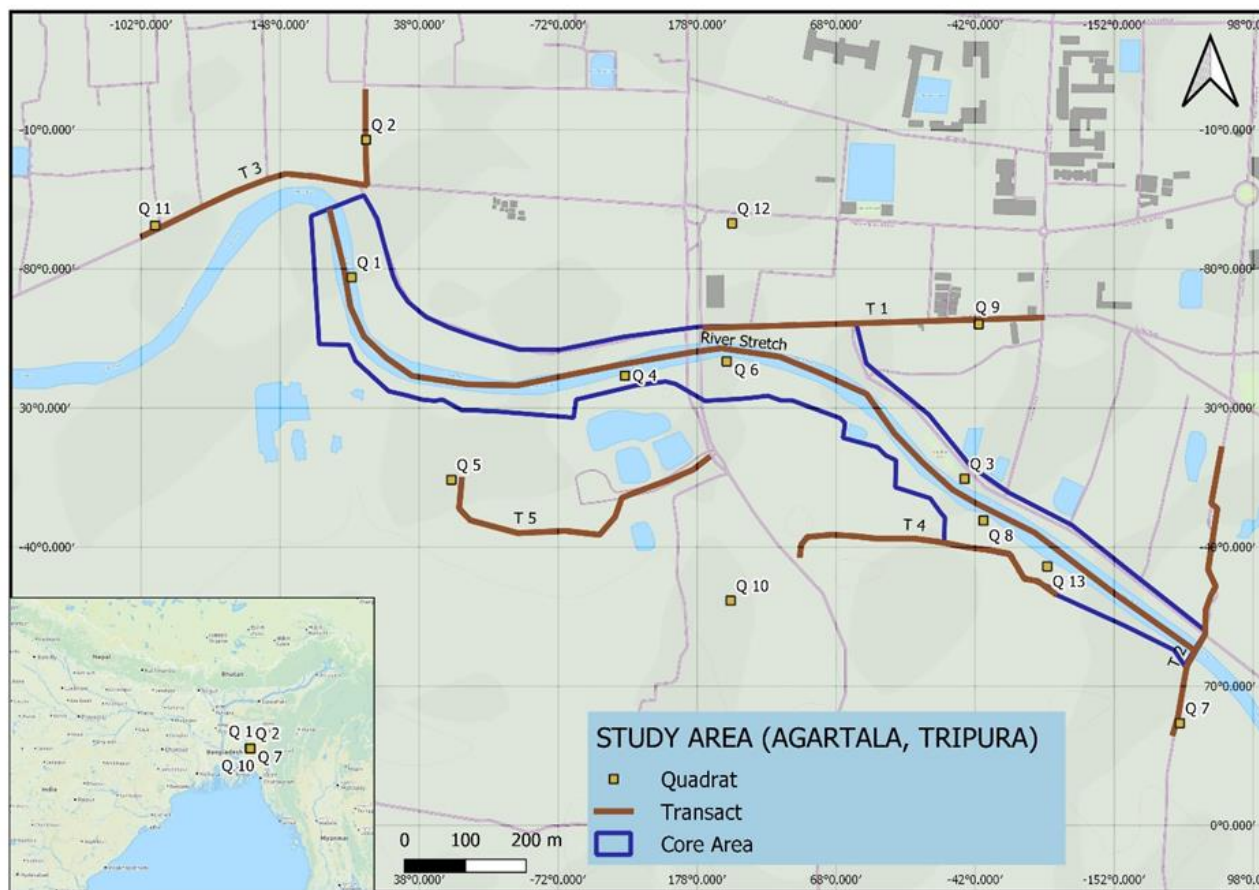


Fig 1: Map Showing Study Area & Sampling Locations (Haora River Stretch, Agartala, Tripura)

**Materials and methods**

Assessment was carried out by taking 13 quadrates along the river. Quadrat size was fixed as 10m x 10m for trees, 5m x 5m for shrubs and 1m x 1m for herb. Faunal species were recorded using line transect method. A certain distance was covered in each transect and observed faunal species were counted. Direct as well as indirect sightings/ observations were recorded during faunal survey. Shannon index and Simpson index were calculated using Biodiversity Pro 2.0 software. For assessment of floral diversity, 13 quadrates were laid in the study area. The quadrat method includes lying down of a square sample plot of suitable size for detailed analysis of vegetation. Quadrat size of 10m X 10m for trees and within these, 5m x 5m quadrat for shrubs species, and 1m x 1m were also laid for herbs. Faunal species were assessed by transect method by traversing a known distance and noting observed faunal species along the length. Survey was done by direct observation/ visual encounter techniques and also through observation of indirect signs. Phyto-sociology factors were calculated in given in the Table 2. Total 13 quadrat & 5 transect were laid in the study area. Shannon index and Simpson index were calculated for flora and fauna. Fauna was categorised based on its IUCN red list 3.1 status and Wildlife Protection Act, 1972 (WPA) status.

Fauna was checked for their IUCN 3.1 status (International Union for Conservation of Nature) and also their status in the Schedules of Wildlife Protection Act, 1972. List of the quadrat locations is

presented in Table 1 below.

Table 1: Sampling Locations

Location	Latitude	Longitude	Landuse
Q 1	23°49'41.46"N	91°15'50.83"E	Dashmi Ghat
Q 2	23°49'48.47"N	91°15'51.69"E	Urban
Q 3	23°49'30.52"N	91°16'26.37"E	Riparian Zone
Q 4	23°49'35.89"N	91°16'6.59"E	Riparian Zone
Q 5	23°49'30.59"N	91°15'56.63"E	Wetland
Q 6	23°49'37.01"N	91°16'12.67"E	Riparian Zone
Q 7	23°49'17.45"N	91°16'39.04"E	Wetland
Q 8	23°49'28.61"N	91°16'27.51"E	Riparian zone/ground
Q 9	23°49'38.92"N	91°16'27.39"E	Urban
Q 10	23°49'24.14"N	91°16'12.77"E	Green Area
Q 11	23°49'44.19"N	91°15'39.36"E	Urban
Q 12	23°49'44.06"N	91°16'12.84"E	Urban
Q 13	23°49'25.91"N	91°16'31.36"E	Riparian Zone

**Results and discussion**

Studies showed that the area has moderate biodiversity. Total 11 tree species, 3 shrub species, 14 herb species were observed through primary survey. Faunal diversity of the area was found to be moderate, 36 birds and three wild mammal and four butterflies were sighted observed in the area through primary survey. No globally threatened species as per IUCN or schedules species as per Wildlife Protection Act, 1972 were observed during the study.

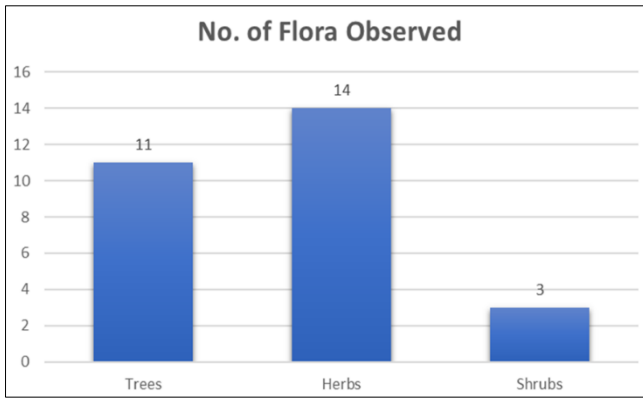


Fig 2: Number of Flora Species Observed

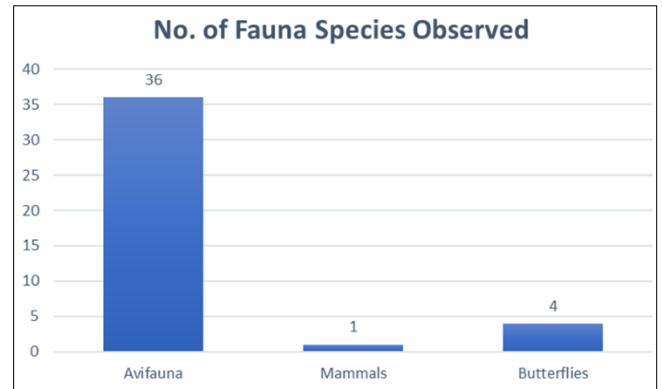


Fig 3: Number of Fauna Species Observed in Study Area

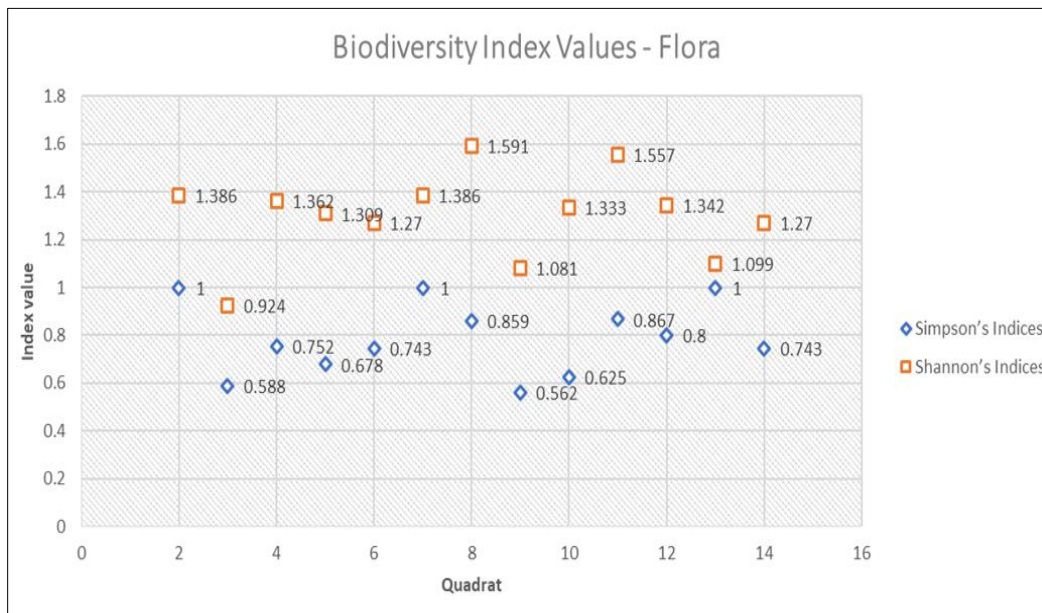


Fig 4: Biodiversity index for Flora

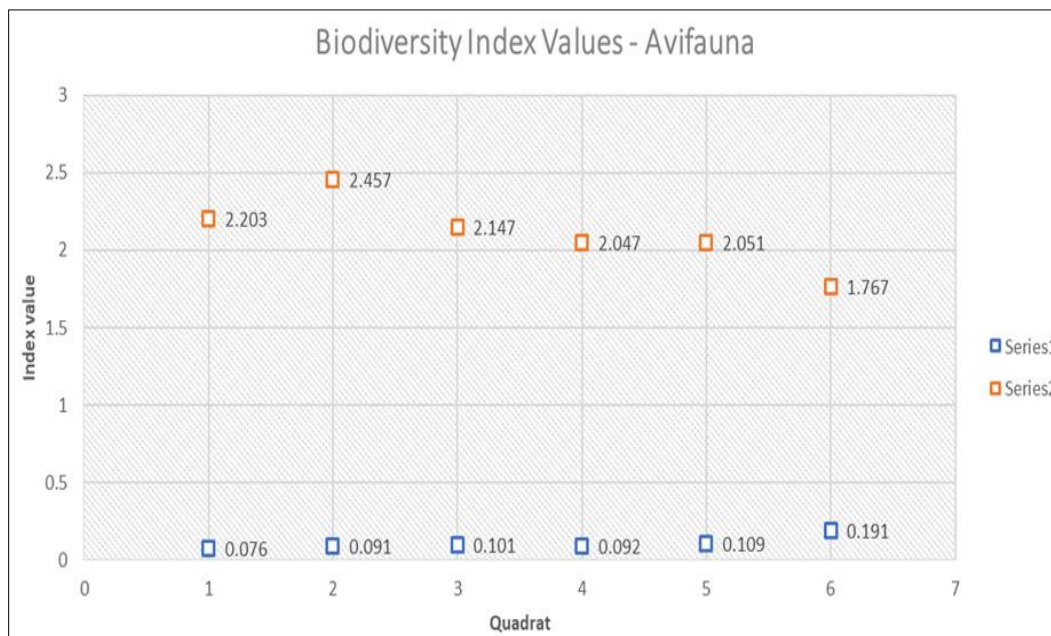


Fig 5: Biodiversity index of Avifauna

Simpson’s Diversity Index measures the diversity by considering species richness and relative abundance of each species present in the sample. Simpson’s diversity index is directly proportional to richness of species and evenness. Shannon index quantitatively

measures the species richness and also considers evenness. Above graph and phytosociological indicators shows the study area supports good biodiversity.

**Table 2:** Checklist of Plants & Phytosociology Indicators

Sr. no.	Name of Species	Frequency	Density	Abundance	RD	RF	RA	IVI
<b>Woody Flora</b>								
1	<i>Trevi nudiflora</i>	0.15	0.003	2	9.5	7.3	5.83	22.63
2	<i>Ziziphus jujuba</i>	0.15	0.002	1.5	9.5	5.5	4.37	19.35
3	<i>Calotropis gigantea</i>	0.08	0.001	1	4.8	1.8	2.91	9.49
4	<i>Solanum sp.</i>	0.15	0.005	3.5	9.5	12.7	10.20	32.45
5	<i>Tectona grandis</i>	0.08	0.005	7	4.8	12.7	20.39	37.88
6	<i>Ficus religiosa</i>	0.08	0.001	1	4.8	1.8	2.91	9.49
7	<i>Ficus sp.</i>	0.08	0.002	2	4.8	3.6	5.83	14.23
8	<i>Ficus hispida</i>	0.23	0.003	1.3	14.3	7.3	3.88	25.45
9	<i>Kadam tree</i>	0.08	0.001	1	4.8	1.8	2.91	9.49
10	<i>Trema oreintalis</i>	0.15	0.002	1	9.5	3.6	2.91	16.08
11	<i>Lagerstromia parviflora</i>	0.08	0.001	1	4.8	1.8	2.91	9.49
12	<i>Cocus nucifera</i>	0.08	0.001	1	4.8	1.8	2.91	9.49
13	<i>Areca catechu</i>	0.08	0.001	1	4.8	1.8	2.91	9.49
<b>Non-woody Flora</b>								
1	<i>Agaratum conyzoid</i>	0.33	2.519	7.6	4.7	7.2	0.03	14.98
2	<i>Alocasia esculanta</i>	0.07	0.185	2.5	1.0	0.5	0.01	2.59
3	<i>Alternanthera sessilis</i>	0.11	0.222	2.0	1.6	0.6	0.01	3.01
4	<i>Alternanthera philoxeroids</i>	0.04	0.259	7.0	0.5	0.7	0.03	4.11
5	<i>Ipomea carnea</i>	0.15	0.015	10.0	9.5	36.3	29.13	75.03
6	<i>Alysicarpus vaginalis</i>	0.04	0.185	5.0	0.5	0.5	0.02	3.09
7	<i>Amaranthus spinosus</i>	0.19	0.370	2.0	2.6	1.0	0.01	4.47
8	<i>Anisomelis indica</i>	0.07	0.259	3.5	1.0	0.7	0.01	3.21
9	<i>Blumea sp.</i>	0.07	0.148	2.0	1.0	0.4	0.01	2.28
10	<i>Borreria hispida</i>	0.26	1.370	5.3	3.6	3.9	0.02	9.71
11	<i>Cassia tora</i>	0.30	3.333	11.3	4.1	9.6	0.05	18.292
12	<i>Cenderella toona</i>	0.07	0.111	1.5	1.0	0.3	0.01	1.97
13	<i>Centella asiatica</i>	0.07	0.815	11.0	1.0	2.3	0.05	7.86
14	<i>Chinopodium ambroides</i>	0.04	0.037	1.0	0.5	0.1	0.01	1.03
15	<i>Christella parasitica</i>	0.04	0.037	1.0	0.5	0.1	0.01	1.03

**Observations**

The biodiversity indices show that the area is good in floral species. In trees *Solanum sp.*, found to be more common. *Cassia tora* found to be a common shrub in the study area. *Alternanthera sessilis* is a most common herb along the river which is exotic and invasive in nature. This herb is reported to block the drain network and irrigation channels. Faunal diversity of the area was found to be diverse, 36 birds, 3 wild mammal and 4 butterflies were sighted in the area through primary survey. No threatened or near threatened species was recorded during the survey. A

consolidated list of avifauna, mammals and butterflies is given in Table No 3.

It can be seen that the study area harbours good biodiversity and the riparian area has an ecological importance by having bamboo thicket. Considering the species, their density, movement, habitat requirement, IUCN status and possible impacts due to various proposed projects including river front development project under Smart City project for Agartala, requires mitigation measures and interventions to improve biodiversity in the area. Mitigation measures include following:

**Table 3:** Recommended interventions

Sr. No.	Type	Interventions Recommended
1.	Invasive Species	Removal of invasive plant species and plantation of native plants in the riparian area
2.	Green Areas	Maintaining existing green areas including wetlands with aquatic plants Development of butterfly garden.
3.	Improving Aquatic Biodiversity	Stopping solid-waste dumping including slaughter waste & water quality improvement in river to enhance aquatic biodiversity.
4.	Habitat Conservation	Shallow edges of the stretch to be maintained to support birds like Wagtails Plantation of fruiting trees to support birds like Lineated Barbet and attract other frugivorous birds Maintaining existing trees to keep intact habitat of Hoary bellied Himalayan Squirrel

**Table 4:** Checklist of Fauna observed

Sr. No	Common Name	Scientific Name	Order	Family	IUCN, 3.1 Status	WPA, 1972 (Schedule)	Endemic
<b>Birds</b>							
1	Black Kite	<i>Milvus migrans</i>	Accipitriformes	Accipitridae	LC	Sch. IV	No
2	Asian palm swift	<i>Cypsiurus balasiensis</i>	Apodiformes	Apodimorphae	LC	Sch. IV	No
3	Eurasian hoopoe	<i>Upupa epops</i>	Bucerotiformes	Upupidae	LC	NA	No
4	Blue Rock pigeon	<i>Columba livia</i>	Columbiformes	Columbidae	LC	Sch. IV	No
5	Spotted Dove	<i>Spilopelia chinensis</i>	Columbiformes	Columbidae	LC	Sch. IV	No
6	Yellow-footed green pigeon	<i>Treron phoenicoptera</i>	Columbiformes	Columbidae	LC	Sch. IV	No
7	Green bee-eater	<i>Merops orientalis</i>	Coraciiformes	Meropidae	LC	Sch. IV	No
8	Pied Kingfisher	<i>Ceryle rudis</i>	Coraciiformes	Alcedinidae	LC	Sch. IV	No
9	White throated Kingfisher	<i>Halcyon smyrnensis</i>	Coraciiformes	Alcedinidae	LC	Sch. IV	No
10	Common kingfisher	<i>Alcedo atthis</i>	Coraciiformes	Alcedinidae	LC	Sch. IV	No
11	Asian Koel	<i>Eudynamys scolopaceus</i>	Cuculiformes	Cuculidae	LC	Sch. IV	No
12	Greater Coucal	<i>Centropus sinensis</i>	Cuculiformes	Cuculidae	LC	Sch. IV	No
13	White-Breasted waterhen	<i>Amaurornis phoenicurus</i>	Gruiiformes	Rallidae	LC	Sch. IV	No
14	Black Drongo	<i>Dicrurus macrocercus</i>	Passeriformes	Dicruridae	LC	Sch. IV	No
15	Brown Shrike	<i>Lanius cristatus</i>	Passeriformes	Lanidae	LC	NA	No
16	Chestnut-tailed Starling	<i>Sturnia malabarica</i>	Passeriformes	Sturnidae	LC	Sch. IV	No
17	Common Myna	<i>Acridotheres tristis</i>	Passeriformes	Sturnidae	LC	Sch. IV	No
18	Great tit	<i>Parus major</i>	Passeriformes	Paridae	LC	Sch. IV	No
19	House Crow	<i>Corvus splendens</i>	Passeriformes	Corvidae	LC	Sch. IV	No
20	House Sparrow	<i>Passer domesticus</i>	Passeriformes	Passeridae	LC	NA	No
21	Jungle Myna	<i>Acridotheres fuscus</i>	Passeriformes	Sturnidae	LC	Sch. IV	No
22	Large billed Crow	<i>Corvus macrorhynchos</i>	Passeriformes	Corvidae	LC	Sch. V	No
23	Oriental Magpie- Robin	<i>Copsychus saularis</i>	Passeriformes	Muscicapidae	LC	Sch. IV	No
24	Pied Starling	<i>Gracupica contra</i>	Passeriformes	Sturnidae	LC	Sch. IV	No
25	Purple sunbird	<i>Cinnyris asiaticus</i>	Passeriformes	Nectariniidae	LC	Sch. IV	No
26	Red Vented Bulbul	<i>Pycnonotus cafer</i>	Passeriformes	Pycnonotidae	LC	Sch. IV	No
27	Rufous Treepie	<i>Dendrocitta vagabunda</i>	Passeriformes	Corvidae	LC	Sch. IV	No
28	White wagtail	<i>Motacilla alba</i>	Passeriformes	Motacillidae	LC	Sch. IV	No
29	Yellow wagtail	<i>Motacilla flava</i>	Passeriformes	Motacillidae	LC	Sch. IV	No
30	Cattle Egret	<i>Bubulcus ibis</i>	Pelecaniformes	Ardeidae	LC	Sch. IV	No
31	Pond Heron	<i>Ardeola grayii</i>	Pelecaniformes	Ardeidae	LC	Sch. IV	No
32	Coppersmith barbet	<i>Psilopogon haemacephalus</i>	Piciformes	Megalaimidae	LC	Sch. IV	No
33	Fulvous breasted woodpecker	<i>Dendrocopos macei</i>	Piciformes	Picidae	LC	Sch. IV	No
34	Lesser Goldenback wood pecker	<i>Dinopium benghalense</i>	Piciformes	Picidae	LC	Sch. IV	No
35	Lineated Barbet	<i>Psilopogon lineatus</i>	Piciformes	Megalaimidae	LC	Sch. IV	No
36	Rose Ringed parakeet	<i>Psittacula krameri</i>	Psittaciformes	Psittaculidae	LC	Sch. IV	No
<b>Mammals</b>							
1	Hoary-bellied Himalayan Squirrel	<i>Callosciurus pygerythrus</i>	Rodentia	Sciuridae	LC	NA	No
2	Indian Grey Mongoose	<i>Herpestes edwardsii</i>	Carnivora	Herpestidae	LC	Sch. II	No
3	Indian Flying Fox	<i>Pteropus giganteus</i>	Chiroptera	Pteropodidae	LC	Sch. V	No
<b>Butterfly</b>							
1	Common emigrant	<i>Catopsilia pomona</i>	Lepidoptera	Pieridae	LC	NA	-
2	Common crow	<i>Euploea core</i>	Lepidoptera	Nymphalidae	LC	NA	-
3	Common sailor	<i>Neptis hylas</i>	Lepidoptera	Nymphalidae	LC	NA	-
4	Striped tiger	<i>Danaus genutia</i>	Lepidoptera	Nymphalidae	LC	NA	-

Note:

- LC: Least Concerned (IUCN)
- Sch. IV: Wildlife Protection Act, 1972- Schedule IV
- NA: Not Applicable

The proposed project with suggested interventions will improve local biodiversity and increase green area in the city. This will also contribute to the Sustainable Goal 6 (Clean Water and Sanitation), 11 (Sustainable Cities and Communities), 14 (Life below water) and 15 (Life on land).

### Conclusion

Biodiversity Assessment shows that the given area is in stress due to disposal of solid waste and anthropogenic pressures. However,

it has potential for rejuvenation with little intervention as mentioned in above. The green areas such as Bamboo thickets has provided good habitat to the fauna in the area.

There will be increase in density of trees along the river stretch if landscaping and new plantations are undertaken. As recommended, green area & butterfly park will help to support biodiversity in the area. The most important intervention is to prevent untreated waste water to the river and disposal of solid waste. This can be accomplished by implementation of proper

management measures such as treatment plant of all the nallas discharging to the river. Low cost and low maintenance technologies such as phyto-filtration technologies are recommended for Nalla treatment. Awareness drive should be taken up with the local population for preventing waste disposal and importance of conservation of river.

### Acknowledgment

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