QUALITATIVE AND QUANTITATIVE STUDY OF LOWER AND HIGHER ORGANISMS AND THEIR FUNCTIONAL ROLE IN THE DEEPOR BEEL ECOSYSTEM

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CHAPTER-I: INTRODUCTION

1.0. INTRODUCTION

Deepor beel is a large natural wetland having great biological and environmental importance (Deka & Goswami, 1992). It is endowed with rich floral and faunal diversity. Besides huge congregation of residential water birds, the Deepar beel ecosystem harbours large numbers of migratory waterfowl each year. Hence, Deepor beel attracted large numbers of ornithologist, tourists and nature lovers. It was declared as an internationally important wetland and was included in the Directory of Asian Wetlands. Besides this, there is marked change in the water spread and land use pattern in an around the beel in different seasons of the year. The inflow of wastewater from Guwahati City to this beel has degraded its water quality making it hazardous for the aquatic flora and fauna (Report, Govt. of Assam 1989, Deka & Goswami, 1993). From the classification point of view the wetland is characterized by freshwater lakes and associated marshes (Lacustrine). It is a naturally depressed area between hills and plains. While the earlier feeding canal of the beel was River Brahmaputra, but now it had completely blocked by the construction of National Highway and urban development. The present water sources of the deepor beel are from the catchments area and river Basishtha. During Monsoon season, about 70 percent hydrophase of the beel has chocked with Aquatic grasses, Water lily and Water hyacinth. The present hydrophase of the ecosystem has maintained at the core zone of the beel, whereas other areas are characterized by aquatic-bed ecophase.

Again, the beel qualifies as a wetland of international importance for several reasons such as, it particularly a good representative example of a wetland characteristic of the appropriate region, outstanding hydrological, biological and ecological role, substantial socio-economic and cultural value within the framework of sustainable use and habitat conservation, supports an appreciable assemblage of rare, vulnerable and endangered species or subspecies of plant or animal or an appreciable number of individuals of any one or more of these species. It has a special value for its endemic plant or animal species or communities; it regularly supports substantial numbers of individuals from particular groups of waterfowl indicative of wetland values, productivity or diversity. The area is the only major storm water storage basin for the Guwahti City and catchments area, which exceeds 40,000 hectares in total area, supports natural fisheries that is a lifeline to a community of over 5000 fisher folk and contribute significantly to regional trade. It is a part of high biological diversity, with over 400 vertebrate species recorded. The study of the lower and higher organism in Deepor beel Ramsar site was not been studied in details. But it is very important to assemblage the overall faunal diversity of this important wetland of Assam. The present study is aimed to find out the overall biodiversity within a constraint time period of one year. The main objectives of the present study are as follows: -

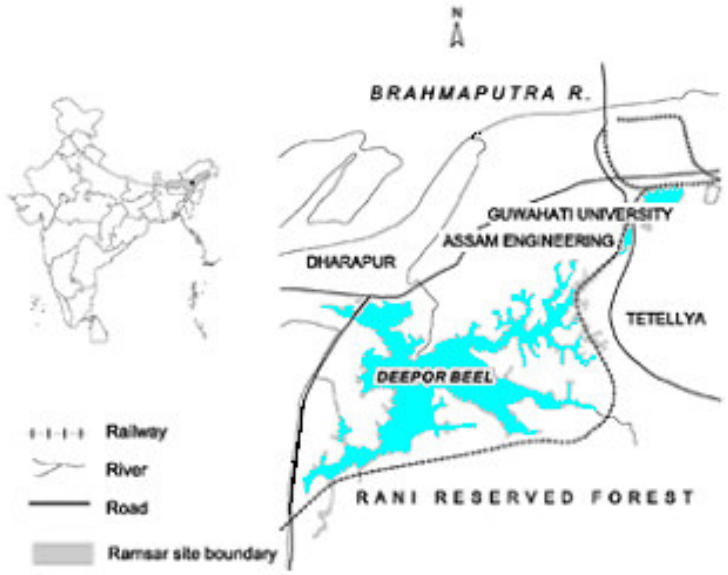
1.1 OBJECTIVES

1. To carry out qualitative and quantitative studies of lower organism specifically insects, molluscs and crustaceans species in Deepor beel.
2. To carry out qualitative and quantitative studies of higher organisms including fish fauna, herpitofauna, avian fauna & mammalian fauna in Deepor beel.
3. Food chain and Food web diagram building for Deepor beel ecosystem.
4. Identification of endangered and endemic fauna in deepor beel Ramsar site.
5. To analyze the diversity and richness of various phylogenic groups of lower and higher organism.
6. Preparation of a set of recommendation for creation of suitable environment for diversified variety of avian species with special reference to endangered, threatened and endemic species.

The study has definite deliverable after completion of field survey, those are as follows: -

1.2. DELIVERABLES

a. A report synthesizing the faunal biodiversity of the Deepor beel.
b. List of endemic and endangered species.
c. A soft copy of the data thus collected.
d. A photographic record of important keystone species.

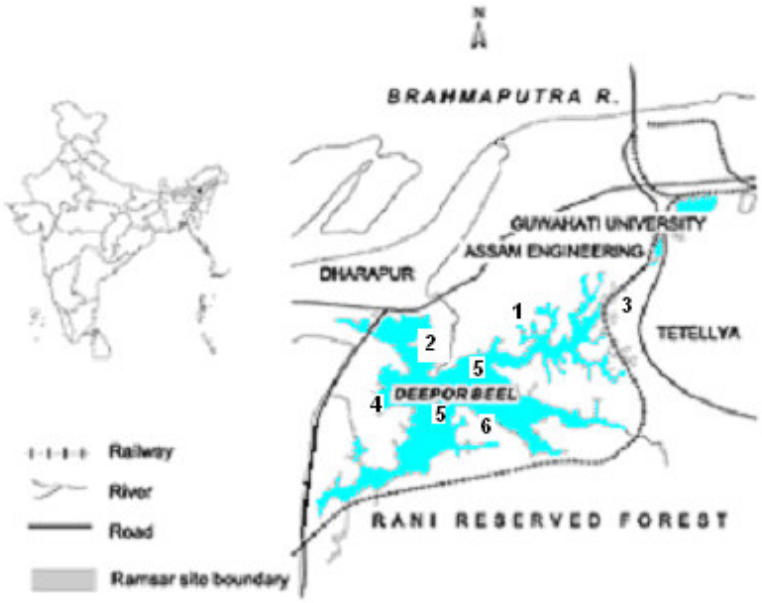


Coordinates
Latitude: 26°05' – 26°11' N
Longitude: 91°35' – 91° 43' E

Area: ~ 40 Sq Km

Elevation: ~ 53 m above MSL

Map1: Shows the general study area of Deepor beel Ramsar site.



Map2: Shows the specifically designed study zones within deepor beel Ramsar site (1= Zone-1; 2: Zone-2; 3: Zone-3; 4: Zone-4; 5: Zone -5; 6: Zone-6).

CHAPTER-II: STUDY AREA AND METHODS

2.0 STUDY AREA AND METHODS

2.1 STUDY AREA

a. Physiography and location

Deepor beel is located within the coordination of 91°35′ to 91°43′ E. and 26°05′ to 26°11′ N. and lies on 165 -186 feet above MSL (Saikia and Bhattacharjee, 1987). It is situated on the Southern bank of the river Brahmaputra and Village Maj Jalukbari, Pachim Jalukbari, Dharapur and National Highway No.37 lie on the North; Dakhin Jalukbari, Tetelia and Pachim Baragoan to the East; Gorbhanga Reserve Forest, Chakardew Hill and Chilla Hill to the South West and the Village Azara and Kahikuchi to the west. The beel considered being of riverine origin, lies on the Southwestern fringe of Guwahati City, covering an area of about 40 km^2. The NH-37 passes a little distance away from the eastern margin of the beel while the Rani Reserve forest and the Meghalaya hills surround the southern part. Several educational institutions including Gauhati University, Assam Engineering College and Assam Forest School are located along the northern fringe of the beel.

Originally the Deepor beel had its natural linkage with the river Brahmaputra through the Borhola beel and the swampy areas of Pandu, lying to the Northeast. But owing to the construction of NH-37 and civil works like residential buildings the earlier link has already been severed. The Deepor beel system receives its water mainly from the streams and rivulets flowing from the south and southwestern side of the beel that are fed by rainwater during monsoon season. The Basistha River is the main inlet of the beel. The Bharulu rivulet that flows through the heart of the city has its confluence with the Brahmaputra at Bharulumukh. Morabharulu, which acts as a link channel joining the Bharulu with the Basistha, discharges the waters of the Bharulu into the Deepor beel through the Basistha Bahini River when the Brahmaputra flows above the level of the Bharulu. During this period the beel practically receives water from the entire city of Guwahati through these channels. Moreover, the

beel receives surface runoff directly from the nearby hills. During the dry season, these streams do not carry much water, and so the water level in the beel touches its minimum. Presently, the Khanajan channel in the north of the beel is functioning as its main outlet that links it to the Brahmaputra River in the north. Deepor beel, which act as a natural storm water reservoir during the monsoon season, is greatly influenced by the rapid pace of urbanization and improper land use pattern of Guwahati City.

The Deepor beel is set in a unique physiographic framework and is characterized by its active hydrologic regime. Geomorphologically, its origin and development are intimately linked with the geologic and tectonic history of the region, hydrology and channel dynamics of rivers and pattern and intensity of land use in the area. It is commonly believed that the beel together with those adjoining it represents an abandoned channel of the Brahmaputra system. The beel is located in a broad U-shaped valley rammed between the steep highlands on the north and south. From these highlands, the beel area receives considerable surface runoff. However, the major inflow to the beel comprising mainly the surplus storm water runoff from the city during the monsoon season is received through the Basistha- Moranala system flowing from the southeast.

The highlands lying immediately to the north and south of the beel are made up of gneisses and schist's of the Archaean age, whereas the beel and its lowland fringe is underlain by recent alluvium consisting of clay, silt, sand and pebbles. Average annual rainfall in the Deepor basin is about 1660 mm, 90% of which occurs between April and September. Originally the Deepor beel had its natural linkage with the river Brahmaputra through the Borhola beel and the swampy areas of Pandu to the Northeast. But due to the construction of NH 37 and other civil work including residential buildings, the earlier link has been disrupted. As indicated earlier, the Basistha River is the main inlet for the Deepor beel. The maximum daily discharge of this river at NH-37 crossing near Kotabari was $5.4/m^3 s^{-1}$ in 1988. The Bharalu River that flows through the heart of the city meets the Brahmaputra at Bharalumukh. The Mora Bharalu, which acts as a link-channel between the Bharalu and the Basistha rivers, discharges the wastes of

Bharalu into the Deepor beel through the Basistha River when the water level of the Brahmaputra remains above that of the Bharalu. In fact, during this period the beel receives water from the entire city up reducing the water level in the beel to the minimum. Presently Khana Nadi to the North of the beel provides the main outlet to it and connects it via a sluice gate with the Brahmaputra. However, the drainage from the beel is greatly hindered when the Brahmaputra remains in spate.

There is no concrete land tenure data of Deepor beel. The entire Deepor beel area (40 km^2) was earlier government vacant land. Various Government Department such as settlement Department, revenue department, fishery department and forest department at the same time demanded their own right on it to implement their departmental activities. Apart from 4.14 sq. km. of Deepor beel core area (the area under bird Sanctuary), the settlement department shows only 36 Bighas of Government vacant land. The rest of area is either encroached without valid Patta or converted in to temporary Patta land by the society's most influential peoples and people from neighboring areas. The allotment of the patta was started systematically since 1989, when the individuals, NGO are starting for Deepor beel conservation movement against Government declaration of railway BG line construction through Deepor beel proper. According to Government land Law, the wetland, lake (Green belt) or river cannot be a Patta land of any individuals or if it is patta land it cannot be converted into settlement areas.

b. Ecological significance

Deepor beel has been serving since long as a storm water receptacle of the surrounding areas. It used to receive storm waters from the hills lying to the north, south and east during the rainy season. It is a unique wetland habitat for wild flora and fauna. Hence it was declared a wildlife sanctuary in 1989 and was included in the Directory of Asian wetlands. A number of endemic endangered and threatened animals and plants are found in it. The wetland produce a large quantity of fish in each year which supports about 500 poor families of fishermen of five villages in an around Azara-Garigoan as their sources of income.

The beel plays an important role in maintaining the environmental quality of the areas in its vicinity and also of the city. It represents one of the last vestiges of the once ubiquitous wetlands of this region. The Deepor beel is an open water system representing a biologically rich wetland environment. The dry wt fish biomass of the beel is about 1.5 to 3.8 gm/m^2. The fish yield in the beel at the rate of 245 kg per hectare is quite noteworthy (Sources, AFDC, Assam). The rate is very high compared with the rates in the country. Migratory fish from the Brahmaputra are also found in the beel. The primary productivity of biomass is estimated at 30.69-50.40 gm/cm^2. The people of the surrounding villages and Garigoan-Sadilapur areas use the fringe areas of Deepor beel for agricultural activities. It is known that nearly 600 hectares of land in the fringe area is under agricultural practice. Considering the state level average production figures of Rabi and Kharif paddy; it can be estimated that in the 600 hectares of agricultural land more than 1500 tones of rice are produced (Govt of Assam, 1990). Based on the present agricultural practices and the number of people engaged in it, it can be reasonably assumed that the fringe areas have played a significant role in the socio-economic condition of the villagers. Traditionally the beel has been used as a recreational ground for hunting of deer, elephant, birds (Phukon 19??) and boating, sight seeing, picnic etc.

c. Land use

The entire beel area is utilizing as a traditional fishing ground by the inhabitants of surrounding villages. The Northeastern part of the beel lays the thickly populated village called Tetelia, which extends up to the NH-37 on the east. The tribal villages are located on the southern fringes of the beel, such as, Pamohi and Mikirpara. The major crop raises by the villagers is Boro-paddy, a winter variety and is planted during December-January and harvested during April-May. The outer fringe areas are using for roads, industries and human settlements, especially in the eastern and northeastern sides. The northern and northeastern sides are occupied for human settlements and as well as public or semi-public purposes. The Assam Engineering College, the Assam Ayurvedic College, the Govt. Sanskrit College and a part of Gauhati University are major

educational institutions located in the northern margins of the beel. The Tetelia high school and few primary schools in the neighboring villages are the outer educational institutions in its fringe areas.

The National Highway No. 37 surrounds the beel on the east and Northeast, and the PWD road skirting the northern fringe of the Rani and Garbhanga reserve forest on its south. Dharapur-Kahikuchi section of the NH-37 located on its west, whereas, Engineering College Road located on the north. Besides, a few other minor roads and tracts also exist in the vicinity of the beel. The newly established Mother Teresa Hospital is also situated in the northwestern border of the Deepor beel.

Prior to construction of B.G. line, there was no rail-road passing through or in the vicinity of the beel except the Rangia-Guwahati B.G. lines that touches part of the Borhola beel system lying to the Northeast of the Deepor beel (originally connected). A number of temporary farmhouses have been constructed in recent years all around the Deepor beel. Besides, several settlements and industrial units including the Border Security Forces housing complex and the Artfed industrial complex have come up in the swampy area of the beel. A number of brick kilns also operate within the beel area itself. Apart from this, the local people regularly using the beel water as a waterway for transporting the villagers of the Southern boundary to the NH. 37. The villagers collect fodder from the beel area for their domestic cattle and collect aquatic seeds such as, Giant water lily, *Nymphea* sp. etc.

d. Biological Diversity

Deepor beel is one of the richest biodiversity areas within the wetland ecosystem of Assam. Its partially deep water and partially shallow water as well as the presence of high land support large numbers of plant and animal species. Again, the presence of hilly terrain and natural forest adjoining the beel area support large numbers of endangered and threatened vertebrate species. Deepor beel is one of the refueling sites on the migratory flyways and some of the largest congregations of aquatic birds in Assam can be seen here, particularly in winter.

Apart from that, large numbers of terrestrial avifauna is also meet in this highly productive beel system.

e. Habitat

The water area of Deepor beel itself offers a variety of habitats through the years as the water regime changes. During the summer, large parts of the beel are covered by aquatic vegetation like water hyacinth; aquatic grasses, water lilies and others sub merged, emergent and floating vegetation. The highland areas, which are completely dry during winter, are also covered by aquatic and semi-aquatic vegetation. The water regime touches the surrounding boundaries such as edges of hilly terrain and National Highways etc. during peak of the monsoon season; hence it is a part of the Deepor beel ecosystem. During the winter a variety of habitat such as deep open water area (hydrophase), marshy lands, mud flat, emergent vegetation, water hyacinth patches, wet-grassland patches, paddy field area, dry grassland areas, and scattered forest areas etc. support manifold habitats for migratory waterfowl, residential waterfowl and terrestrial avifauna. The scattered forest present within the beel area supports a large variety of lizard species. These habitats support specific overlapping communities. Feeding relationships forming a very complex energy transformation system and food web links these communities.

f. Vegetation

Phytoplankton is one of the major components of the lowest level of the producers in the Deepor beel ecosystem. Again, the fluctuations of water regime during summer and winter also influence the diversity and abundance of the lowest level of the food web. Phytoplankton community is present in higher range throughout the period the dominant species are represented by *Oscilatoria spp. and Microcystis spp.* A total of 18 genera of phytoplankton are reported only from the core area of the Deepor beel ecosystem. During the retreating monsoon, a total of 18 genera of phytoplankton has been reported which was about 62% of the total planktonic population of the sample (499 individual/l) whereas, during winter season, 68.64% phytoplankton was estimated from a plankton density of 542 ind./l and constituted by 15 genera (Chetry, 1999). The available

phytoplankton species were *Volvox sp., Anacysistis sp., Oscillotoria sp., Spirogyra sp., Ulothrix sp., Diatom sp., Ceratium sp., Selenastrum sp., Microcystis sp., Anabaena sp., Zygnema sp., Closterium sp., Hydrodictyon sp., Tribonema sp., Chlorella sp., Navicula sp., Melosira sp., and Synedra sp*. etc. (Sarma *et al*., 1993). There are three peaks of Phytoplankton population: the major one is a winter and retreating monsoon bloom with a minor bloom during the pre-monsoon (Chetry, 1999). The population density of phytoplankton reaches fairly high levels during winter season and re-treating monsoon but remain low during summer season.

g. Other aquatic Plants

Deepor beel appears to be relatively high with respect to the biodiversity of free floating, emergent and submerged aquatic macrophyte (Saikia & Bhattacharjee, 1987). The free floating plants *Eicchornia crassipes, Azolla pinnate, Pistia stratiotes*, *Lemna minor, Lemna major, Spirodela polkyrrhiza* are exist throughout the year and they become plentiful during the summer.

The emergent vegetation includes *Trapa bispinosa, Utricularia flexuosa, Eleocharis pantaginea, Nelumbo nucifera, N. lotus, Nymphaea alba, N. rubra, Sagitaria sagitifolia, Euryale ferox. Ipomea reptans, Oelia alismoides, Marsilia minuta, Limnophilia aquatica, Monochoria leaqinolis.* The submerged plants dominate the Deepor beel habitat. The foremost are the *Potamogeton crispum, Valisnaria spiralis, Hydrilla verticillata, Najas foveolata, and Paspalum serobiculatum*. *Halophila ovata, H. Beccari and Ruppia maritima* etc. The other cultivated and non-cultivated plants species available in the beel area are *Alium cepa, Pisum sativum, Brassica juncia, B. rugusa*, *Beta vulgaris, Momordia charantia, Ducus carrota* and *Triticum aestivum.* The weeds which are prevalent in the cropped area are *Amaranthus spinosus, A. Viridis, Cyperus rutundus, Cortoria strata, Agaratum conyzoid, Solanum khasianum, Cassia tora, Cassia occidentalis, Solanum torvum, Lucus aspera, Michania scandenses, Cynodon dactylon, Xanthium strumarium, Polygonum hydropiper, P. plebum, P. occidentalis, P. barbahim, Hydrocoliu japonica, Cyperus esculentus, Cyperus flavidus, Elusin indica, Cyperus silletensis, Cyperus flavidus, Elusin indica, Cyperus silletensis.*

The weeds found in the beel bank and the wasteland in between the beel proper are *Eupatorium odoratum, Achyranthus aspera, Cyperus esculonsis,*

Pharagmites karka, Imperata cylindrica, Vitax trifolia, Accum basilium, Saccharum spontaneum, Arundo donax, Lentena caemera, etc. The dominant tree species found in the high land of Deepor beel are *Tamarind indica, Ficus bengalensis, Ficus religiosa, F. glomarata, Cleofropis gigantia, Dillenea indica, Phoenix sylvistris, Megnifera indica, Albizzia lebbek, Albizia procera, Zigyphus mauricianus, Alstonia scolaris, Casia fistula, Bombax ceba, Bambusa vulgaris, B. aurundinaceae etc.*

h. Climate

Deepor beel has a meso-thermal climate, characterized by high humidity and moderate temperature (Singh & Dutta 1960). The temperature ranges between 10.6°C to 30°C. The annual average precipitation is 3000 to 4000 mm. Most rainfall is occurring during monsoon period (May-September). The pre-monsoon season (March-May) has a maximum temperature of 27° C and minimum of 24° C, and relative humidity between 50.5-76.8%. Although the weather is dry for the greater part of the period, occasional hailstorms and heavy showers are not uncommon. The monsoon season (May -September) has a maximum temperature of 32°C and minimum of 27.3°C. The relative humidity is 82.5%. Warm humid and cloudy weather (it may continue for weeks) is characteristics for this season. The retreating monsoon covers the period from September to October with maximum and minimum temperatures of 27° and 25° C respectively. The relative humidity is 82% and the rainfall gradually decreases to average as the season advances, when the morning mist and fogs start appearing. The winter season begins in November and continues until January. The average field temperature during this period remains at 20 ± 2°C and the relative humidity measures about 77.5%. This season also experiences occasional rainfall due to the west monsoon. January is the coldest month, with a lowest temperature of 17.6°C (Saikia & Bhattacharjee, 1987).

2.2 METHODS OF STUDY

The Study has been carried out from November 1, 2004, in Deepor beel Ramsar site to achieve the excepted goal. To collect the winter month data of

birds, fish, molluscs domestic mammals, insects and crustaceans species, following study has been designed to get the expected goal.

a. Study design

For specific study: The entire Deepor Beel ecosystem including peripheral habitat was categorized in to six different zones on the basis of habitat stratification (see Table-1 for coordination). The physical descriptions of the zones were such as: -

(1) Zone-1: It is the Northern bank of Deepor beel near APRO and Assam Engineering College, where reckless destruction of wetland habitat has been done. The land use pattern of this zone is mainly illegal settlements, agricultural practices, cattle grazing, recreational use, earth cutting and soil gatherings etc. **Zone-2:** It is the Northwestern bank of Deepor beel, starting from the lips of Khanajan outlet through temporary farmhouse. Here, the farmers were practiced paddy and Cole crops every year and leading to degradation of beel ecosystem. The zone could be identified in presence of winter season fishing-camp on beel proper. **Zone 3:** It is he Northeastern boundary of Deepor beel ecosystem starting from the Tetelia Railway crossing towards southern bank of Deepor beel. **Zone 4**: It is the Western boundary of the Deepor beel approaching from Azara Gadhuli-bazaar towards beel proper. In this zone of beel has been utrified due to extensive nutrient load. **Zone 5**: Southern boundary of the Deepor beel adjoining to Garbhanga reserve forest, Forest beat office, Mainakhulung, Pamohi etc. **Zone 6.** This zone is covered the whole open water space for the assemblages of major parts of Migratory or residential water birds all through the year.

Table 1: Selected study zones along with their GPS Location (Latitudes & longitudes), height and area descriptions.

Zone	Latitude	Longitude	Altitude (msl)	Description
I	26˚08′ 5.2″- 26˚07′ 43.5″	91˚39′12″- 91˚38′46.6″	47-36 m	Northern bank of Deepor beel near APRO and Assam Engineering College.
II	26˚08′02″- 26˚ 07′24.3″	91˚37′ 40"- 91˚38′ 24.3"	47	North western bank of Deepor beel starting from Khanajan outlet at NH 37 to beel proper
III	26° 09' 5.2"-	91° 40' 49.1"-	48-38	North Eastern part of Deepor beel

	26º 06' 47.7"	91º 40' 30.1"		starting from Tetalia railway crossing towards southern part of deepor beel on the rail line.
IV	26º 06' 58"- 26º 07' 13"	91º 37' 26"- 91º 38' 06"	45-44	Western part of Deepor beel approaching From Azara Gadhuli bazar /Battalion camp to beel proper.
V	26º 06' 41.8"- 26º 05' 50"	91º 42'40. 7"- 91º 37' 24"	48-56	Southern boundary of Deepor beel adjoining to Garbhanga reserve forest from Garchuck to Matiapahar
VI	26º 06' 43.6"- 26º 06' 24"	91º 39'47. 5"- 91º 37' 39"	42-51	This Zone covers the Actual beel (Water area) Starting from Bhangra than to Silar Tapu through proper beel water area.

b. Data Collection

(i) **Birds:** Line and point transacts, flush count techniques and total counts of bird species were made on the basis of habitat characteristics and bird congregations pattern in sample sites in various months of the year for qualitative and quantitative data of residential and migratory birds in Deepor beel (as per Bibby *et al.*, 2000). The identification of the bird's species was made as per Ali & Ripley (1983) and Grimmett *et al.* (1999).

(iii) **Mammals:** The mammalian fauna of Deepor beel, such as wild mammals and domestic cattle etc. were surveyed in belt transact and compass bearing methods in pre-defined habitat zones (as described in sampling designed). The data of larger mammals were collected using total count methods (head count techniques). Apart from that, the available Buffalo-sheds were also surveyed to gather the overall population abundance and density within sampling area during dry season.

(iii) **Herpitofauna:** The data of Amphibian and Reptilian faunas were collected using SSS (Systematic Sampling Survey) and Active Searching Methods (ASM), as described by IUCN Amphibian survey methodology and line transact methods (Heyer *et al.* 1993). Most of the amphibian surveys were done during dark after 1800 hours.

(iv) **Fish fauna:** To gather the qualitative and quantitative data of fish fauna in Deepor beel, all existing fish camps were sampled along with direct sampling methods using convenient fishing gears etc. The fish faunal data were also collected at the time of community fishing took place during the month of

January in Deepor beel. The identification of the fishes was made as per the books of Talwar & Jhingran (1991).

(v) Arthropods and Molluscs (aquatic Insects, Crustacean and molluscs species etc): At least 50 quadrate samplings were done to collect the qualitative and quantitative data of Arthropods and Molluscan species in Deepor beel during this period. For Crabs data collection, mud holes were surveyed along with direct observation during night hours in a line transact along the water edge. For Aquatic insects drag nets and light traps were used.

(vi) Zoo Plankton: For Zoo Plankton data collection, the water samples viz. 100-50 liters (best is the 100 liters/sample, for density measurements) were collected from various sampling points. The collected water samples were allowed to passed through smallest match sized plankton net, and then the bottom depositions of net at glass tubes were collected and taken to the laboratory after adding 4% formaline solution, as preservatives. Each sample was then centrifuged for measuring volume and after volume measurement; the precipitate parts were made into 100 ml after adding water on it. Majority of specified sampling zones were become dry during winter season; hence, the collected data were pooled together in each season to determine the seasonal abundance of zooplankton in deepor beel ecosystem. The best sampling time for Zooplankton was the early morning to before 0900 hours and no data were collected during evening time. For identify of different Zooplankton species, the books of Battish (1992) was followed.

c. Data analysis

The diversity of birds, fish, herpitofauna and other species were estimated in terms of species evenness, using Margalef'sD Index, Shannon Wiener and Simpson's D Index and bootstrap method was used to calculate 95% confidence intervals. In order to test for differences in diversity between habitats zones samples in different months of the year (at Z1, Z2, Z3, Z4, Z5 and Z6), pair-wise randomization tests were carried out based on 10,000 re-samples of species

abundance data following Solow (1993). The analyses were performed as per the method of May (1975) using Species Diversity and Richness software.

For each species of higher organism, we calculated the proportion of individuals recorded in each zone [formulae used, $[(Z_1)/\Sigma(Z_1 + Z_n)]$ to indicate Z_1 preference (value of '**1**' for species only in 'Z_1', value of '0' for species only in 'Z_2' …etc.) and proportion of individuals in 'Z_2' [formulae for light preference, $[(Z_2)/\Sigma(Z_1 + Z_n)]$ to indicate the 'Z_2' preference (value of '1' for species only in 'Z_2', value of '0' for species only in 'Z_1'). Data were arcsine transformed for analysis and only selected data ($Z_1 + Z_n \geq 3$) were used. For statistical analysis of data, t-test using equal variance, Spearman Rank correlation and one-way ANOVA were used as per Dytham (1999). All statistical analyses were done using SPSS, Statistical Software, Version 11.0.1. (as per Dytham 1999).

CHAPTER-IV: RESULTS

4.0. RESULTS

4.1 HIGHER ORGANISMS

a. AVIAN DIVERSITY

Altogether 84,866 individuals were sampled from 232 species of avian faunas belonging to 42 different families in 72 different sampling events within 6 study zones of Deepor beel Ramsar site (see Table-2; Appendix-I; Fig-1). Of which 137 species were residential and 97 species were migratory. The analysis of Shannon-Winner index **(SI)**, Margalef's D Index **(M_D)** and Simpsons index **(SM_D)** of diversity (*pair wise randomized test based on 10,000 random sample)* showed that, the species diversity of avian fauna in different study zones were significantly varies at 5% level (See Table-2; Figure-2, 3 and 4). Total individual sampled in all the six Zones during the months of November were 7289 belonging to 126 species. The highest number of bird counts in different months and sampling zones showed that, the greatest individuals were counted in the study **Zone-2_N** in November and followed by **Zone-6_N** in the same month (see Fig-5). Study showed that during sampling of 12 months period at deepor beel, 19 species had population of above 1000-12,000 (See Fig.- 6) and 16 species had population of above 500-900 (See Fig.- 7), of which the highest counted species were *Phalacrocorax niger* (12,309 individuals), *Anas acuta* (7024, individuals), *Anas strepera* (4944 individuals), Anastomus oscitans (3592, individuals), *Dendrocygna javanicus* (3634, individuals), *Dendrocygna bicolor* (2837), *Bubulcus ibis* (3298, individuals) and sturnus contra(3014, individuals) etc. (see Fig-6).

Comparision of Shannon Wiener Diversity indices between study **Zones '1_N-6_N'** showed that, **Zone-1_N** was more diverse than **Zone-4_N** and **Zone-6_N** at 5% level (*pair wise randomized test based on 10,000 random samples;* **SI: Zone-1_N**: H′ = 2.81; **Zone-4_N:** H′= 2.58; P< 0.02, Δ=-0.231; **Zone-6_N:** H′ = 2.45; P< 0.001, Δ=0.355), whereas, **Zone–5_N** was more diverse than **Zone-1_N** at 5% level (**SI: Zone–5_N**: H′ = 2.96; P< 0.03, Δ = 0.149; Fig-2). However, the diversity of zones 2&3 was same with **Zone-1_N** at 5% level (*pair wise randomized test based on 10,000 random samples)*. Of all the species scored, the maximum of 76 species were sampled in **Zone–5_N** followed by **Zone-1_N**, 67 species, **Zone-2_N**, 66 species, **Zone-6_N**, 46 species, **Zone-**

3$_N$, 41 species and 27 species in **Zone-2$_N$** (see Table-2). Comparing the diversity of Margalef's D index (which represented the species diversity and species richness at the same time) during November month, showed that, the index of diversity was higher in **Zone-1$_N$** than **Zone-4$_N$, Zone–5$_N$ and Zone-6$_N$** at 5% level (**Zone-1$_N$**: **M$_D$** =10.0; Zone 4:**M$_D$** = 4.25, **Zone–5$_N$: M$_D$** =9.74 **and Zone-6$_N$: M$_D$** =5.44; Δ=5.79, Δ=. 31 and Δ=-4.61 respectively, Fig 3; Table- 2).

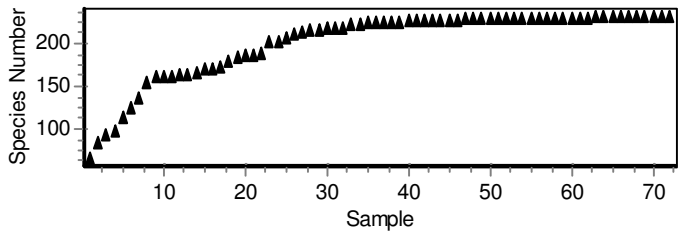


Figure: 1: Species accumulation curve of avian diversity in 72 sampling events at Deepor beel Ramsar site.

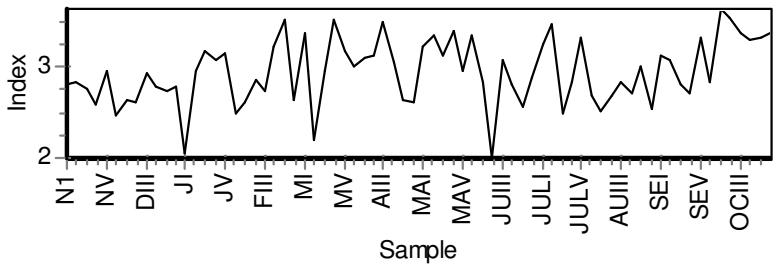


Fig.2: Shannon Index of Diversity of Avian fauna in Depor beel from November 2004 to October 2005(data were analyzed using monthly collected data of birds in six different study zones).

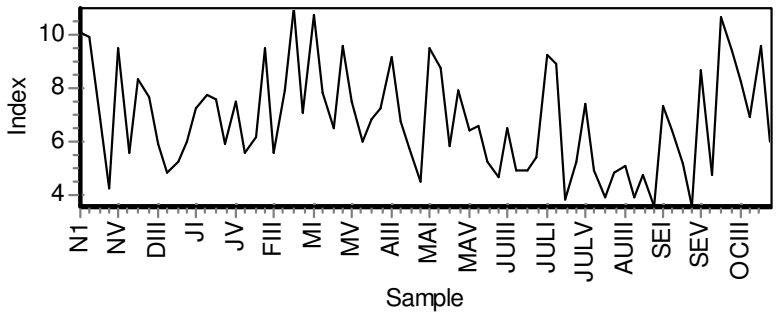


Fig.3: Margalef's D Index of Diversity of Avian fauna in Deepor beel from November 2004 to October 2005(data were analyzed using monthly collected data of birds in six study zones).

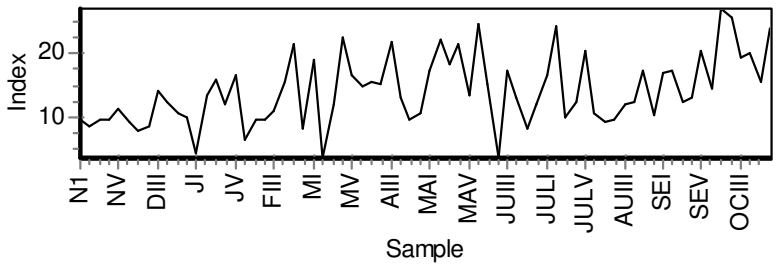


Fig.4: Simpson's Index of Diversity of Avian fauna in Deepor beel from November 2004 -October 2005(data were analyzed using monthly collected data of birds in six study zones).

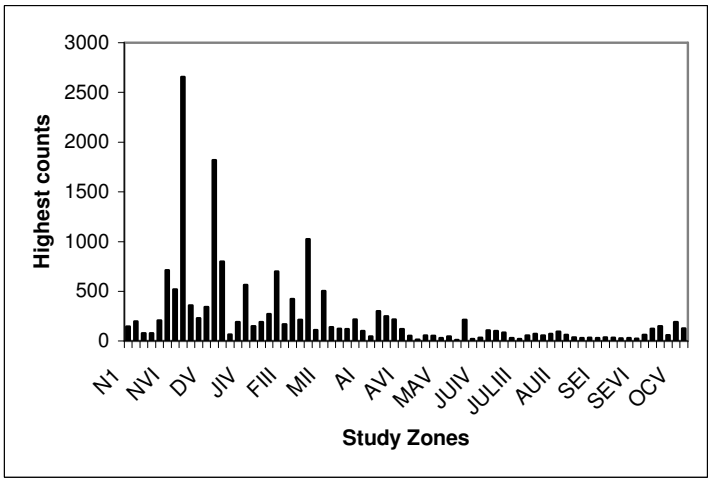


Figure- 5. Highest number of individual counted in various study zones in different Months of the year.

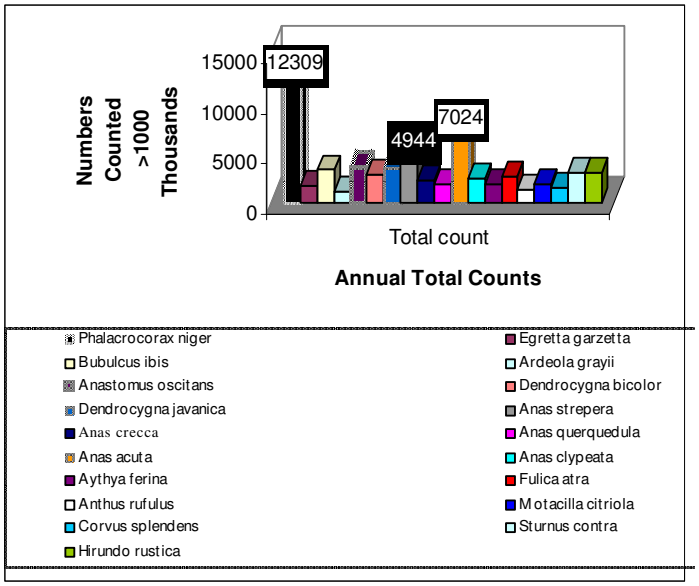


Fig. 6: Shows the numbers of birds counted between 1000 and 13000 individuals at deepor beel during survey.

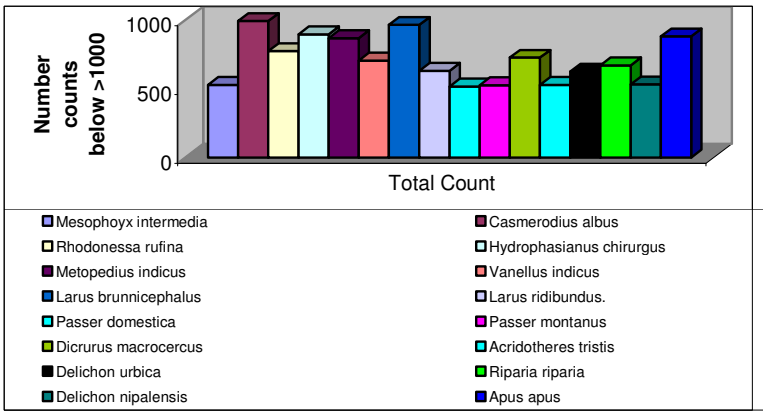


Fig. 7: Shows the number of birds counted between 500 and 1000 individuals at deepor beel during survey.

During the months of December, altogether 2707 individuals were sampled belonging to 121 species in six different study zones, of which maximum numbers of 72 species were recorded in **Zone-2**$_D$ followed by **Zone-1**$_D$, 63 species, **Zone-6**$_D$, 54 species, **Zone-3**$_D$, 46 species, **Zone-5**$_D$, 40 species and **Zone-4**$_D$ 36 species. Comparing diversity between different study Zone during the month of December showed that, **Zone-3**$_D$, **Zone-4**$_D$, **Zone-5**$_D$ and **Zone-6**$_D$ was more diverse than **Zone-1**$_D$ at 5% level (*pair wise randomized test based on 10,000 random samples;* **SI: Z-1**$_D$**:** H′ = 2.61; **Z-3**$_D$**:** H′ = 2.93, **Zone-4**$_D$**:** H′ = **2.8; Zone-**

5$_D$: H′ = **2.72; Zone-6$_D$:** H′ = **2.77;** Δ= -0.30, Δ=0.15, Δ= 0.095, Δ= -0.138, respectively; see Fig.-2 and Table-2). Comparing Margalef's D Index of diversity between various zones Showed that, **Zone-1$_D$** was more diverse than **Zone-2**$_D$, **Zone-3**$_D$**, Zone-4**$_D$, **Zone-5**$_D$ and **Zone-6**$_D$ at 5% level (*pair wise randomized test based on 10,000 random samples;* **Z-1$_D$:** M$_D$: **8.2; Zone-2$_D$:** M$_D$: **7.5; Zone-3 $_D$:** M$_D$: 5.75; **Zone-4**$_D$: M$_D$**:** 4.86; **Zone-5**$_D$: M$_D$: **5.23; Zone-6**$_D$: M$_D$: 5.9; Δ= -0.61, Δ= -2.44, Δ= -3.33, Δ= -2.96, Δ= -2.29 respectively, see Fig.- 3).

During January, altogether 7675 individuals were sampled covering all six zones and recorded total of 115 species, of which, the maximum number of 56 species were recorded at **Zone-1$_J$**, followed by **Zone-5$_J$**, 54 species, **Zone-3$_J$**, 53 species, **Zone-2$_J$**, 49 species, **Zone-4$_J$**, 46 species and **Zone-6$_J$,** 36 species. Comparing Shannon diversity indices between different zones in January showed that, **Zone-5$_J$**, **Zone-3$_J$** and **Zone-4$_J$** was more diverse than **Zone-1$_J$, at 5% level (***pair wise randomized test based on 10,000 random samples;* **SI: Zone-5$_J$:** H′ = **3.15; Zone-1$_J$:** H′ = **2.02; Zone-3$_J$:** H′ = **3.17; Zone-4$_J$**.: H′ = **3.1;** Δ= 1.11, Δ= 1.13, Δ=1.02 respectively). Comparing Margalef's D index of diversity indices between different zones during January showed that, **Zone-1$_J$** was more diverse than **Zone-4$_J$** at 5% level **(Zone-1$_J$: M$_D$: 7.25; Zone-4$_J$: M$_D$: 5.79;** Δ= -1.45; see Table-2).

During February, altogether 14,408 individuals were sampled covering all six zones and recorded total of 126 species, of which, the maximum number of 84 species were recorded at **Zone-5$_F$**, followed by **Zone-2$_F$**, 78 species, **Zone-4$_F$**, 63 species, **Zone-6$_F$**, 59 species, **Zone-1$_F$**, 45 species and **Zone-3$_F$,** 38 species. Comparing Shannon diversity indexes between different study zones during February showed that, **Zone-2$_F$**, **Zone-3$_F$**, **Zone-4$_F$** and **Zone-5$_F$** was more diverse than **Zone-1$_F$** at 5% level, and others were significant differences **(***pair wise randomized test based on 10,000 random samples;* **SI: Zone-2$_F$: H′=2.86; Zone-1$_F$: H′=2.59;** Δ= 0.26; **Zone-3$_F$: H′=2.73;** Δ= -0.13; **Zone-4$_F$: H′=3.21;** Δ= 0.61; **Zone-5$_F$: H′=3.51;** Δ= -0.91). Comparing diversity of Margalef's D Index showed that, **Zone-2$_F$**, **Zone-4$_F$** and **Zone-5$_F$** was more diverse than **Zone-1$_F$** at 5% level: **M$_D$:**

Zone-1$_F$: 6.07; Zone-2$_F$: M$_D$: 9.47, Δ= 3.44; **Zone-4$_F$: M$_D$: 7.93,** Δ= 1.89; **Zone-5$_F$: M$_D$: 10.98,** Δ= 4.94; See Table-2).

During March, altogether 6291 individuals were sampled covering all six zones and recorded total of 132 species, of which, the maximum number of 74 species were recorded at **Zone-1$_M$**, followed by **Zone-4$_M$**, 67 species, **Zone-2$_M$**, 54 species, **Zone-5$_M$**, 51 species, **Zone-6$_M$**, 46 species and **Zone-3$_M$,** 44 species. (see Table-2). Comparing Shannon diversity indexes between different study zones during March showed that, **Zone-1$_M$** was more diverse than **Zone-2$_M$**, **Zone-3$_M$, Zone-5$_M$** and **Zone-6$_M$**, **whereas, Zone-4$_M$** was more diverse than **Zone-1$_M$**, at 5% level **(***pair wise randomized test based on 10,000 random samples;* **SI: Zone-1$_M$: H'=3.35; Zone-2$_M$: H'=2.18;** Δ= -1.17; **Zone-3$_M$: H'=2.94;** Δ= -0.41; **Zone-5$_M$: H'=3.16;** Δ= 0.18; **Zone-6$_M$: H'=3.00;** Δ= 0.34; **Zone-4$_M$: H'=3.51;** Δ= -0.16; See Table-2). Comparing diversity of Margalef's D Index also showed that, **Zone-1$_M$**, **Zone-3$_M$** and **Zone-5$_M$** was more diverse than **Zone-2$_M$ and Zone-1$_M$** was more diverse than **Zone-5$_M$** and **Zone-6$_M$** at 5% level (**Zone-1$_M$: M$_D$: 10.58; Zone-2$_M$: M$_D$: 7.70,** Δ= -2.88; **Zone-3$_M$: M$_D$: 6.45,** Δ= -4.13; **Zone-5$_M$: M$_D$: 7.50,** Δ= -3.07; **Zone-6$_M$: M$_D$: 6.00,** Δ= -4.57; See Table-2).

During April, altogether 6665 individuals were sampled covering all six zones and recorded total of 114 species, of which, the maximum number of 72 species were recorded at **Zone-3$_A$**, followed by **Zone-4$_A$**, 49 species, **Zone-1$_A$**, 44 species, **Zone-2$_A$**, 43 species, **Zone-5$_A$**, 41 species and **Zone-6$_A$,** 30 species (see Table-2). Comparing Shannon diversity indices between different study zones during April showed that, **Zone-3$_A$**, was more diverse than **Zone-1$_A$** at 5% level **(***pair wise randomized test based on 10,000 random samples;* **SI: Zone-1$_A$: H'=3.07; Zone-3$_A$: H'=3.48;** Δ= 0.41), whereas, **Zone-1$_A$** was more diverse than **Zone-5$_A$** and **Zone-6$_A$** at 5% level (**Zone-5$_A$: H'=2.64;** Δ= 0.43; **Zone-6$_A$: H'=2.61;** Δ= 0.45, See Table 2). Comparing the diversity of Margalef's D index showed that, **Zone-2$_A$**, was more diverse than **Zone-1$_A$** at 5% level **(Zone-1$_A$: M$_D$: 6.64; Zone-2$_A$: M$_D$: 7.24;** Δ= 0.59), whereas, **Zone-1$_A$** was more diverse than **Zone-5$_A$** and **Zone-6$_A$** at 5% level (**Zone-5$_A$: M$_D$: 5.7;** Δ= -0.93; **Zone-6$_A$: M$_D$: 4.46;** Δ= -2.18, See Table-2).

During May, altogether 2431 individuals were sampled covering all six zones and recorded total of 95 species, of which, the maximum number of 58 species were recorded at **Zone-1$_{MA}$**, followed by **Zone-4$_{MA}$**, 50 species, **Zone-2$_{MA}$** and **Zone-6$_{MA}$** 43 species, **Zone-3$_{MA}$**, 37 species and **Zone-5$_{MA}$** 35 species (see Table-2). Comparing the diversity of Margalef's D between study zones showed that, **Zone-1$_{MA}$**, was more diverse than **Zone-3 $_{MA}$**, **Zone-4 $_{MA}$**, **Zone-5$_{MA}$ and Zone-6 $_{MA}$** at 5% level **(***pair wise randomized test based on 10,000 random samples;* **Zone-1 $_{MA}$: M$_D$: 9.32; Zone-3$_{MA}$: M$_D$: 5.70;** Δ= -3.62; **Zone-4$_{MA}$: M$_D$: 7.88;** Δ= -1.43;**Zone-5$_{MA}$: M$_D$: 6.41;** Δ= -2.91; **Zone-6$_{MA}$: M$_D$: 6.59;** Δ= -2.74; see Table-2). Comparing Shannon diversity indexes between different zones showed that, **Zone-2$_{MA}$, Zone-4 $_{MA}$ and Zone-6 $_{MA}$** was more diverse than **Zone-1$_{MA}$ at 5% level (SI: Zone-1$_{MA}$: H'=3.20; Zone-2$_{MA}$: H'=3.32;** Δ= 0.11;**Zone-4$_{MA}$: H'=3.38;** Δ=0.17; **Zone-6 $_{MA}$: H'=3.35;** Δ=-0.14, respectively).

During June, altogether 1719 individuals were sampled covering all six zones and recorded total of 66 species, of which, the maximum number of 35 species were recorded at **Zone-6$_{JU}$**, followed by **Zone-3$_{JU}$**, 31 species, **Zone-5$_{JU}$** 30 species, **Zone-2$_{JU}$** 28 species, **Zone-4$_{JU}$**, 27 species and **Zone-1$_{JU}$** 24 species. (See Table-2). Comparing Shannon diversity between different study zones showed that, **Zone-1$_{JU}$** was more diverse than **Zone-2$_{JU}$**, and **Zone-5$_{JU}$** at 5% level **(***pair wise randomized test based on 10,000 random samples;* **SI: Zone-1$_{JU}$: H'=2.82; Zone-2$_{JU}$: H'=1.98;** Δ= -0.84; **Zone-5$_{JU}$: H'=2.55;** Δ= -0.27; see Table 2). Comparison of Margalef's D between different study zones showed that, **Zone-1$_{JU}$**, was more diverse than **Zone-2$_{JU}$**, **Zone-4$_{JU}$**, **Zone-5$_{JU}$** and **Zone-6$_{JU}$** at 5% level **(Zone-1$_{JU}$: M$_D$: 5.22; Zone-2$_{JU}$: M$_D$: 4.50;** Δ= -0.72; **Zone-4$_{JU}$: M$_D$: 4.88;** Δ= 0.35;**Zone-5$_{JU}$: M$_D$: 4.89;** Δ= -0.33; **Zone-6$_{JU}$: M$_D$: 5.42;** Δ= -0.21; see Table-2).

During July, altogether 2148 individuals were sampled covering all six zones and recorded total of 94 species, of which, the maximum number of 61 species were recorded from **Zone-1$_{JUL}$**, followed by **Zone-2$_{JUL}$**, 52 species, **Zone-5$_{JUL}$** 47 species, **Zone-4$_{JUL}$** 30 species, **Zone-6$_{JUL}$**, 29 species and **Zone-3$_{JUL}$** 19 species. (See Table-2). Comparing the diversity of Shannon Wiener index between different study zones showed that, **Zone-1$_{JUL}$** was more diverse than

Zone-3$_{JUL}$, **Zone-4 $_{JUL}$**, and **Zone-6 $_{JUL}$** at 5% level (*pair wise randomized test based on 10,000 random samples;* **SI: Zone-1$_{JUL}$: H'=3.24; Zone-3$_{JUL}$: H'=2.49;** Δ= -0.75; **Zone-4$_{JUL}$: H'=2.84;** Δ= -0.40; **Zone-6$_{JUL}$: H'=2.68;** Δ= 0.56; see Table-2), whereas, **Zone-2$_{JUL}$** was more diverse than **Zone-1$_{JUL}$** at 5% level (**SI: Zone-2$_{JUL}$: H'=3.5;** Δ= 0.21). Comparison of Margalef's D index between different study zones showed that, **Zone-1 $_{JUL}$**, was more diverse than **Zone-3$_{JUL}$**, **Zone-4$_{JUL}$**, **Zone-5$_{JUL}$** and **Zone-6$_{JUL}$** at 5% level (**Zone-1$_{JUL}$: M$_D$: 9.24; Zone-3$_{JUL}$: M$_D$: 3.86;** Δ= -5.38; **Zone-4 $_{JUL}$: M$_D$: 5.19;** Δ= -4.04;**Zone-5$_{JUL}$: M$_D$: 7.38;** Δ= -1.86; **Zone-6$_{JUL}$: M$_D$: 4.94;** Δ= -4.30; see Table-2).

During August, altogether 1681 individuals were sampled covering all six zones and recorded total of 46 species, of which, the maximum number of 30 species were recorded at **Zone-2$_{AUG}$**, followed by **Zone-3$_{AUG}$**, 29 species, **Zone-5$_{AUG}$** 28 species, **Zone-1$_{AUG}$** 24 species, **Zone-4 $_{AUG}$**, 22 species and **Zone-6$_{AUG}$** 18 species. (See Table-2). Comparison of diversity Shannon Wiener Index between study zones showed that, **Zone-2$_{AUG}$**, **Zone-3$_{AUG}$**, **Zone-4$_{AUG}$** and **Zone-5$_{AUG}$** was more diverse than **Zone-1$_{AUG}$** at 5% level (*pair wise randomized test based on 10,000 random samples;* **SI: Zone-1$_{AUG}$: H'=2.5; Zone-2$_{AUG}$: H'=2.7;** Δ= 0.17; **Zone-3$_{AUG}$: H'=2.82;** Δ= 0.30; **Zone-4$_{AUG}$ H'=2.71;** Δ= 0.20; **Zone-5$_{AUG}$ H'=3.0;** Δ= 0.48; see Table-2). Comparison of Margalef's D index between study zones showed that, **Zone-2 $_{AUG}$**, **Zone-3$_{AUG}$** and **Zone-5$_{AUG}$** was more diverse than **Zone-1$_{AUG}$** at 5% level (*pair wise randomized test based on 10,000 random samples;* **Zone-1$_{AUG}$: M$_D$: 3.94; Zone-2$_{AUG}$: M$_D$: 4.86;** Δ= 0.92; **Zone-3$_{AUG}$: M$_D$: 4.92;** Δ= 0.97; **Zone-5$_{AUG}$: M$_D$: 4.77;** Δ= 0.82; see Table-2).

During September, altogether 1405 individuals were sampled covering all six zones and recorded total of 76 species, of which, the maximum number of 48 species were recorded at **Zone-5$_{SEP}$**, followed by **Zone-1$_{SEP}$**, 40 species, **Zone-2$_{SEP}$** 38 species, **Zone-3$_{SEP}$** 27 species, **Zone-6$_{SEP}$**, 26 species and **Zone-4$_{SEP}$** 20 species (see Table-2). Comparison of Shannon diversity Index between study zones showed that, **Zone-1 $_{SEP}$**, was more diverse than **Zone-3$_{SEP}$**, **Zone-4$_{SEP}$** and **Zone-6$_{SEP}$** at 5% level (*pair wise randomized test based on 10,000 random samples;* **SI: Zone-1$_{SEP}$: H'=3.11; Zone-3$_{SEP}$: H'=2.78;** Δ= -0.33; **Zone-4$_{SEP}$: H'=2.70;** Δ= -0.40; **Zone-**

6$_{SEP}$ H'=2.82; Δ= -0.27; see Table 2), whereas, **Zone-5$_{SEP}$** was more diverse than **Zone-1$_{SEP}$** at 5% level (SI: **Zone-5$_{SEP}$ H'=3.31;** Δ= 0.20; see Table-2). Comparison of Margalef's D index between study zones also showed that, **Zone-1$_{SEP}$** was more diverse than **Zone-3$_{SEP}$**, **Zone-4$_{SEP}$** and **Zone-6$_{SEP}$** at 5% level **(***pair wise randomized test based on 10,000 random samples;* **Zone-1$_{SEP}$: M$_D$: 7.12; Zone-3$_{SEP}$: M$_D$: 4.98;** Δ= -2.15; **Zone-4$_{SEP}$: M$_D$: 3.59;** Δ= -3.53; **Zone-6$_{SEP}$: M$_D$: 4.75;** Δ= -2.38; see Table-2), whereas, **Zone-5$_{SEP}$** was more diverse than **Zone-1$_{SEP}$** at 5% level (*pair wise randomized test based on 10,000 random samples;* **Zone-5$_{SEP}$: M$_D$: 8.49;** Δ= 1.36; see Table-2).

During October, altogether 6103 individuals were sampled covering all six zones and recorded total of 106 species, of which, the maximum number of 71 species were recorded from **Zone-1$_{OCT}$**, followed by **Zone-2$_{OCT}$**, 68 species, **Zone-5$_{OCT}$** 67 species, **Zone-3$_{OCT}$** 59 species, **Zone-4$_{OCT}$**, 44 species and **Zone-6$_{OCT}$** 43 species. (See Table-1). Comparing the diversity of Shannon Wiener Index between study zones showed that, the **Zone-1$_{OCT}$**, was more diverse than **Zone-2$_{OCT}$**, **Zone-3$_{OCT}$** and **Zone-4$_{OCT}$** and **Zone-6$_{OCT}$** at 5% level **(***pair wise randomized test based on 10,000 random samples;* **SI: Zone-1$_{OCT}$: H'=3.63;Zone-2$_{OCT}$: H'=3.5;** Δ= -0.095; **Zone-3$_{OCT}$: H'=3.38;** Δ= -0.25; **Zone-4$_{OCT}$: H'=3.29;** Δ=-0.32; **Zone-6$_{OCT}$: H'=3.35;** Δ= -0.28; see Table-2). Comparison of Margalef's D index between study zones showed that, **Zone-1$_{OCT}$** was more diverse than **Zone-2$_{OCT}$**, **Zone-3$_{OCT}$**, **Zone-4$_{OCT}$**, **Zone-5$_{OCT}$** and **Zone6$_{OCT}$** at 5% level **(***pair wise randomized test based on 10,000 random samples;* **Zone-1$_{OCT}$: M$_D$: 10.52; Zone-2$_{OCT}$: M$_D$: 9.28;** Δ= -1.24; **Zone-3$_{OCT}$: M$_D$: 8.25;** Δ= -2.27; **Zone-4$_{OCT}$: M$_D$: 6.94;** Δ= -3.98; **Zone-5$_{OCT}$: M$_D$: 9.57;** Δ= -0.95; **Zone-6$_{OCT}$: M$_D$: 5.82;** Δ= 4.69 see Table-2).

b. ZONAL VARIATION OF DIVERSITY

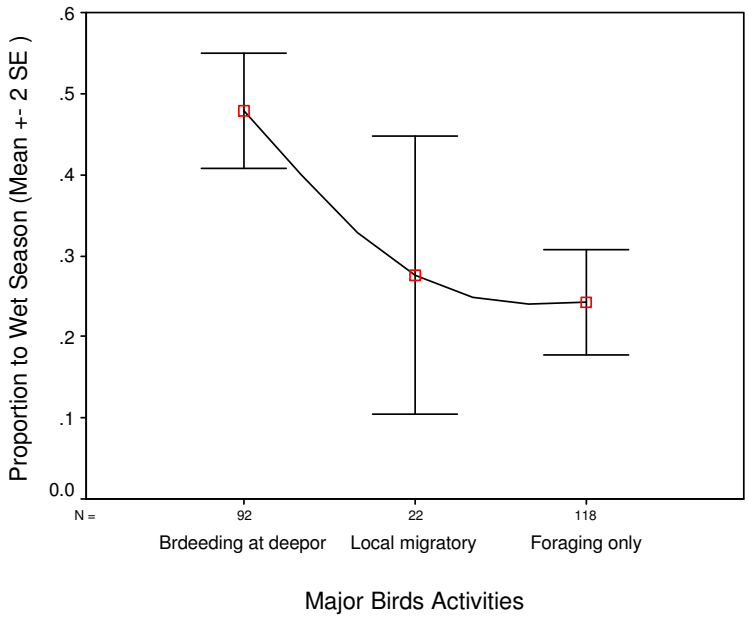
Comparison of avian diversity in different study zones showed that, the Margalef's D Index of diversity is higher at Zone-1, Zone-2 and Zone 5 than Zone3, Zone-4 and Zone-6 (*pair wise randomized test based on 10,000 random samples;* **M$_D$: Zone-1**=18.41; **Zone-3**: 14.67; Δ= -3.72; **Zone-4**: 15.1; Δ= -3.31; **Zone-5**: 14.67; Δ= -3.72,p<01; **Zone-6**: 14.67; Δ= -3.72,p<01; **Zone-2**: 18.23). The analysis of relationship between study zones showed significant but opposite relation

between Z_1, Z_2, Z_3, Z_4, Z_5 and Z_6, where the diversity of Z_1, Z_2, Z_5 was significantly higher than Z_4, Z_3, Z_6 (Spearman rank correlation: **Z_1vs Z_4**: r^{est} = -0.175, P<0.008; **Z_1vsZ_6**: r^s =-0.251, P<0.001; **Z_5vsZ_6**: r^s =-0.213, P<0.002; **Z_5vsZ_2**: r^s =-0.246, P<0.002; **Z_5vsZ_3**: r^s =-0.218, P<0.001; n = 232).

4.1.1. STATUS VS ACTIVITY

Study showed that, out of 232 avian fauna recorded in deepor beel Ramsar site 135 were residential and 97 were migratory in status (During dry season (Nov.-April), the abundance of both migratory and residential birds are significantly higher than wet season at deepor beel (One way ANOVA: **DRY vs. Resident**: $F_{1, 231=}$ 23.58, p< 0.001; **DRY vs. Migratory**: $F_{1, 230=}$ 44.50, p< 0.001; **Resident: WET**: Mean proportion:0. 43 ± 0.35 SD, n = 135, **Resident DRY:** Mean proportion, 0.75± 0.44 SD, n= 134**;** Migratory**: WET**: mean proportion: 0.20± 0.35 SD, n = 97, **Migratory DRY:** Mean proportion:1.16 ± 0.49 SD, n = 97). The migratory birds visited the beel in year round and they performed various activities and utilized the deepor beel resources. The major activity patterns of the birds at the beel were the breeding, foraging and shifting locally for water abundances.

The study showed that, of the total 232 avian species recorded at deepor beel Ramsar site, 92 species were use the wetland habitat as their regular breeding ground, whereas, 22 species were use the beel as their regular site for local migration (**LM**) owing to water condition of neighboring habitats and greatest numbers of 122 species were use deepor beel as a permanent foraging (**FORAG)** site (see Fig.-8, 9 & 10). The analysis of various groups of birds sampled at deepor beel showed that, the proportional abundance of breeding birds at deepor beel was significantly higher during wet season than dry season, whereas, the proportional abundance of local migratory and foraging birds was significantly higher during dry season (Mean Proportion: **Wet vs. Breeding:** Mean =0.66±0.38SD; **Dry vs. Breeding:** Mean =0.48±0.34SD; **Dry vs. LM:** Mean =1.07±0.55SD; **Wet vs. LM:** Mean =0.28±0.40SD, n= 22; Dry **vs. FORAG:** Mean =1.09±0.50SD; **Wet vs. FORAG:** Mean =0.25±0.35SD, n= 118; ANOVA: **Propwet vs. Activity**: $F_{2, 231=}$ 12.05, p< 0.001; **Propdry vs. Activity**: $F_{2, 230=}$ 22.88, p< 0.001).



Figure–8: Activity patterns of avian fauna at Deepor beel Ramsar site during Wet season.

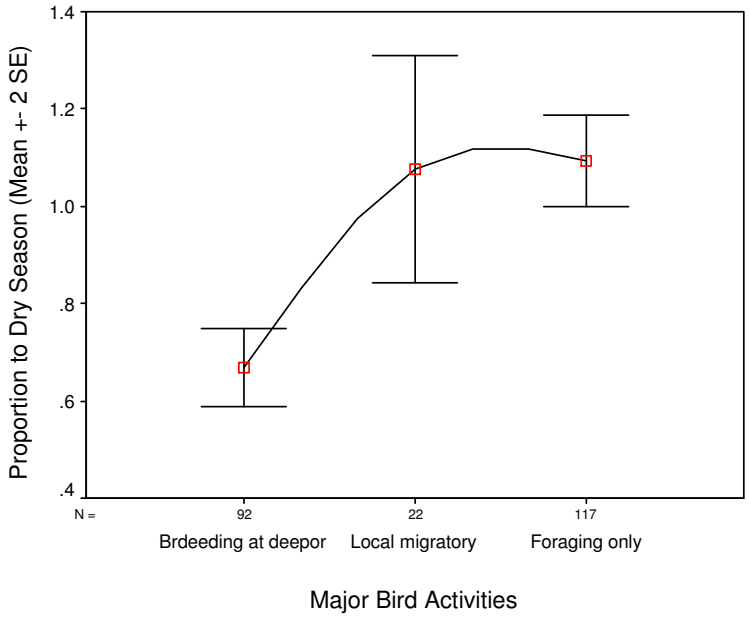


Figure-9: Activity patterns of avian fauna at Deepor beel during Dry Season.

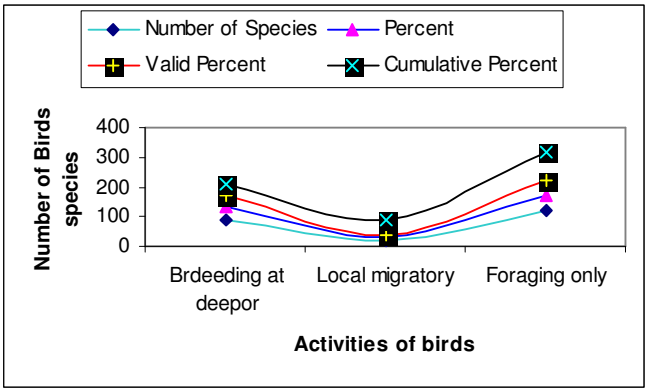


Figure-10: Relationships of avian species and its valid percents and cumulative percent of activities at deepor beel.

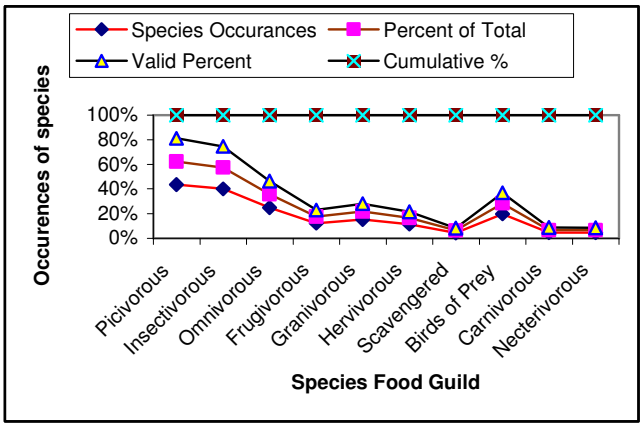


Figure-11: Percent of availability different food guild species occurs at Deepor beel Ramsar site during study.

4.1.2. FEEDING GUILD

Study revealed that, the deepor beel harbors altogether 10 feeding guild species, such as, greatest numbers of 80 species were strictly restricted to Insectivorous feeding guild, 38 were restricted to Picivorous feeding guild species, 30 species were from Birds of prey feeding guild, 16 species were from Granivorous feeding guild, 12 from Herbivorous feeding guild, 11 from Frugivorous feeding guild, 5 were each from Carnivorous and Necterivorous feeding guild species and only 4 species were restricted to Scavengered feeding guild species (see Table-3). The study also showed that, the species occurrences, percentage of total, valid percent and cumulative percent of Picivorous, Insectivorous, Omnivorous and Birds of prey species were comparatively higher than the other feeding guild species during 12 months study period (see Fig.- 11). Again, excluding carnivorous feeding guild species, the proportional abundance of all feeding guild species was higher during dry season (**see Table-3; Fig 12**) than wet season **(see Table-3; Fig. 13)**.

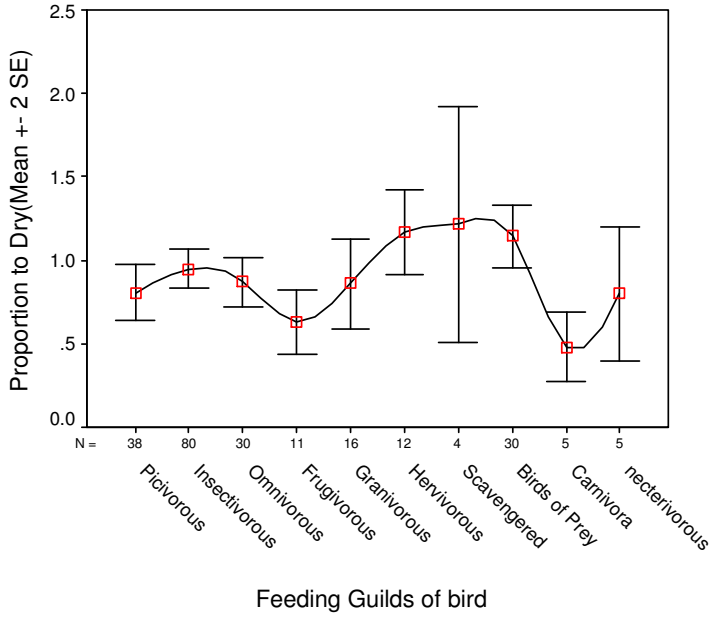


Figure-12: Proportional abundance of various feeding guild species during Dry Season at Deepor Beel.

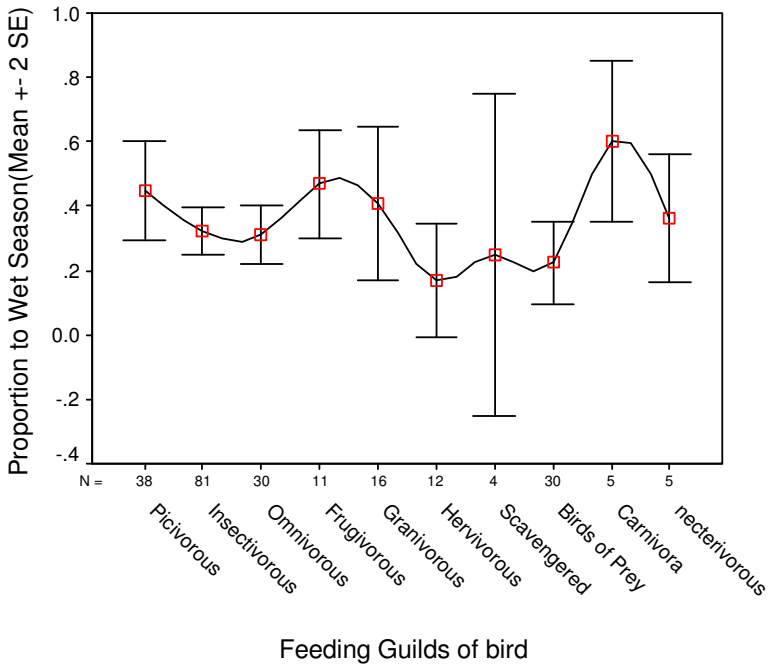


Figure-13: Proportional abundance of various feeding guild species during Wet Season at Deepor beel.

Table: 2: Species Diversity indices of avian fauna at six different study zones of Deepor beel in different months of the year.

Sample	Shannon Wiener Index		Margalef's D	Simpson's	Total Species	Total Counts
	H	Variance H	Index	Index		
Nov- 1	2.811	0.003003	10.06	9.35	67	708
Nov- II	2.826	0.00327	9.901	8.371	66	710
Nov- III	2.759	0.004851	6.842	9.301	41	346
Nov-1V	2.58	0.0023	4.257	9.641	27	449
Nov-V	2.946	0.001593	9.467	11.22	70	1189
Nov-VI	2.458	0.0002718	5.565	9.085	46	3887
Dec-I	2.63	0.001036	8.33	7.743	63	1924
Dec-II	2.608	0.000149	7.69	8.332	72	11630
Dec-III	2.934	0.0003679	5.882	14.18	46	2489
Dec-IV	2.781	0.000646	4.862	12.3	36	1337
Dec-V	2.722	0.0006332	5.233	10.59	40	1724
Dec-VI	2.768	0.0001895	6.011	9.654	54	7961
Jan-I	2.036	0.001236	7.247	4.111	56	1977
Jan-II	2.945	0.002671	7.741	13.38	49	493
Jan-III	3.172	0.001021	7.538	15.75	53	1130
Jan-IV	3.069	0.00055	5.922	12.05	46	2362
Jan-V	3.154	0.0009495	7.509	16.65	54	1162
Jan-VI	2.475	0.003271	5.548	6.407	36	549
Feb-I	2.602	0.0008418	6.173	9.485	45	1464
Feb-II	2.86	0.0006156	9.478	9.343	78	3376
Feb-III	2.735	0.001253	5.559	10.75	38	930
Feb-IV	3.216	0.000527	7.932	15.43	63	2480
Feb-V	3.511	0.0006911	10.98	21.71	84	1915
Feb-VI	2.644	0.0004376	7.063	8.022	59	4242
Mar-I	3.356	0.001371	10.73	19.18	74	991
Mar-II	2.187	0.003261	7.845	3.537	54	975
Mar-III	2.945	0.001716	6.456	12.03	44	781
Mar-IV	3.516	0.001144	9.588	22.69	67	976
Mar-V	3.162	0.001432	7.505	16.46	51	782
Mar-VI	3.003	0.0005665	6.009	14.79	46	1787
Apr-I	3.085	0.00164	6.797	15.32	44	646
Apr-II	3.109	0.003693	7.243	15.1	43	330
Apr-III	3.485	0.0004231	9.128	21.78	72	2663
Apr-IV	3.046	0.0009999	6.72	13.2	49	1265
Apr-V	2.641	0.00114	5.715	9.49	41	1096
Apr-VI	2.619	0.001392	4.465	10.42	30	662
May-I	3.217	0.002968	9.483	17.2	58	452
May-II	3.335	0.007544	8.727	22.02	43	137

May-III	3.116	0.001266	5.859	18.42	37	552
May-IV	3.378	0.001857	7.885	21.59	50	500
May-V	2.94	0.005851	6.417	13.46	35	200
May-VI	3.346	0.0009444	6.585	24.58	43	589
June-I	2.819	0.009581	5.219	15.23	24	82
June-II	1.998	0.006132	4.662	3.411	28	404
June-III	3.068	0.007292	6.453	16.92	31	120
June-IV	2.8	0.003944	4.871	13.19	27	208
June-V	2.554	0.003786	4.893	7.959	30	375
June-VI	2.864	0.002036	5.427	12.1	35	526
Jul-I	3.239	0.002023	9.237	16.68	61	662
Jul-II	3.452	0.002958	8.866	24.49	52	315
Jul-III	2.493	0.007771	3.86	9.92	19	106
Jul-IV	2.838	0.00373	5.197	12.24	30	265
Jul-V	3.318	0.001741	7.376	20.3	47	511
Jul-VI	2.675	0.003911	4.941	10.41	29	289
Aug-I	2.515	0.002804	3.944	9.02	24	341
Aug-II	2.687	0.003206	4.861	9.412	30	390
Aug-III	2.828	0.003337	5.087	11.9	29	298
Aug-V	2.713	0.003187	3.917	12.34	22	213
Aug-V	2.993	0.001981	4.768	17.27	28	288
Aug-VI	2.536	0.004657	3.574	10.18	18	153
Sep-I	3.121	0.004411	7.304	16.83	40	238
Sep-II	3.064	0.002512	6.37	17.18	38	333
Sep-III	2.8	0.005245	5.161	12.18	27	186
Sep-IV	2.703	0.002689	3.596	13.06	20	197
Sep-V	3.326	0.004317	8.656	20.18	48	254
Sep-VI	2.836	0.003691	4.746	14.42	26	194
Octo-I	3.633	0.001335	10.67	27.14	71	775
Octo-II	3.541	0.0006842	9.418	25.47	68	1363
Octo-III	3.376	0.0009979	8.251	19.25	59	1129
Octo-IV	3.291	0.001782	6.937	20.07	44	492
Octo-V	3.314	0.001515	9.57	15.66	67	989
Octo-VI	3.356	0.0003913	5.963	23.93	43	1352
Total Individuals sampled						84866

Table: 3: Mean Abundance of different feeding guild species occurring at Deepor beel Ramsar site during **DRY** & **WET** Seasons of the year.

Food Guild	N	Mean	SD	SE
Wet Season				
Picivorous	38	.4486	.47266	.07668
Insectivorous	81	.3220	.34152	.03795
Omnivorous	30	.3116	.25314	.04622
Frugivorous	11	.4699	.27713	.08356
Granivorous	16	.4081	.47821	.11955
Herbivorous	12	.1682	.30405	.08777
Scavengered	4	.2503	.50059	.25029

Birds of Prey	30	.2241	.34629	.06322
Carnivora	5	.6006	.28165	.12596
Necterivorous	5	.3607	.22330	.09986
Total	232	.3393	.36814	.02417
Dry Season				
Picivorous	38	.8044	.51534	.07668
Insectivorous	80	.9500	.52390	.03795
Omnivorous	30	.8708	.40066	.04622
Frugivorous	11	.6336	.32198	.08356
Granivorous	16	.8593	.53170	.11955
Herbivorous	12	1.1679	.43959	.08777
Scavengered	4	1.2177	.70612	.25029
Birds of Prey	30	1.1457	.51697	.06322
Carnivora	5	.4820	.22986	.12596
Necterivorous	5	.7992	.44562	.09986
Total	231	.9224	.50684	.02417

4.1.3. THREATENED BIRDS

Altogether 14 endangered species of avian fauna under Indian Wildlife protection Act, 1972 and 17 globally threatened species were recorded in Deepor beel during survey period (Plate-I; see Table-4). Among all the globally threatened species, two species were recognized as critically endangered, one was endangered and seven species were each in vulnerable and near threatened category (see Table-5).

Table: 4: Schedule I species under Indian Wildlife Protection Act 1972 in Deepor beel.

SL.NO.	Scientific Name	English name
1	*Pelecanus philippensis*	Spot-billed Pelican
2	*Leptoptilos javanicus*	Lesser Adjutant Stork
3	*L. dubius*	Greater Adjutant
4	*Dendrocygna bicolor*	Fulvous Whistling Teal
5	*Aythya baeri*	Baer's Pochard
6	*Pandion haliatus*	Osprey
7	*Haliaeetus leucoryphus*	Pallas's Sea Eagle
8	*Pellorneum palustre*	Marsh Babbler
9	*Falco chicquera*	Red-necked Falcon
10	*Falco peregrinus*	Peregrine Falcon
11	Besra	*Accipiter virgatus*
12	Eurasian Sparrowhawk	*A. nisus*
13	Besra	*Accipiter virgatus*
14	Grey-headed Fish eagle	*Ichthyophaga ichthyaetus*

Table: 5: Various categories of IUCN Red Data Book and Globally threatened species of birds in Deepor beel. (**Category**: CR: Critically endangered; EN: Endangered; V: Vulnerable; CD: Conservation dependent; NT: Near threatened and DD: Data deficient)

Sl. No.	Scientific name	English name	Status
1	*Gyps bengalensis*	Whiterumped Vulture	CR
2	*G. indicus*	Longbilled Vulture	CR
3	*Leptoptilos dubius*	Greater Adjutant	En
4	*Pelecanus philippensis*	Spotbilled Pelican	V
5	*Leptoptilos javanicus*	Lesser Adjutant Stork	V
6	*Haliaeetus leucoryphus*	Pallas's Sea Eagle	V
7	*Dendrocygna bicolor*	Fulvous Whistling Teal	V
8	*Aythya baeri*	Baer's Pochard	V
9	*Pellorneum palustre*	Marsh Babbler	V
10	*Eurynorhynchus pygmeus*	Spoon-billed Sandpiper	V
11	*Anhinga melanogaster*	Oriental Darter	NT
12	*Ephippiorhynchus asiaticus*	Black-necked Stork	NT
13	*Aythya nyroca*	Ferrugineous Duck	NT
14	*Ichthyophaga ichthyaetus*	Greyheaded Fish Eagle	NT
15	*Sarcogyps calvus*	Redheaded Vulture	NT
16	*Circus macrourus*	Pallid Harrier	NT
17	*Sterna acuticauda*	Black-bellied Tern	NT

4.2 FISH SPECIES

4.2.1. FISH DIVERSITY

The study sampled altogether 24,797 individuals of fish fauna belonging to 61 species at deepor beel Ramsar site in six different study zones (Plate-II; See Appendix-II). Among all the fish species recorded at Deepor beel, 5 fish species were exotic and rest 54 species were indigenous fishes of Assam. Altogether 8 endangered fish species were recorded in deepor beel Ramsar site during study, those were such as *Cirrhinus reba, Ompok bimaculatus, Ompok pabda, Botia derio, Nandus nandus, Rasbora alenga, Bracidanio rario and Channa barca* (See Table-6). Again, altogether 20 economically important large fish species were found in deepor beel of which *Labio rohita, Catla catla, Labio calbasu, Channa marulius, Channa striatus, Notopterus chitala, Notopterus notopterus, Cirrhinus mrigala, Wallago attu etc*. were important. The largest catch of fish species was found from

Wallgo attu, 35 kg, /individual, *Catla catla*, 8 kg / individuals, *Cyprinus carpio*, 8 kg/ indivials, *Labio rohita,* 6kg/ individual, *Channa striatus,* 5kg/ individuals, *Channa grachua,* 8kg/ individual, *Hypophthalmichthys molitrix*, 7kg/ individual and *Aorichthys seenghala*, 10 kg/ individuals. The diversity and abundance of various economically important fish species was found to be higher in deeper bezel. In general, the fishing was found to be continued in the ecosystem throughout year and was sold in the daily markets of entire Gujarat city and local markets.

Analysis of the Shannon Wiener Index, Margalef's D Index and Simpson's D Index of diversity showed that, diversity of fish fauna was higher in several months and lower in others and few of them had same diversity (see Fig.-14, 15, 16 and Table-7). Comparing diversity of Shannon Wiener index (**SI**) between study zones during the months of November-December (ND) showed that, the diversity of fish species was significantly higher in $Zone_1$ than $Zone_2$, Zone $_6$, whereas, $Zone_4$ was higher than $Zone_5$ at 5% level (**SI**: ND_{Z1}: H′= 3.0, ND_{Z2}: H′= 2.84, Δ=-0.15; ND_{Z6}: H′= 2.84, Δ=-0.15 and ND_{Z4}: H′= 3.04; ND_{Z5}: H′= 2.65; Δ=-0.41; see Table-6; *pair wise randomized test based on 10,000 random sample).*

Comparing the diversity of Shannon Wiener index (**SI**) between study zones during the months of January-February (JF) showed that, the diversity of fish species was significantly higher in $Zone_1$ than $Zone_2$, $Zone_4$, $Zone_5$ and Zone $_6$ at 5% level (**SI**: JF_{Z1}: H′=3.021; JF_{Z2}: H′= 2.30, Δ=-0.73; JF_{Z4}: H′=2.38, Δ=-0.6; JF_{Z5}: H′= 2.75, Δ=-0.22; JF_{Z6}: H′= 2.81; Δ=0.20; see Table-6; *pair wise randomized test based on 10,000 random samples).*

Comparing diversity of Shannon Wiener index (**SI**) between study zones during the months of March (M) showed that, the diversity of fish species was significantly higher in $Zone_1$ than $Zone_2$, $Zone_5$ and $Zone_6$ at 5% level (**SI**: M_{Z1}: H′=3.05; M_{Z2}: H′= 2.92, Δ=--0.13; M_{Z5}: H′= 2.59, Δ=-0.46; M_{Z6}: H′= 2.68; Δ=0.36; see Table-6; *pair wise randomized test based on 10,000 random samples).*

Comparing diversity of Shannon Wiener index (**SI**) between study zones during the months of April (A) showed that, the diversity of fish species was

significantly higher in $Zone_3$ than $Zone_1$, whereas, the $Zone_1$ was more diverse than $Zone_4$, $Zone_5$ and $Zone_6$ at 5% level (**SI**: A_{Z3}: H′= 3.05, A_{Z1}: H′= 2.98, Δ=-0.08; A_{Z4}: H′=2.30, Δ=-0.67; A_{Z5}: H′= 2.75, Δ=0.22; A_{Z6}: H′= 2.64, Δ=-0.34; see Table-6; *pair wise randomized test based on 10,000 random samples).*

Comparing the diversity of Shannon Wiener index (**SI**) between study zones during the months of May-June (MJ) showed that, the diversity of fish species was significantly higher in $Zone_2$, $Zone_3$, $Zone_4$, $Zone_5$ and $Zone_6$ was more diverse than $Zone_1$ at 5% level (**SI**: MJ_{Z1}: H′= 2.31, MJ_{Z2}: H′= 2.84, Δ=0.53; MJ_{Z3}: H′=2.84, Δ=0.53; MJ_{Z4}: H′= 3.1, Δ=0.76; MJ_{Z5}: H′= 2.74, Δ=0.43; MJ_{Z6}: H′= 2.93, Δ=-0.62; see Table-6; *pair wise randomized test based on 10,000 random samples).*

Comparing diversity of Shannon Wiener index (**SI**) between study zones during the months of July-August (JA) showed that, the diversity of fish species was significantly higher in $Zone_2$, $Zone_3$, $Zone_4$, $Zone_5$ and $Zone_6$ than $Zone_1$ at 5% level (**SI**: JA_{Z1}: H′= 2.5, JA_{Z2}: H′= 2.7, Δ=0.21; JA_{Z3}: H′=2.72, Δ=0.23; JA_{Z4}: H′= 2.74, Δ=-0.25; JA_{Z5}: H′ = 2.70, Δ= 0.2; MJ_{Z6}: H′ = 2.8, Δ=-0.26; see Table-6; *pair wise randomized test based on 10,000 random sample).*

Comparing diversity of Shannon Wiener index (**SI**) between study zones during the months of September-October (SO) showed that, the diversity of fish species was significantly higher in $Zone_2$, $Zone_3$, $Zone_4$, $Zone_5$ and $Zone_6$ than $Zone_1$ at 5% level (**SI**: SO_{Z1}: H′= 2.5, SO_{Z2}: H′= 2.7, Δ=0.18; SO_{Z3}: H′=2.72, Δ=0.245; SO_{Z4}: H′= 2.72, Δ=-0.25; SO_{Z5}: H′= 2.69, Δ=0.2; MJ_{Z6}: H′= 2.8, Δ=-0.27; see Table-6; *pair wise randomized test based on 10,000 random sample).*

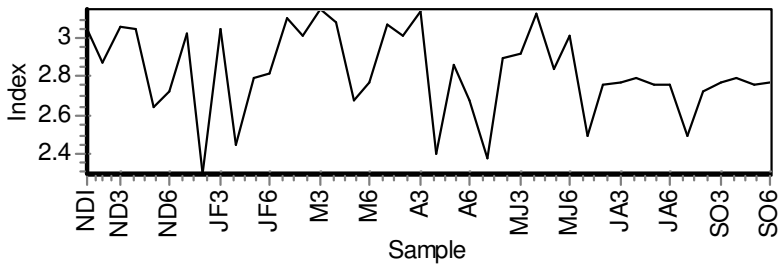


Fig.14: Shannon Wiener Index of Fish fauna in Deepor beel Ramsar site during study period (data were analyzed using monthly collected data of birds in six different study zones).

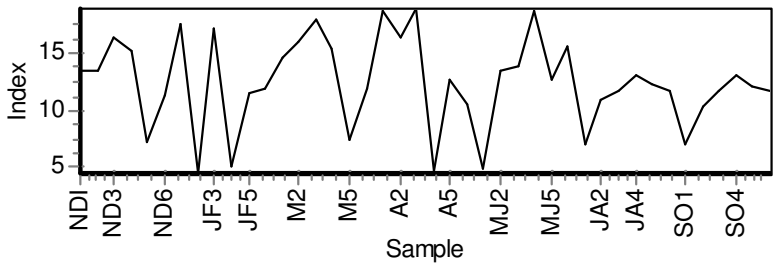


Fig.15: Simpson D Index of Fish fauna in Deepor beel Ramsar site during study period (data were analyzed using monthly collected data of birds in six different study zones).

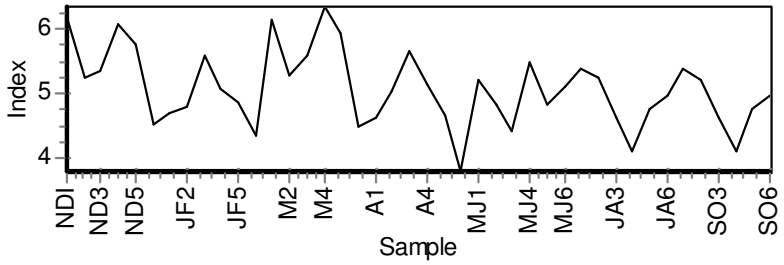


Figure-16: Margalef's D Index of Fish fauna in Deepor beel Ramsar site during study period (data were analyzed using monthly collected data of birds in six different study zones).

Table-6. Endangered fish species (Under wildlife protection Act, 1972) of Deepor beel Ramsar site.

Sl No	English Name	Scientific Name	Relative density
1	Bhangon.	*Cirrhinus reba*	91.8
2	Phul Dorikona or Zebra Fish	*Brachidanio rario*	7.2

3	Vedhengi/ Vetki fish	*Nandus nandus*	314.80
4	Aleng	*Rasbora alenga*	30.5
5	Rukumoi Chenga	*Channa barca*	20.2
6	Pabha.	*Ompok bimaculatus*	11.0
7	Pabha.	*Ompok pabda*	25.60
8	Botia	*Botia dario*	110.0

Table-7. Diversity of fish fauna at Deepor beel Ramsar Site in various months of the year in six different study zones.

Sample	Shannon Wiener Index		Margalef's D Index	Simpson's D Index
	H	Variance H		
NDI	3.045	0.002314	6.145	13.44
ND2	2.874	0.002089	5.236	13.4
ND3	3.055	0.001095	5.325	16.38
ND4	3.046	0.00572	6.057	15.22
ND5	2.648	0.00842	5.733	7.215
ND6	2.72	0.003647	4.521	11.29
JF1	3.021	0.0006078	4.705	17.55
JF2	2.301	0.001255	4.789	4.419
JF3	3.047	0.0007831	5.58	17.13
JF4	2.444	0.002348	5.078	4.936
JF5	2.787	0.001807	4.869	11.44
JF6	2.81	0.001798	4.34	11.98
M1	3.098	0.001852	6.126	14.61
M2	3.007	0.001496	5.261	15.94
M3	3.145	0.001001	5.579	17.95
M4	3.074	0.004727	6.325	15.36
M5	2.677	0.008438	5.908	7.349
M6	2.772	0.003414	4.493	11.91
A1	3.061	0.0004686	4.622	18.67
A2	3.007	0.0006483	5.031	16.32
A3	3.133	0.0006549	5.648	18.95
A4	2.404	0.002674	5.12	4.52
A5	2.86	0.001445	4.657	12.73
A6	2.674	0.001667	3.808	10.56
MJ1	2.378	0.002325	5.218	4.869
MJ2	2.89	0.001185	4.825	13.46
MJ3	2.917	0.001414	4.434	13.92
MJ4	3.124	0.001277	5.473	18.74
MJ5	2.841	0.002168	4.815	12.65
MJ6	3.012	0.001743	5.095	15.57
JA1	2.496	0.005282	5.38	6.918
JA2	2.754	0.003305	5.245	10.82
JA3	2.764	0.001809	4.631	11.69
JA4	2.795	0.00125	4.115	13.11
JA5	2.754	0.001044	4.774	12.2
JA6	2.753	0.001598	4.978	11.65
SO1	2.497	0.005244	5.377	6.943
SO2	2.724	0.003316	5.212	10.27

SO3	2.764	0.001782	4.626	11.74
SO4	2.795	0.00125	4.115	13.11
SO5	2.752	0.001059	4.777	12.14
SO6	2.763	0.001549	4.962	11.76

4.2.2. FISH DENSITY

The estimated density of fish species in different study periods and zones showed that, the Ecological density of fish species was higher during the months of January-February (J-F) and April, than the others, whereas the highest crude density was found during J-F and followed by the months of April and May-June (See Figure-17, 18 and 19).

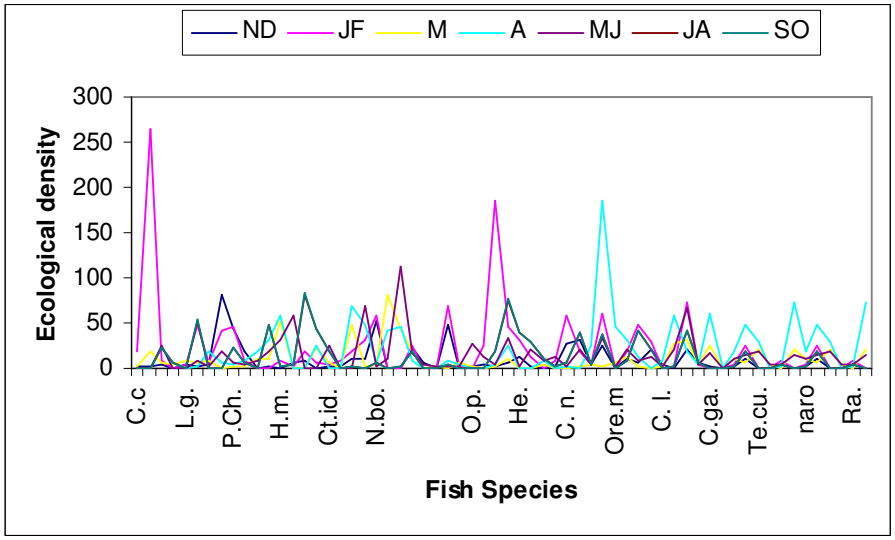


Figure-17: Ecological density of fish species in Deepor beel Ramsar site.

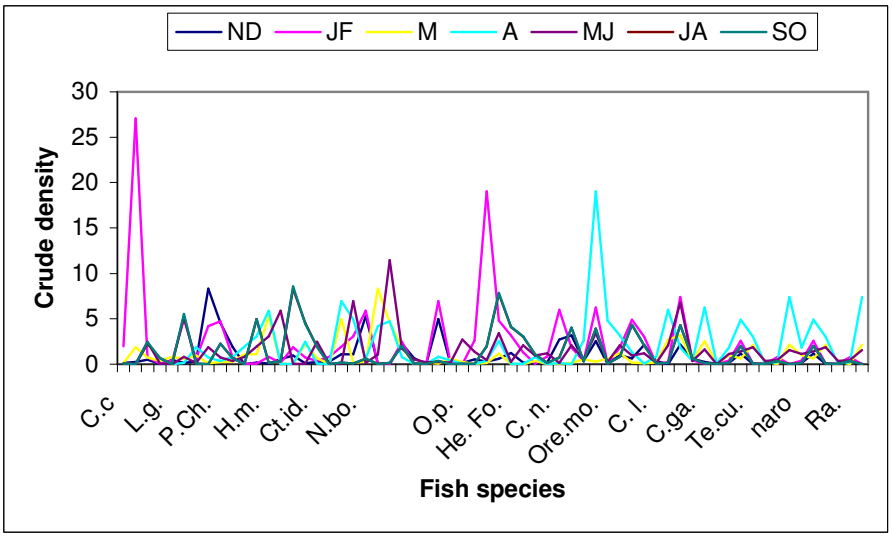


Figure- 18. Crude density of fish species in Deepor beel Ramsar site.

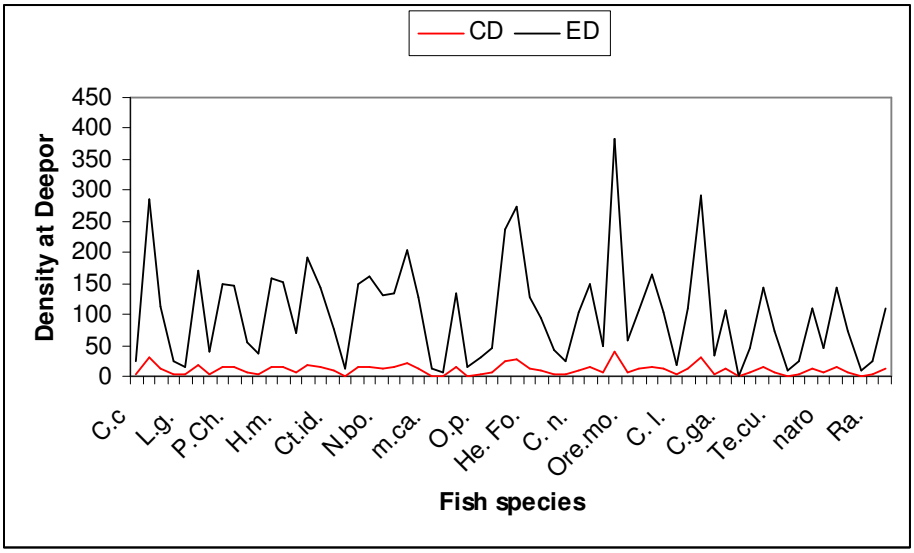


Figure-19: Overall density (d/km^2) of Fish species at Deepor beel Ramsar site (**CD**: Crude density; **ED**: Ecological density).

4.2.3. ORNAMENTAL FISH

Study found that deepor beel supports various ornamental fishes, of which 11 species were important. Those were such as *Badis badis, Colisa lalia, Colisa fasciatus, Pseudomabius ranga, Chanda nama, Botia Dario, Danio deverio, Bracidanio verio. B. rario, Parluciosoma daniconius, Puntius ssp* (more than one species) (see appendix-II).

4.3. AMPHIBIAN SPECIES

4.3.1. AMPHIBIAN DIVERSITY

During present study, altogether 11 species of amphibian fauna were recorded in Deepor beel Ramsar site (See Table-8). Study found that, the abundance of *H. tigerina, R. syanopyletes and B.melanosticus* were higher in Deepor beel Ramsar site than the other amphibian species (Figure-20). Distribution and abundance of amphibian species in different study zones were also not similar. The species *H. tigerina,* and *B. melanostictus* were recorded all six study zones and found to be higher in zone-1. The species *R. tytleri* was found to be higher in zone-5, followed by zone-2 and 1. The species *Rana tytleri* was the only species of **IUCN RED DATA** category, recorded in Deepor beel Ramsar site (Plate-I; see Table-10). In study zone-6, *R. syanophylectes* was the most abundant species, whereas,

the most abundant amphibian species in Zone-2 and zone-4 was *B.melanosticus* (See Figure-21).

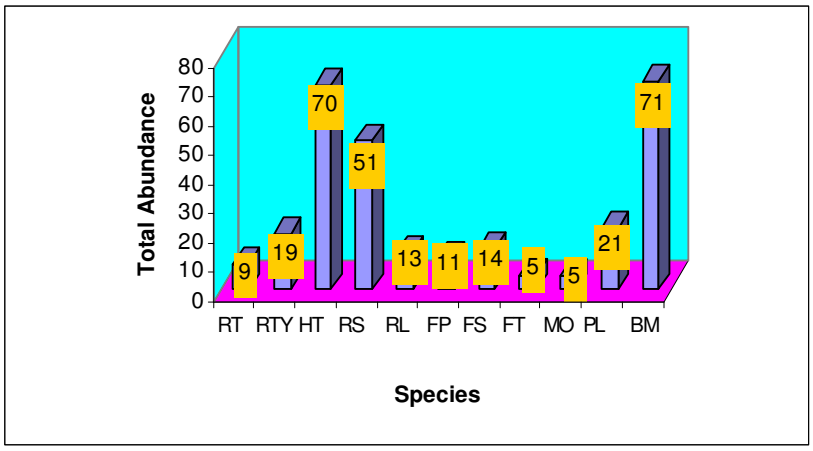


Figure-20. Abundance of amphibian species in Deepor beelramsar site during study period (RT: *Rana tytlery;* RTY*: Rana typiensis;* HT: *Haplobtrachus tigerina;* RS*: Rana syanophylectes;* RL*: Rana leptoglosus;* FP: Fezerzerya *pieri; FS: Fezerzerya pieri;* FT*: F. terai; MO: Mycrohyla ornate; PL: Polypedatus leucomystes;* BT*: Buffo melanostictus).*

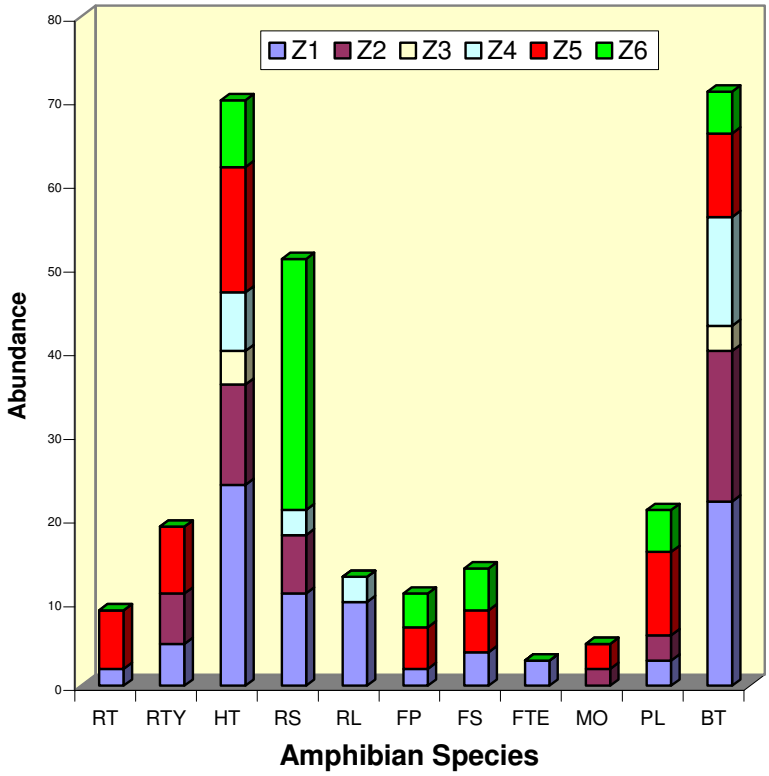
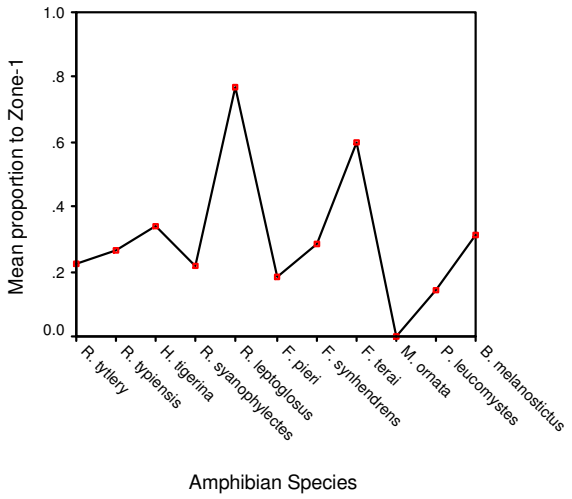


Figure.21: Distribution and abundance of amphibian fauna in different study zones of Deepor beel Ramsar site. (RT: *Rana tytlery;* RTY*: Rana typiensis;* HT: *Haplobtrachus tigerina;* RS*: Rana syanophylectes;* RL*: Rana leptoglosus;* FP: Fezerzerya *pieri; FS: Fezerzerya pieri;* FTE*: F. terai; MO: Mycrohyla ornate; PL: Polypedatus leucomystes;* BT*: Buffo melanostictus).*

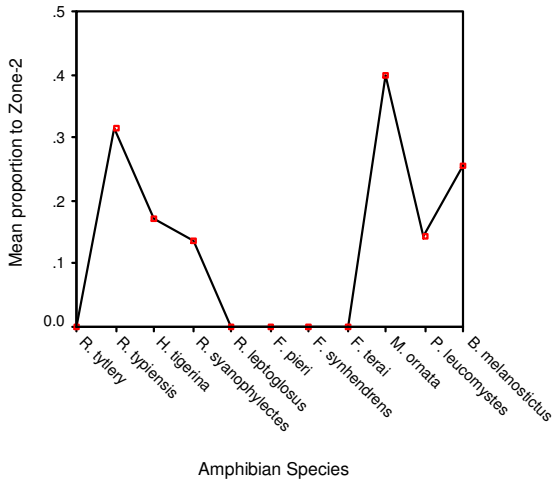
Table-8: Proportional abundance of Amphibian species in six study zones of Deepor beel Ramsar Site.

Amphibian Species	Proportional abundance					
	Z1	Z2	Z3	Z4	Z5	Z6
Rana tytlery	0.22	0.00	0.00	0.00	0.**78**	0.00
Rana typiensis	0.26	0.32	0.00	0.00	0.**42**	0.00
Haplobtrachus tigerina	0.**34**	0.17	0.06	0.10	0.21	0.11
Rana syanophylectes	0.22	0.14	0.00	0.06	0.00	0.**59**
Rana leptoglosus	0.**77**	0.00	0.00	0.23	0.00	0.00
Fezerzerya pieri	0.18	0.00	0.00	0.00	0.**45**	0.36
F. synhendrense	0.29	0.00	0.00	0.00	**0.36**	**0.36**
F. terai	0.**60**	0.00	0.00	0.00	0.40	0.00
Mycrohyla ornata	0.00	0.40	0.00	0.00	0.**60**	0.00
Polypedatus leucomystes	0.14	0.14	0.00	0.00	0.**48**	0.24
Buffo melanostictus	0.**31**	0.25	0.04	0.18	0.14	0.07

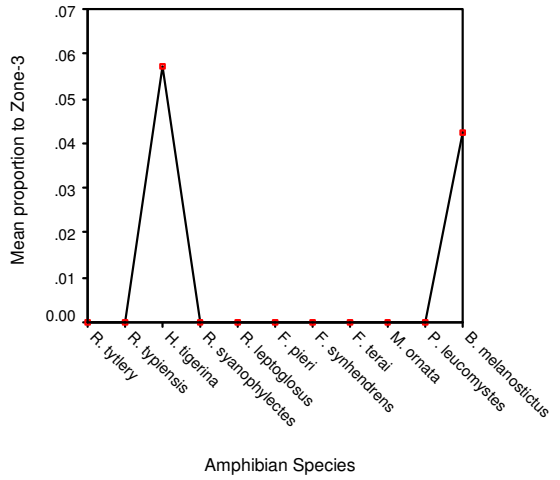
The analysis showed that, the proportional abundance of *Rana leoptoglosus* was higher in zone-1, 2 and 4, *F. piari* in zone-5 and 6, *Rana syanophylectes* in zone-6, *H. tigerina* in zone-3, *R. terai* in zone 1, *F. synhendrens* in zone –6 and R. tytleri in zone-6 (See Fig-22, a, b.c, d, e, f). Analysis of Shannon wiener Index of diversity in different study zones showed that, the Zone-1 and Zone-5 was more diverse than the zone-2, zone-3, zone-4 and zone-6 at 5% level (SI: **Zone1**: H′=1.935, zone-2: H′=1.56,Δ=-0.37; Zone-3: H′=0.68,Δ=1.25; Zone-4: H′=1.2,Δ=-0.73; Zone-6: H′=1.44,Δ=-0.65; **Zone 5**: H′=1.98, Zone 4: H′=1.2, Δ=-0.78; zone-2: H′=1.56, Δ=-0.42; Zone-3: H′=0.68,Δ=-1.3; Zone-6: H′=1.44, Δ=-0.54; see Table-9).



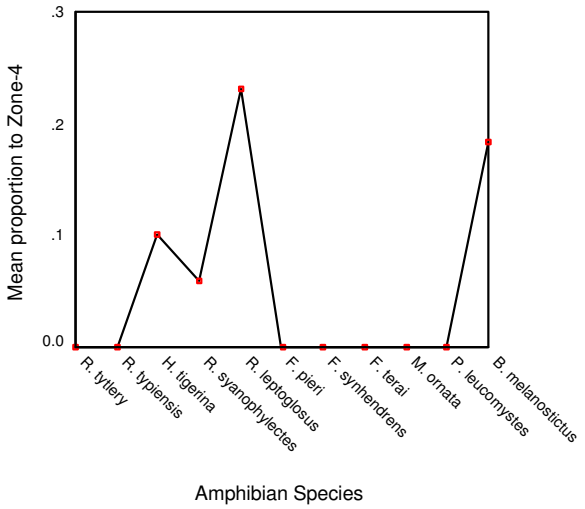
(a)


Mean proportion to Zone-2
.5
.4
.3
.2
.1
0.0
R. tytlery
R. typiensis
H. tigerina
R. syanophylectes
R. leptoglosus
F. pieri
F. synhendrens
F. terai
M. ornata
P. leucomystes
B. melanostictus
Amphibian Species

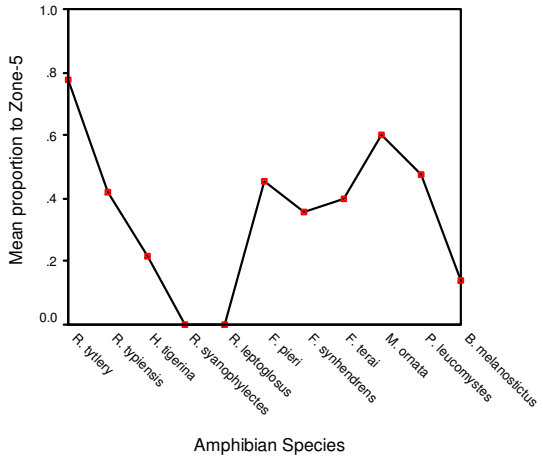
(b)


Mean proportion to Zone-3
.07
.06
.05
.04
.03
.02
.01
0.00
R. tytlery
R. typiensis
H. tigerina
R. syanophylectes
R. leptoglosus
F. pieri
F. synhendrens
F. terai
M. ornata
P. leucomystes
B. melanostictus
Amphibian Species

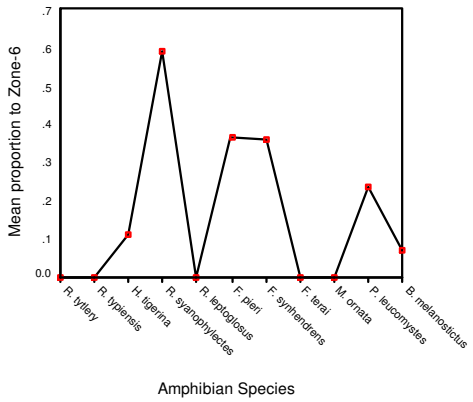
(c)


Mean proportion to Zone-4
.3
.2
.1
0.0
R. tytlery
R. typiensis
H. tigerina
R. syanophylectes
R. leptoglosus
F. pieri
F. synhendrens
F. terai
M. ornata
P. leucomystes
B. melanostictus
Amphibian Species

(d)



(e)



(f)

Fig. 22: Proportional abundance of amphibian species in different study zones of Deepor beel ramsa site, (a) Zone-1, (b) Zone-2, (c) Zone-3, (d) Zone-4, (e) Zone-5, (f) Zone-6.

Table-9. Species Diversity indices of Amphibian fauna in six different study zones of Deepor Beel Ramsar site during study period.

Sample	Shannon Wiener index		Margalef's D Index	Simpson's D Index
	H	Variance H		
Z1	1.935	0.007769	2.02	5.792
Z2	1.561	0.009158	1.292	4.355
Z3	0.6829	0.0131	0.5139	2.333
Z4	1.198	0.01546	0.9208	3.095
Z5	1.979	0.003828	1.69	7.315
Z6	1.44	0.01371	1.237	3.198

Table 10: IUCN RED DATA Species of Amphibian fauna found in Deepor beel.

Sl No	Common Name	Scientific Name	IUCN Status
1	----------	*Rana tytleri*	Schedule-I

4.4. REPTILIAN FAUNA

4.4.1. DIVERSITY AND ABUNDANCE

Study sampled altogether 33 reptilian species in Deepor beel Ramsar site, of which 13 species were from snake group, 11 species from lizard group and 9 species from turtle and tortoise group (Appendix-III; See Table- 11). Study showed that, among all the recorded snake species, the species *Lycodon aulicus*, *Xenochrophis piscator* and *Enhydris enhydris* were more abundant in deepor beel than others. Again, the species *Lycodon aulicus*, *Python molurus bivittatus*, *Rabdophis subminutus* and *Naja kaouthia* were more common in Zone-1, whereas, the species *Xenochrophis piscator and Enhydris enhydris* were more common in Zone-5 (see Figure-23). The Lizard species *Hemidactylus brooki* and *H. garnoti* were commonly found throughout all study zones of deepor beel (See Fig. 24). Among turtle/tortoises, the species *Trionix hurum* and *Kachuga tecta* were found to be more common species in Deepor beel in all occasions (see Fig.-25).

Comparing the diversity of Shannon wiener index between study zones showed that, the species diversity index of Zone-2 and Zone-5 was more diverse than Zone-1 at 5% level (**SI**: Zone-1: H'= 2.495, Zone-2: H'= 2.823, Δ=0.33; Zone-5: H'= 2.68, Δ=0.20; *pair wise randomization test, based 10,000 resample using bootstrap methods*). The analysis of Margalef'sD index ($\mathbf{M}_D$), which represents both the species diversity and species richness showed that, the Margalef's index of Zone1 was higher than Zone-4 at 5% level (Margalef's D Index: Zone-1: $\mathbf{M}_{D=}$4.83, Zone-4: $\mathbf{M}_{D=}$ 3.75, Δ= -1.07; *pair wise randomization test, based 10,000 resample using bootstrap methods).*

Table -11: Diversity and Relative density of Reptilian fauna In Deepor beel Ramsar Site, observed during study period.

Common Name	Family/Scientific Name	Relative Density
SNAKES		
	Typhlopidae Merrem, 1820	
Diard's Worm Snake	*Typhlops diardii* Schlegel, 1839	0.08
	Pythonidae Fitzinger, 1826	
Burmese Python	*Python molurus bivittatus* Kuhl, 1820	1.12
	Colubridae Oppel, 1811	
Indian Rat Snake (Mochura)	*Ptyas mucosa* (Linnaeus 1758)	0.72
White-barred Kukri Snake	*Oligodon albocinctus* (Cantor, 1839)	0.72
Painted Bronzeback tree snake (Karsola)	*Dendreaphis pictus* (Gmelin, 1789)	0.96
Common Wolf Snake	*Lycodon aulicus* (Linnaeus, 1758)	2.32
Checkered Keel back (Dhura sap)	*Xenochrophis piscator* (Schneider, 1799)	1.76
Red-necked Keel back	*Rhabdophis subminiatus* (Schlegel, 1837)	0.8
Striped Keelback	*Amphiesma stolatum* (Linnaeus, 1758)	0.96
Himalayan Mountain Keel back	*Amphiesma platyceps* (Blyth, 18540)	0.08
Common Smooth-scaled Water Snake	*Enhydris enhydris* (Schneider, 1799)	1.2
	Elapidae Boie, 1827	
Monocled Cobra	*Naja kaouthia* Lesson, 1831	1.52
Common Krait	*Bungarus caeruleus* (Schneider, 1801)	0.48

LIZARDS	***Agamidae***	
Khasi Hill Garden Lizard	*Calotes jerdoni* Gunther, 1870	0.32
Indian Garden Lizard	*Calotes jversicolor* (Daudin 1802)	3.44
	Gekkonidae	
Ticticky House Gecko	*Hemedactylus frenatus* Schlegal 1836	1.52
Assam Greyish-brown Gecko	*Hemedactylus garnoti* Dum. And Bibr. 1836	11.68
Common India Takshak	*Gekko gecko* (Linnaeus 1758)	0.48
Spotted House Gecko	*Hemedactylus brooki* Gray, 1845	12.48
	Scincidae	
Common Indian Skink	*Mabuya carinata* (Schneider, 1801)	1.76
Bronzy Grass Skink	*Sphenomorphys maculatus* (Blyth, 1853)	1.68
Dotted Garden Skink	*Riopa punctata* (Linnaeus, 1766)	1.84
	Anguidae	
Indian Monitor Lizard	*Varanus bengalensis* (Linnaeus, 1758)	1.04
Yellow Monitor Lizard	*V. flavescens*	0.32
TORTOISES and *TURTLES*		
Indian Roofed Terrapin	*Kachuga tecta* (Gray)	2.8
Smith's Terrapin	*Kachuga smithi* (Gray)	0.32
Khasi Hill Terrapin	*K. sylhetensis* (Jerdon)	0.24
Spotted Black Terrapin	*Geoclemys hamiltoni* (Gray)	0.16
Brahmini Terrapin	*hardella thurgii (Gray)*	0.24
Indian Mud Turtle	*Lissemys punctata* Lacepede	1.2
Peacock Softshell	*Trionix hurum* (Gray)	1.84
Chitra Turtle	*Chitra Indica* (Gray)	0.8
Ganges Soft-shell Turtle	*Trionix gangeticus*	0.8

4.4.2. ENDANGERED SPECIES

Study showed that, deepor beel harboars altogether 9 endangered reptilian species under Indian wildlife protection Act, 1972. Of which, one species was from snake such as *Python molurus bivittatus*, one from Lizards such as *V. flavescens* and highest of seven species were recorded from Turtles and Tortoises (See Table-12).

Table- 12. Endangered Reptilian fauna in Deepor Ramsar Site (Under Indian Wildlife Protection Act, 1972)

Sl No	Common Name	Scientific Name	Status (IWPA)
1	Burmese Python	*Python molurus bivittatus* Kuhl, 1820	**Schedule-I**
2	Yellow Monitor Lizard	*V. flavescens*	**Schedule-I**
3	Indian Roofed Terrapin	*Kachuga tecta* (Gray)	**Schedule-I**
4	Khasi Hill Terrapin	*K. sylhetensis* (Jerdon)	**Schedule-I**
5	Spotted Black Terrapin	*Geoclemys hamiltoni* (Gray)	**Schedule-I**
6	Indian Mud Turtle	*Lissemys punctata* Lacepede	**Schedule-I**
7	Peacock Softshell	*Trionix hurum* (Gray)	**Schedule-I**
8	Khasi Hill Terrapin	*K. sylhetensis* (Jerdon)	**Schedule-I**
9	Ganges Soft-shell Turtle	*Trionix gangeticus*	**Schedule-I**

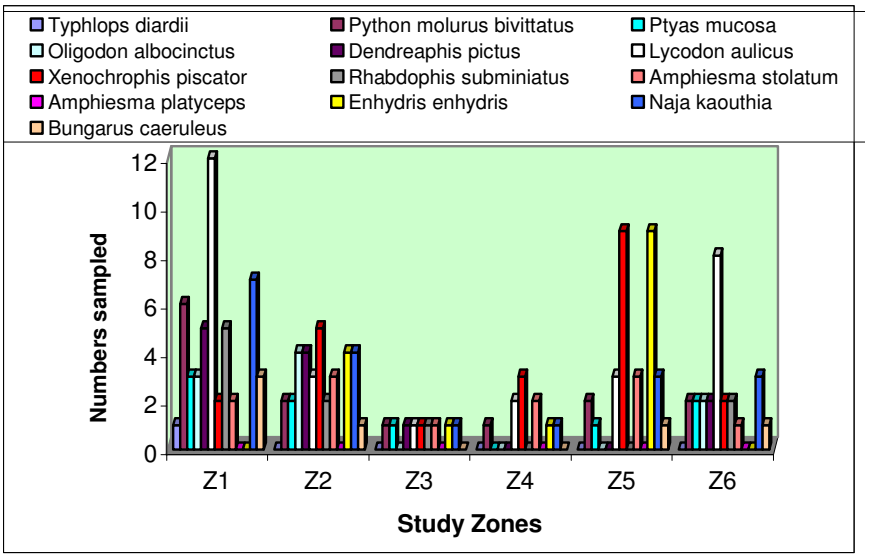


Figure- 23. Abundance of Snake species in Deepor beel Ramsar site.

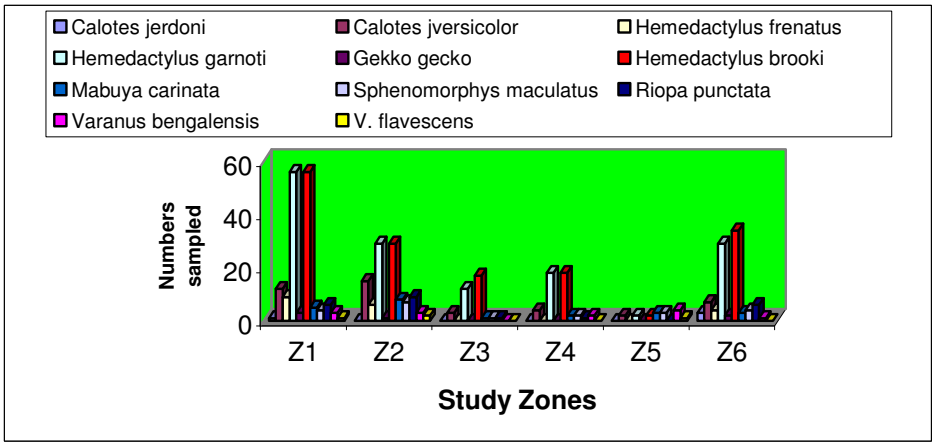


Fig. 24. Abundance of Lizard species in Deepor beel Ramsar Site.

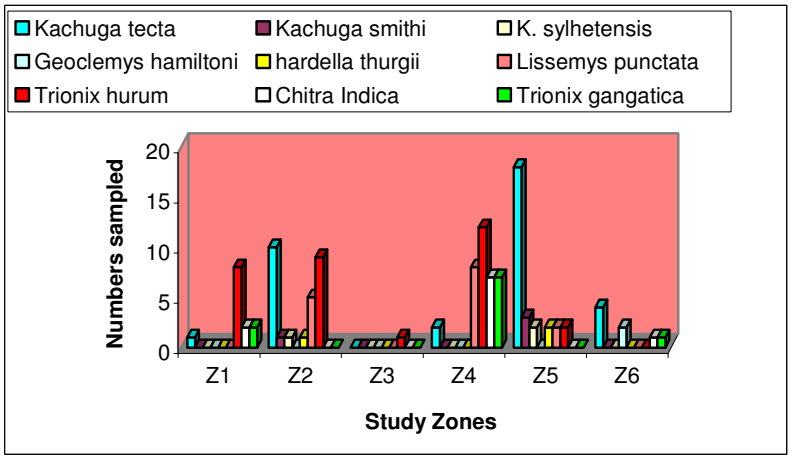


Fig.25. Abundance of Turtle and Tortoise species in Deepor beel Ramsar Site.

4.5. MAMMALIAN FAUNA

4.5.1. ABUNDANCE & DIVERSITY

Study revealed that, Deepor beel sustained altogether 24 species of mammalian fauna belonging to 15 families, of which, four were domestic and other 19 were free ranging wild mammalian species (see Appendix-IV). Of the total 23 mammalian species found at deepor beel, three (3) species were endangered categories under wildlife protection Act 1972, such as *Elephas maximus, Muntiacus muntjak, Hystrix brachyura, Cervus unicolor* (Plate-I;Table-13; See Appendix-IV). Analysis of the mean abundance of various mammalian species in different study zones showed that, the mean abundance of *Bovidae* (domestic cattles) family was higher throughout the study period, whereas, the family *Suidae* (domestic Pig) was higher during the months of December, February, March and April (see Figure-26-36 and 38). The mean abundance of *Elephantidae* was higher during the months of May- August and the peak abundance months was August (See Fig-34).

Analysis of Shannon Wiener, Margalef's D and Simpson's D index of diversity showed that, the all three index of diversity was significantly higher during the month of November at Zone 1 than the other at 5% level (SI: $Zone_{1N}$: H'= 1.70; **MD**: 2.53; **SIM**: 4.01; see Figure 38-40; Table-14) *pair wise randomization test using 10,000 random samples, botstrapmethods was used*)

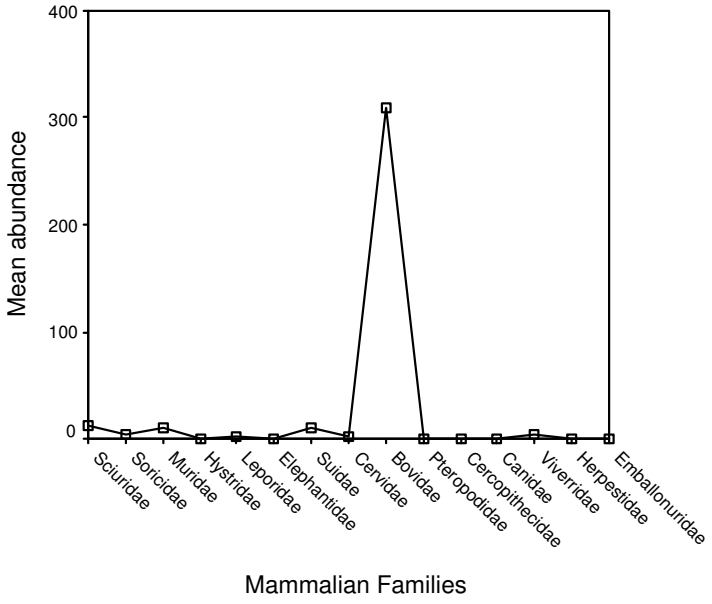


Fig: 26. Mean abundance of mammalian families during November at Deepor beel Ramsar site

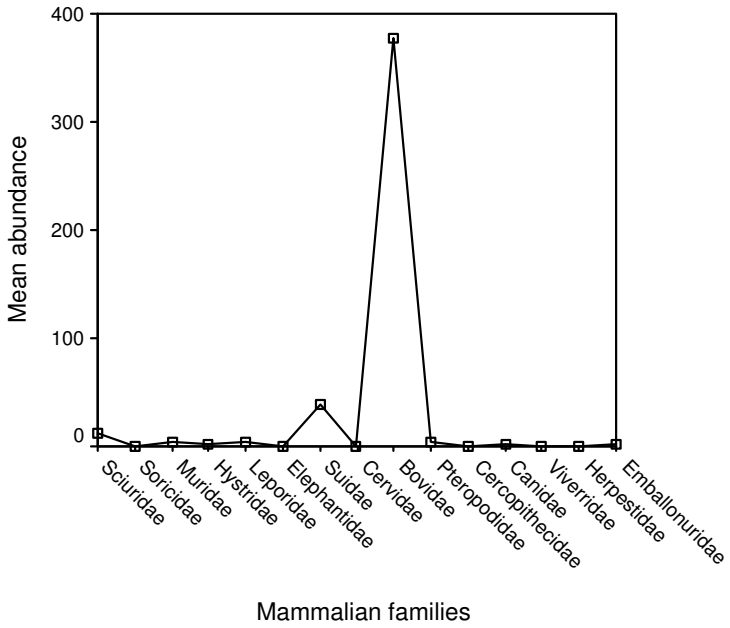


Fig: 27: Mean abundance of mammalian families during December at Deepor beel Ramsar site.

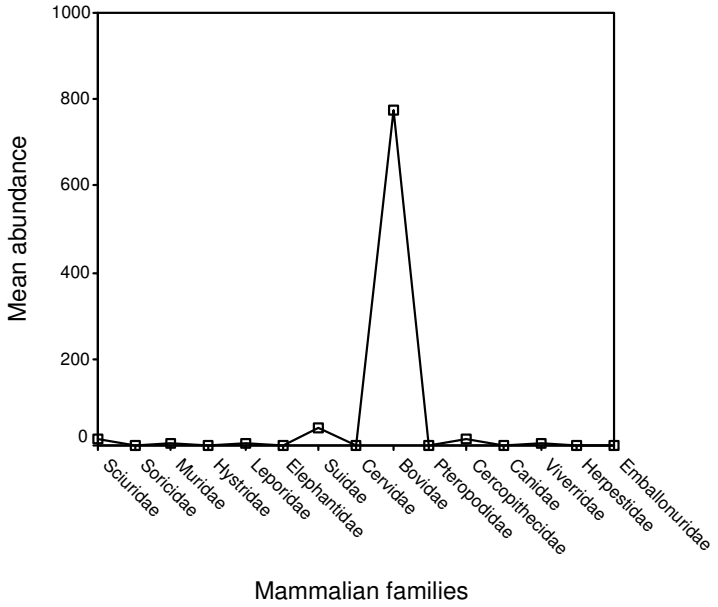


Fig: 28: Mean abundance of mammalian families during January at Deepor beel Ramsar site

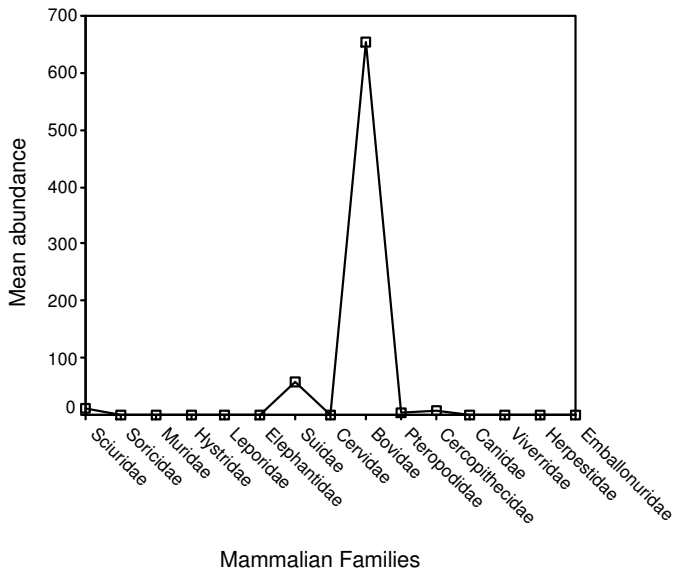


Fig: 29: Mean abundance of mammalian families during February at Deepor beel Ramsar site

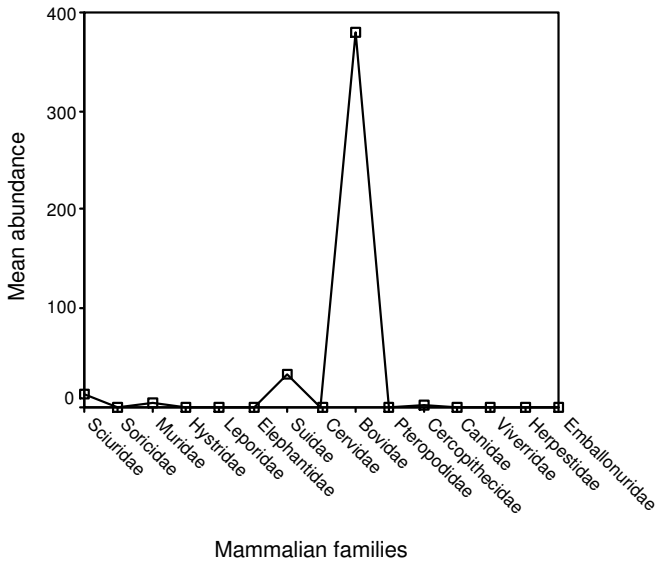


Fig: 30: Mean abundance of mammalian families during March at Deepor beel Ramsar site

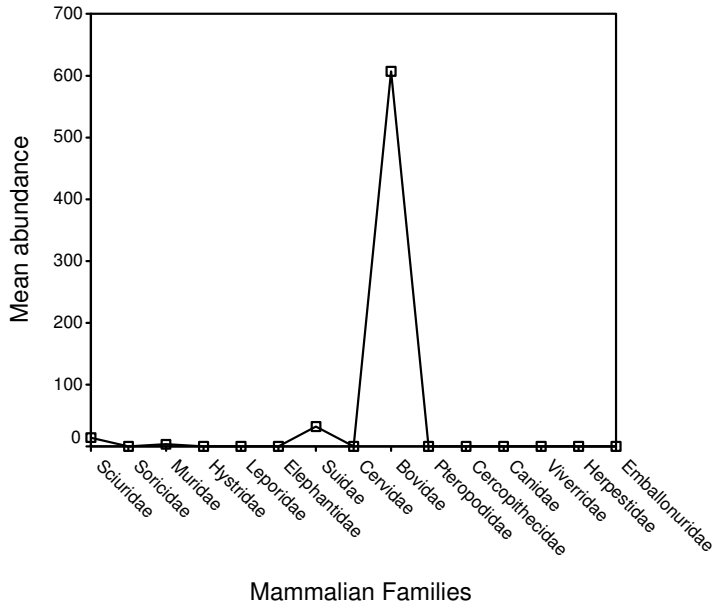


Fig: 31: Mean abundance of mammalian families during April at Deepor beel Ramsar site.

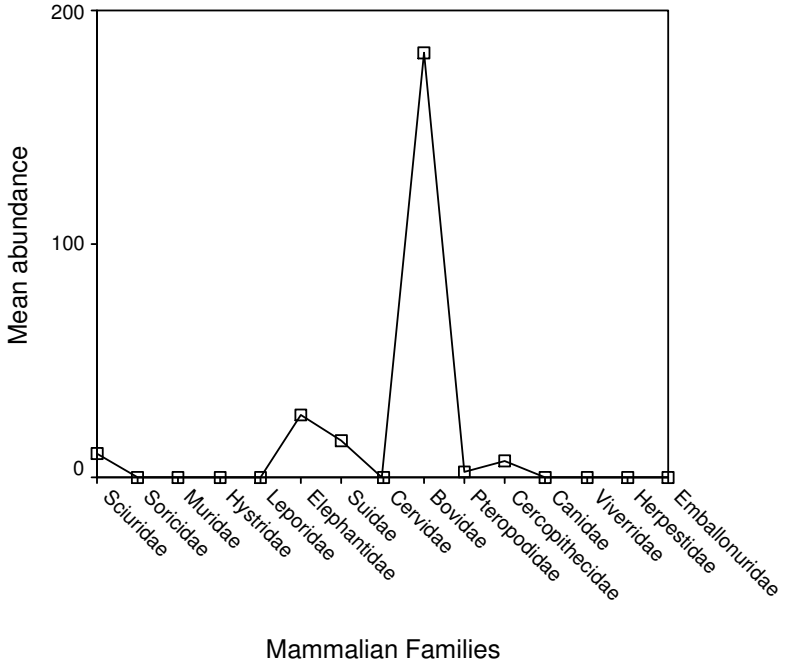


Fig: 32: Mean abundance of mammalian families during May at Deepor beel Ramsar site

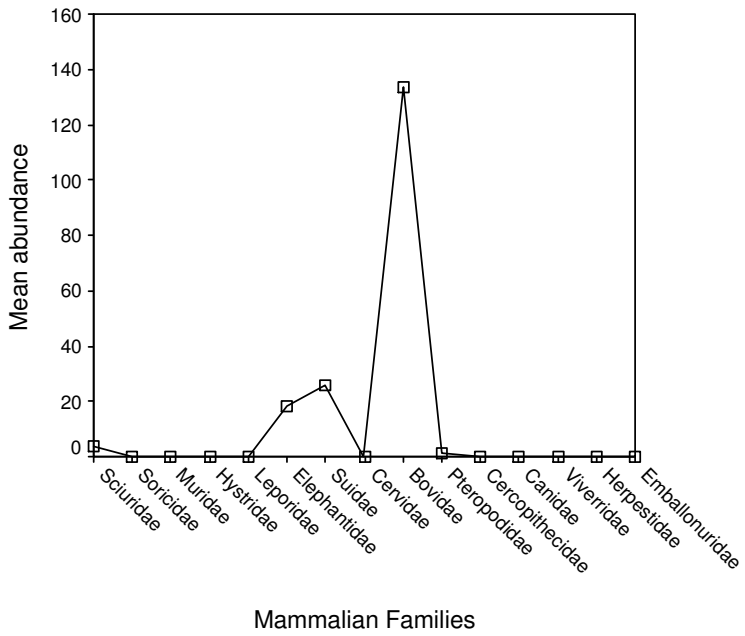


Fig: 33: Mean abundance of mammalian families during June at Deepor beel Ramsar site.

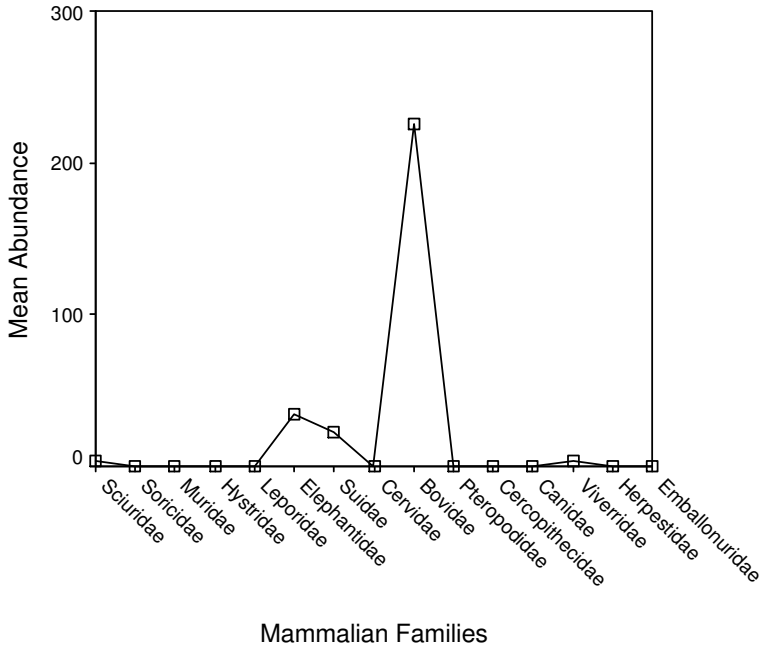


Fig: 34: Mean abundance of mammalian families during July at Deepor beel Ramsar site

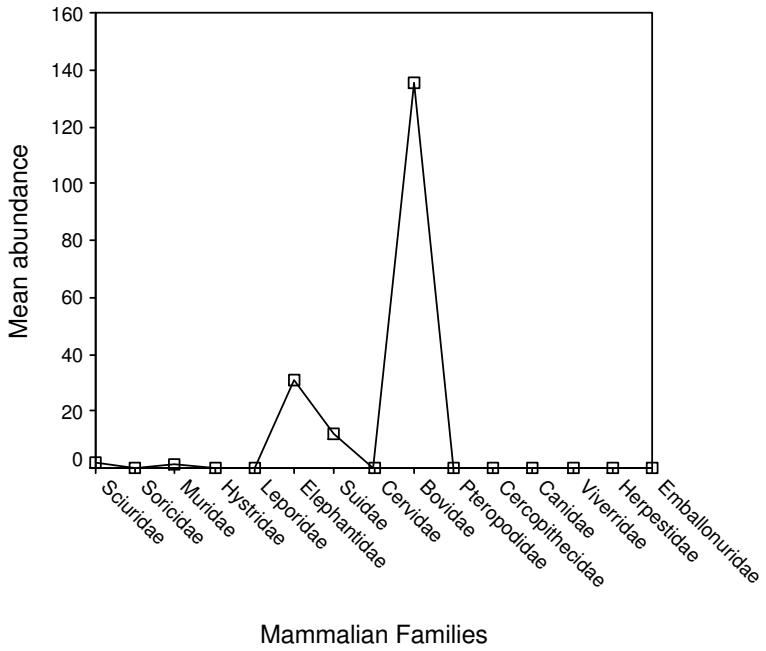


Fig: 35: Mean abundance of mammalian families during August at Deepor beel Ramsar site

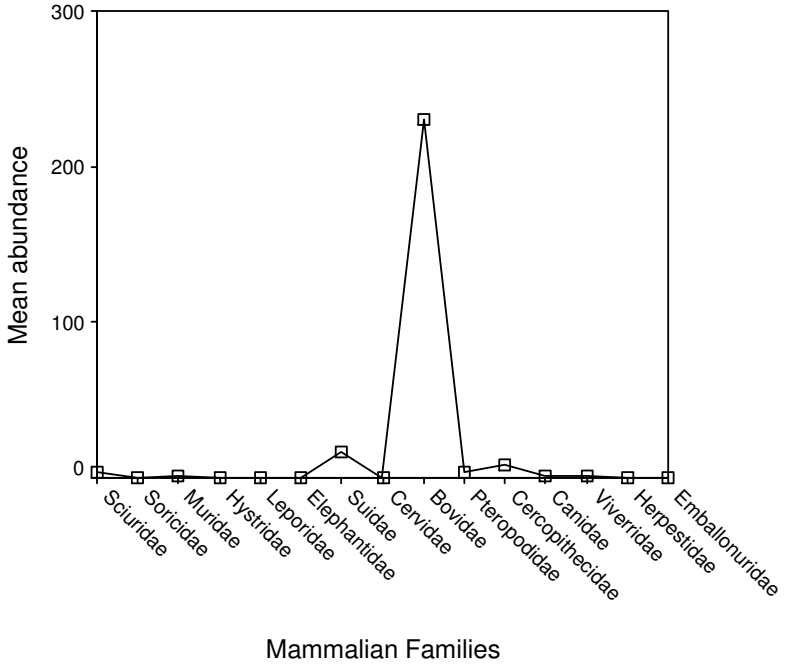


Fig: 36: Mean abundance of mammalian families during September at Deepor beel Ramsar site

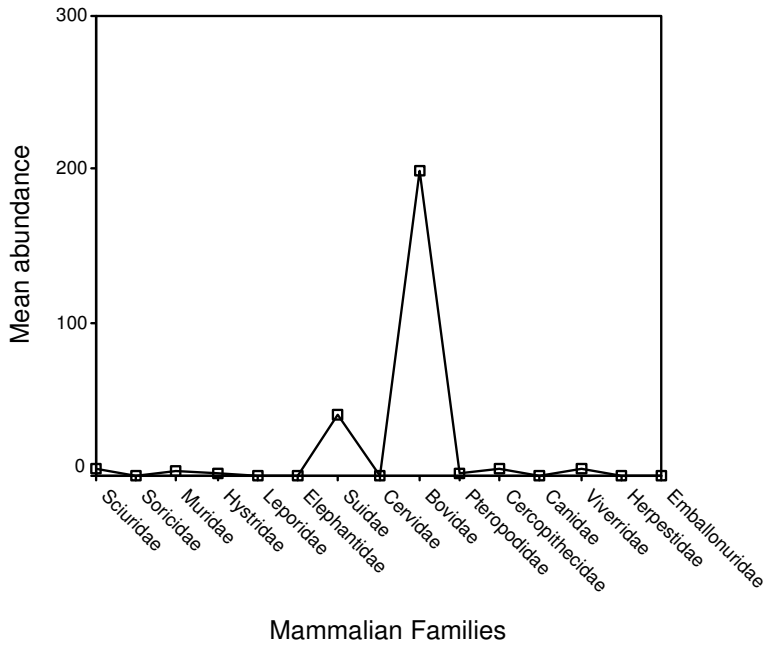


Fig: 37: Mean abundance of mammalian families during October at Deepor beel Ramsar site.

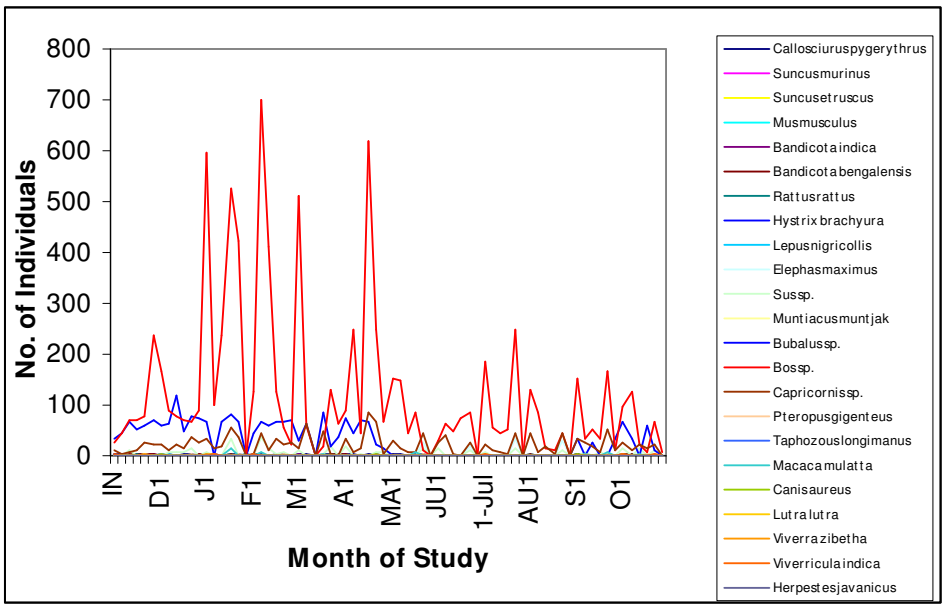


Figure-38. Monthly variation of population abundance in mammalian species at Deepor beel in different study Zones.

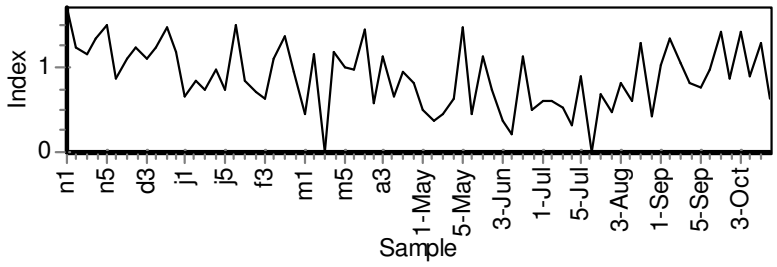


Fig-39: Shannon Wiener Index of Diversity for Mammalian fauna in DeeporBeel

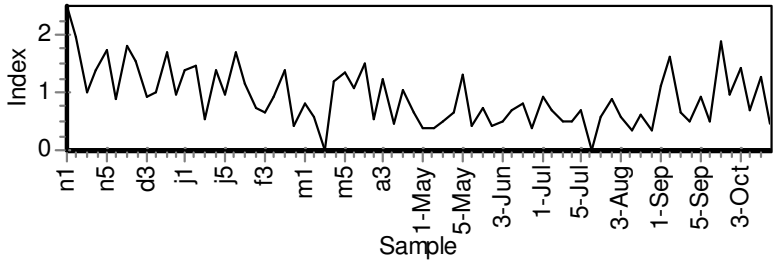


Fig.-40: Margalef's D index of Diversity for Mammalian fauna in Deepor beel

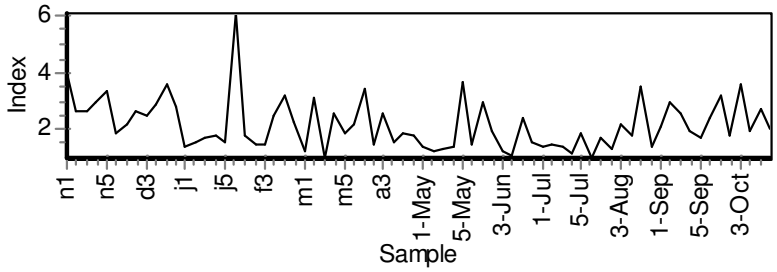


Fig.-41: Simpson's D index of Diversity for Mammalian fauna in Deepor beel

Table-13. Endangered Mammalian fauna of deepor beel Ramsar site.

Sl. No.	English Name	S. Name	Total Sampled
1	Indian Elephant	*Elephas maximus*	110
2	Barking Deer	*Muntiacus muntjak*	3
3	Chinese Porcupine	*Hystrix brachyura*	3
4	Sambar	*Cervus unicolor*	1

Table. 14: Shannon Wiener index, Margalef'sD Index and Simpson's Index of Diversity of mammalian fauna in deepor beel Ramsar sites (data in the bold are significantly higher than the others at 5% level).

Sample	Shannon Wiener Index		Margalef'sD	Simpson's D Index
	H	Variance H		
Nov.-Z1	**1.70**	0.01441	**2.53**	**4.016**
Nov.-Z2	1.235	0.01185	1.95	2.656
Nov.-Z3	1.139	0.004239	0.9889	2.64
Nov.-Z4	1.343	0.006444	1.393	2.943
Nov.-Z5	1.485	0.005533	1.724	3.358
Nov.-Z6	0.8666	0.00268	0.8595	1.843
Dec.-Z1	1.096	0.004897	1.798	2.17
Dec.-Z2	1.229	0.005578	1.541	2.666
Dec.-Z3	1.089	0.002699	0.9209	2.511
Dec.-Z4	1.232	0.004289	1.001	2.869
Dec.-Z5	1.473	0.003845	1.691	3.588
Dec.-Z6	1.179	0.002875	0.9455	2.81
Jan.-Z1	0.6492	0.00189	1.37	1.405
Jan.-Z2	0.831	0.01192	1.445	1.583
Jan.-Z3	0.7269	0.001962	0.5198	1.701
Jan.-Z4	0.9627	0.001895	1.368	1.796
Jan.-Z5	0.721	0.001936	0.9554	1.559
Jan.-Z6	1.499	0.03285	1.668	**6.111**
Feb.-Z1	0.8355	0.005375	1.154	1.819
Feb.-Z2	0.7044	0.001404	0.7405	1.473
Feb.-Z3	0.6182	0.001923	0.6436	1.44
Feb.Z4	1.091	0.002525	0.9187	2.525
Feb.Z5	1.367	0.004978	1.379	3.179
Feb.-Z6	0.9439	0.002592	0.4185	2.274
Mar.-Z1	0.4564	0.001979	0.7879	1.235
Mar.-Z2	1.145	0.0007226	0.5741	3.094
Mar.-Z3	0	0	0	1
Mar.-Z4	1.185	0.005214	1.182	2.605
Mar.-Z5	0.9921	0.007878	1.349	1.83
Mar.-Z6	0.971	0.007469	1.07	2.191
Apr.-Z1	1.439	0.003412	1.48	3.456
Apr.-Z2	0.5879	0.002488	0.5238	1.459
Apr.-Z3	1.115	0.005483	1.223	2.537
Apr.-Z4	0.6575	0.001014	0.451	1.522
Apr.-Z5	0.9403	0.002994	1.022	1.899
Apr.-Z6	0.8193	0.008758	0.6619	1.771
May-Z1	0.508	0.002874	0.3827	1.423
May-Z2	0.3706	0.0039	0.3922	1.233
May-Z3	0.4503	0.01294	0.5062	1.319

May-Z4	0.6168	0.009607	0.65	1.428
May-Z5	1.464	0.005778	1.287	3.635
May-Z6	0.4506	0.03345	0.4024	1.435
June-Z1	1.119	0.003409	0.7085	2.955
June-Z2	0.72	0.001855	0.4289	1.978
June-Z3	0.3548	0.01292	0.5014	1.211
June-Z4	0.2053	0.009085	0.6886	1.082
June-Z5	1.115	0.00472	0.8049	2.403
June-Z6	0.5004	0.02272	0.3693	1.522
July-Z1	0.5918	0.004975	0.9255	1.387
July-Z2	0.5969	0.01056	0.7038	1.495
July-Z3	0.5211	0.01186	0.5062	1.424
July-Z4	0.3015	0.01247	0.4991	1.162
July-Z5	0.8953	0.002589	0.6849	1.838
July-Z6	0	0	0	1
Aug.-Z1	0.6839	0.003095	0.5796	1.708
Aug.-Z2	0.4743	0.009975	0.8724	1.288
Aug.-Z3	0.8014	0.007718	0.5672	2.174
Aug.-Z4	0.6058	0.01109	0.353	1.789
Aug.-Z5	1.291	0.001193	0.6144	3.502
Aug.-Z6	0.4227	0.02043	0.3338	1.367
Sep.-Z1	1.018	0.004436	1.106	2.065
Sep.-Z2	1.327	0.01254	1.621	3
Sep.-Z3	1.044	0.003577	0.6573	2.563
Sep.-Z4	0.822	0.0103	0.5139	1.922
Sep.-Z5	0.7524	0.003522	0.9187	1.723
Sep.-Z6	0.965	0.004833	0.4926	2.385
Oct.-Z1	1.412	0.004495	1.856	3.191
Oct.-Z2	0.8643	0.005488	0.9681	1.819
Oct.-Z3	1.409	0.009189	1.427	3.607
Oct.-Z4	0.8855	0.00849	0.6753	1.927
Oct.-Z5	1.287	0.007631	1.26	2.737
Oct.-Z6	0.6365	0.01804	0.4551	2

4.6. LOWER ORGANISM

4.6.1. CRUSTACEANS

a. Crabs

Altogether two families of crustacean were recorded in Deepor beel Ramsar site such as *Paratelphusidae and Palinomidae.* In *Paratelphusidae* family, two species of Crabs were recorded in Deepor beel such, as *Paratelphusa eduntula* and *P. guirini,* of which the species *P. guirini* was more abundant than other (see Appendix-V). Again, the study Zone-5 was more suitable for the Crab species *P. guirini,* whereas, the study Zone-6 was more suitable for the Crab species *Paratelphusa eduntula* in deepor beel (See Fig-41)

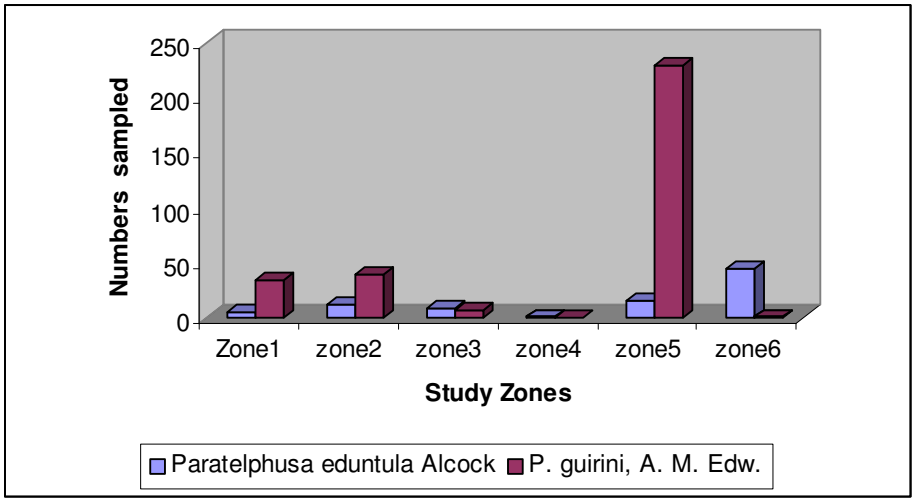


Figure.42. Abundance of Crabs species in deepor beel Ramsar site in six different study Zones.

4.6. 1.b. FRESHWATER PRAWN

Study sampled altogether three species of freshwater Prawn belonging to *Palinomidae* family in Deepor beel Ramsar site, such as *Macrobrauchium dayanum, M. assmensis* and *M. lamerrie.* Of which, the species *Macrobrauchium dayanum* was abundantly found throughout the study sites. Among all the six study zones, the zone-2 and zone-5 was found to be more suitable for the Prawn species, whereas the Zone-4 and Zone-6 was less suitable for all the Prawn species (Figure-42).

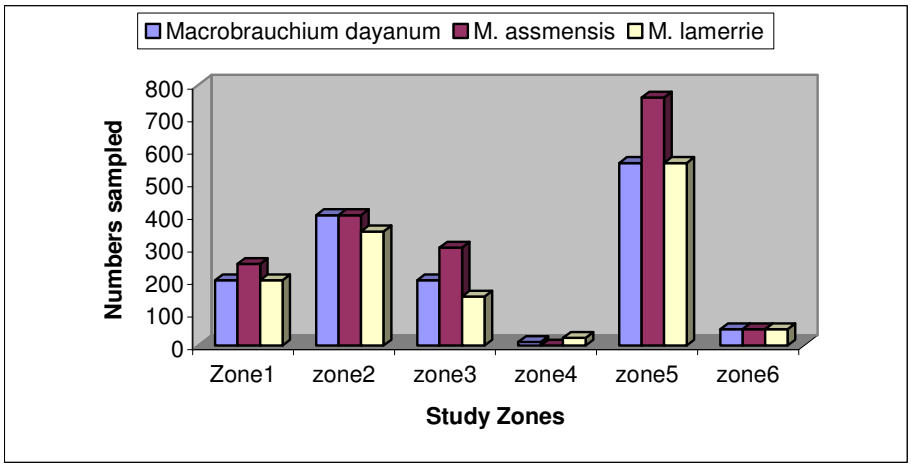


Figure.43. Abundance of Fresh water Prawn in deepor beel Ramsar site in six different study Zones.

4.7. AQUATIC INSECT

4.7.1. DIVERSITY & ABUNDANCE

Study sampled altogether 25 species of aquatic insects belonging to 10 families in deepor beel Ramsar site, of which 10 species were found in nymph stage (See Appendix-V) and others were in adult stages. Study also showed that,

the abundance of various insect species was higher in zone-5 than others (Figure-43). Of all the 25 aquatic insect species recorded at deepor beel, the *Ranatra filiformis* species had greatest abundance followed by *Corixa* ssp. and *Nepa apculata* species. The availability of nymph species in the wetland ecosystem, especially at the study Zne-5 indicates that, the productivity of the zone5 was highest than the rest (see Fig-44). Study also found out that, the distribution and abundance of aquatic insects species were higher between the months of December and May at deepor beel ecosystem (see Fig-45).

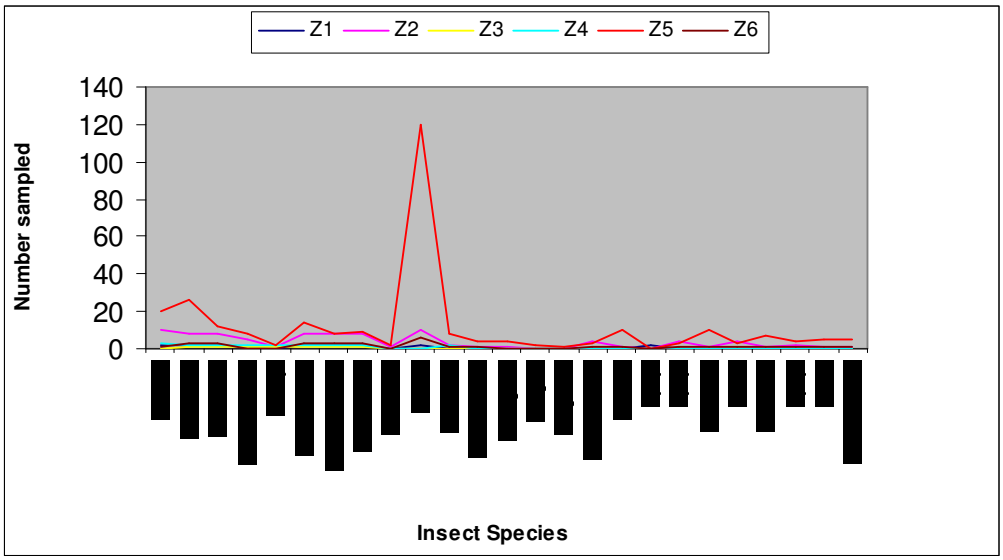


Fig. 44. Abundance of Insect species in different study Zones of Deepor beel Ramsar site.

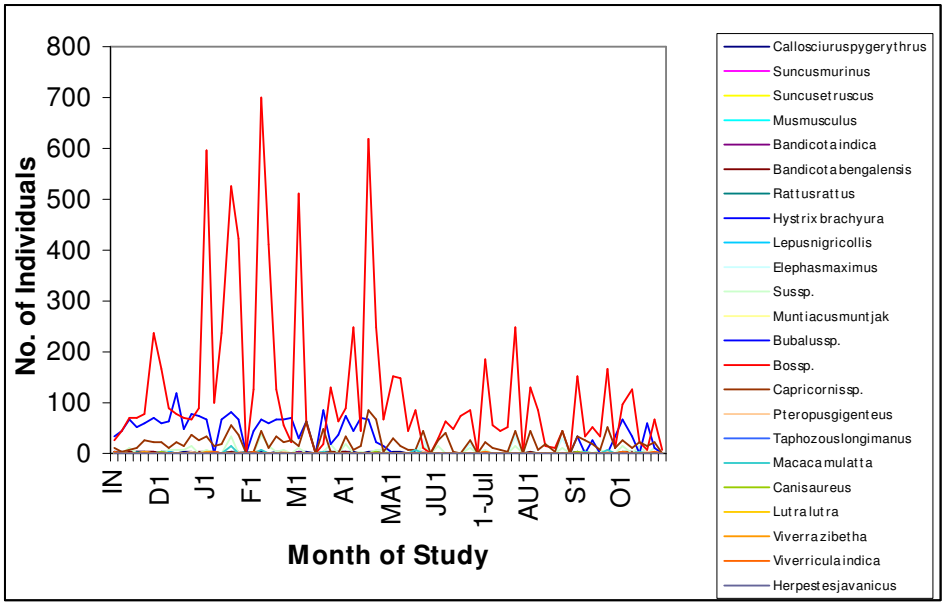


Figure-45: Monthly variation of aquatic Insects species in Deepor beel Ramsar site.

Table: 15. Diversity index of aquatic insects in six different zones at deepor beel Ramsar site.

Sample Zone	Margalef'sD Index	Simpsons D Index	Shannon Wiener Index	
			H	Variance H
Z1	2.824	17.00	2.181	0.01541
Z2	4.667	15.50	2.759	0.00675
Z3	3.083	07.00	1.946	0.06122
Z4	2.717	15.55	2.187	0.01223
Z5	4.057	05.18	2.353	0.006423
Z6	4.862	17.60	2.671	0.021500

Comparing the diversity of Shannon Wiener index and Margalef's D index in six different study zone showed that, there was no significant different between each diversity (See Table-14). Whereas, the Simpsons D index of diversity in different study zones showed significant difference at 5% level, in which the diversity of Zone-6 was significantly higher than Zone-5 (**SIM:** Zone-5 = 5.18, Zone-6 = 17.6, Δ =12.6), Zone-4 was significantly higher than Zone 5 (**SIM:** Zone4 =15.55, Δ=-10.37), Zone1 was significantly higher than Zone5 (**SIM:** Zone1= 17.0, Δ= -11.82) and Zone3 at 5% level (**SIM:** Zone3 = 7.0, Δ =10.0; pair wise randomization test using 10,000 random samples, bootstrap method was used; See Table-15).

4.8. MOLLUSCAN SPECIES

4.8.1. DIVERSITY & ABUNDANCE

Study sampled altogether 4878 individuals belonging to 5 different molluscan species in six study zones of deepor (see Table-16 & **Appendix-VI).** Of which, the highest sample was made from Zone-6, 1468 individuals, The species *Corbiculus assamensis* was recorded only very trace numbers (see Figure-46) from the study Zone-3 (2 numbers) and Zone-6 (4 numbers), whereas, the species *Bellamy bengalensis* was found to be the most abundant molluscan fauna in deepor beel. The species was sampled at higher numbers in Zone-6, 4 and 3 and less numbers counted in Zone-5, 2 and 1 respectively (see Figure-46). Again, the species *Pila globosus* and *Lymnea acuminate* were almost equally distributed in all study zones.

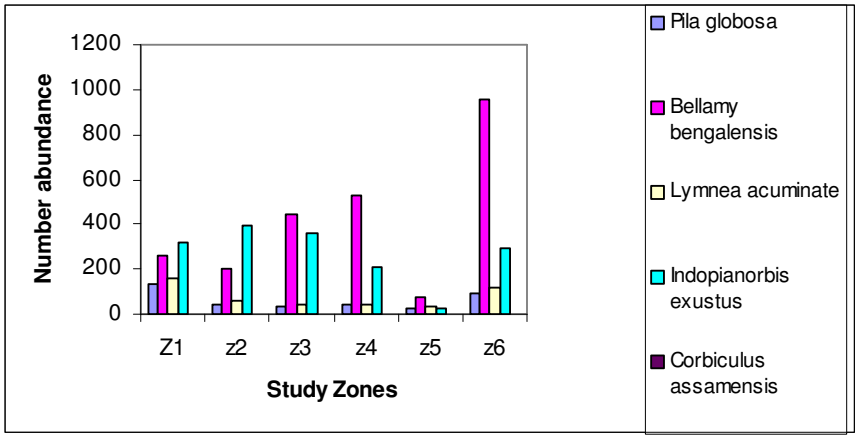


Fig-46: Abundance of difference Molluscan species in different study Zones of Deepor beel.

The comparing diversity between study zones showed that, the Shannon Wiener index of diversity was significantly higher in zone-1 than Zone-6, 3, 4 and 2 at 5% level (**SI**: Zone-1: H′=1.327, Zone-6: H′=0.99, Δ=-0.33; Zone-4: H′=0.93, Δ=0.39; Zone-3: H′=0.99, Δ=-0.34; Zone-2: H′=1.05, Δ=-0.23; pair wise randomization test using 10,000 random sampling; bootstrap methods was used for comparison of diversity between two zones). The Margalef's D index and Simpsons D index of diversity was not significantly different between each study zones (for diversity index, also see Table-17).

4.8.2. DENSITY OF MOLLUSCAN SPECIES

Analysis of spearman Rank correlation between the densities of Molluscan species in different study zones showed that, the zone-1 had significant and positive correlation with zone-2 (Spearman Rank Correlation: r^s =1.0, P< 0.1, n = 5), zone-3 (r^s = 0.90, P< 0.5, n = 5), zone-4 (r^s = 0.90, P< 0.5, n = 5) and zone-6 (r^s = 0.90, P< 0.5, n = 5, See Table 17). Again, the analysis of mean density of molluscan species in six different study zones showed that, the mean density of *Indopianorbis exustus* and *Bellamy bengalensis* was higher in Zone1-Zone3, whereas, the species *Bellamy bengalensis* was higher in Zone4-Zone6 (see Figure–47 a, to f).

Table-16**:** Density (d/m²) and distribution of Molluscan species in deepor beel Ramsar Site.

Species	Density/m²					
	Z_1	Z_2	Z_3	Z_4	Z_5	Z_6
Pila globosus	26.40	8.00	6.40	8.00	4.80	18.40
Bellamy bengalensis	51.20	40.80	88.40	106.00	14.40	190.80
Lymnea acuminate	31.60	11.60	8.40	8.80	7.20	24.00
Indopianorbis exustus	63.20	79.20	71.60	41.60	5.60	58.00
Corbiculus assamensis	0.00	0.00	0.40	0.00	0.00	0.80

Table-17. Diversity index of Molluscan species in Deepor beel ecosystem in Various study zones.

Sample Zone	Margalef's D Index	SimpsonsD Index	Shannon Wiener Index		Total Individuals
			H'	Variance	
Zone-1	0.444	3.587	1.327	0.0001	862
Zone-2	0.458	2.4	1.025	0.0007	698
Zone-3	0.590	2.355	0.991	0.9913	876
Zone-4	0.447	2.065	0.935	0.9345	822
Zone-5	0.591	3.313	1.285	1.285	160
Zone-6	0.549	2.097	0.995	0.9948	1460
Total Individuals					4878

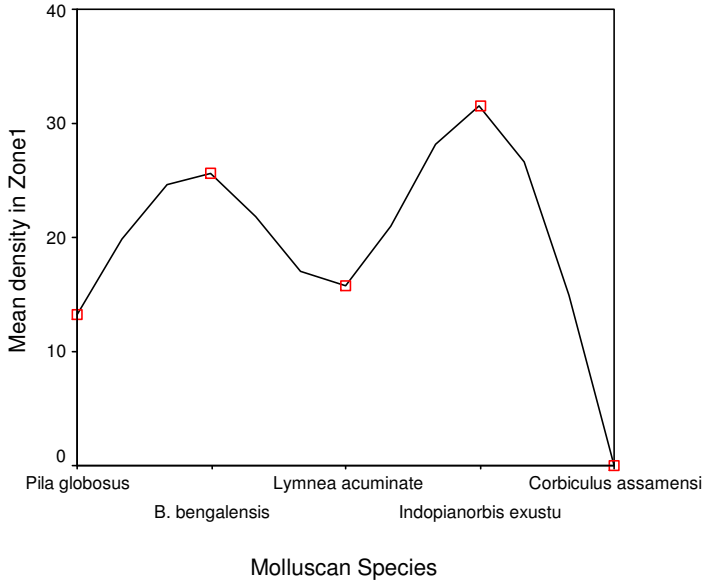


Figure-47 (a)

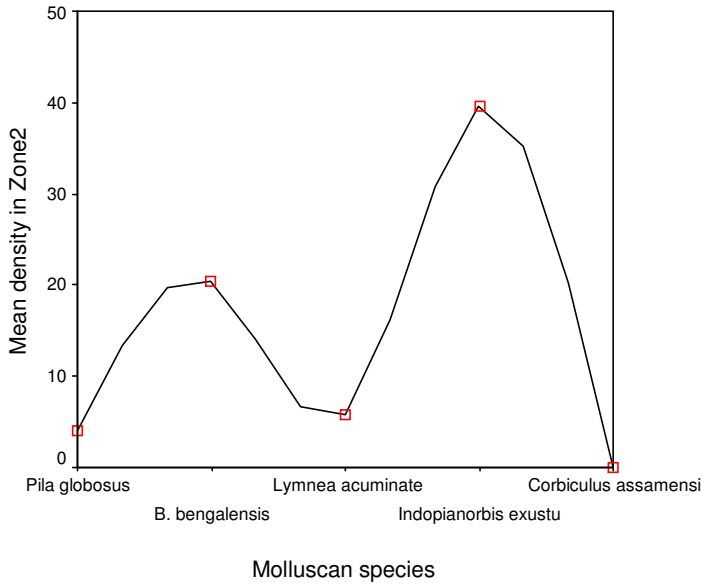


Figure-47 (b)

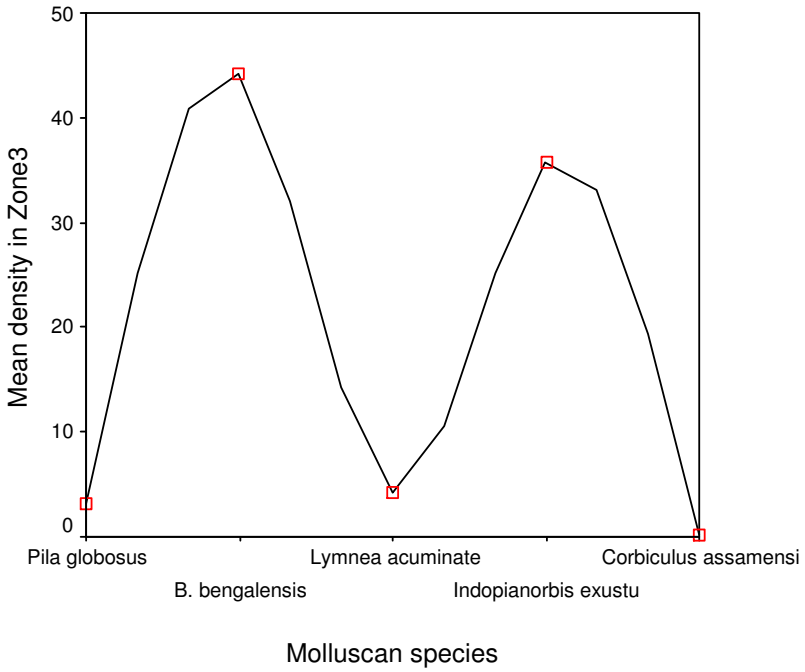


Figure-47 (c)

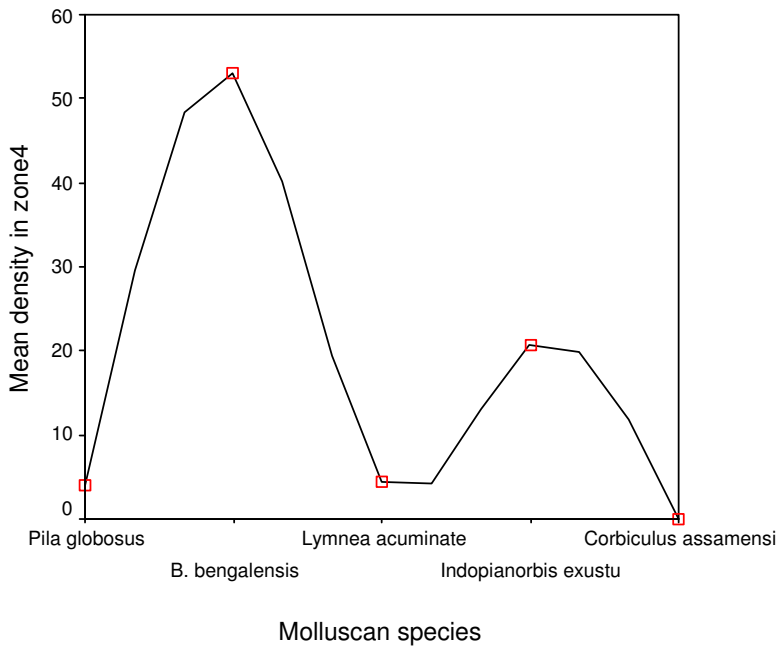


Figure-47 (d)

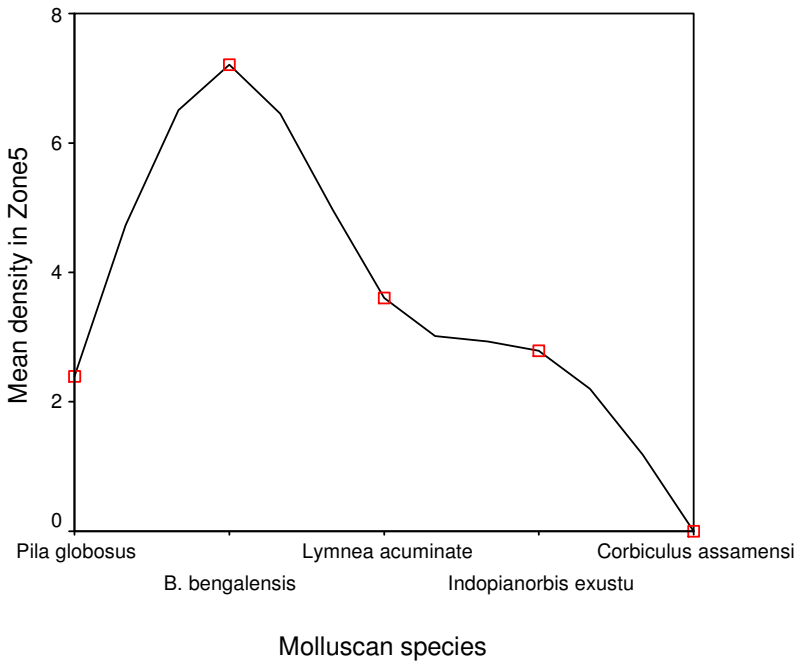


Figure-47 (e)

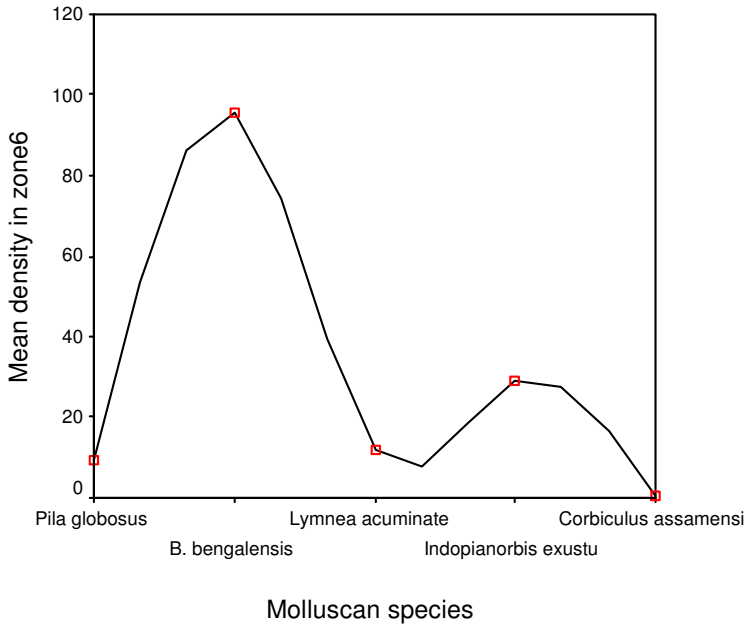


Figure-47 (f)

Figure- 47: Mean density (no/m^2) of Molluscan species in six different study zones of Deepor beel Ramsar Site (**a**=Zone-1; **b**=Zone-2; **c**= Zone-3; **d**=Zone-4; **e**= Zone-5; **f** = Zone-6).

4.9. ZOOPLANKTONS

4.9.1. DISTRIBUTION & ABUNDANCE

The study sampled altogether 64 Zooplankton species belonging to 6 different planktonic groups, in deepor beel Ramsar site, those were such as Protozoa (16 species), Rotifera (30 species), Cladocera (11 species), Copepoda (4 species), Ostracoda (2 species) and Insecta (1 species) (see Appendix-VII). Among the entire 6 Plankton groups, the group Protozoa was the dominant group (based on abundance) in the ecosystem, followed by Rotifera, Cladocera and Copepoda. But the number of species was highest in Rotifera group, which represented total of 30 species (see Appendix-VI and Fig-54). The group Ostracoda and Insecta was the lowest abundant group within the beel ecosystem (see Figure-48). Again, the peak abundance season of all the plankton was retreating monsoon and less abundant during Pre-monsoon season (see Fig. 48). Again the abundance of different zooplankton species were found to be varies among different groups in different seasons of the year. Among protozoan, the species *Paramacium ssp.* was the dominant species and peak was found during retreating monsoon (see Figure- 49), whereas, in Cladoceran, the species *Moina brachiata* was the dominant species and peak was found during winter season (see Figure-51). Again, in Copepoda, the *Nauplius* larvae dominate the group, which peak was found during retreating monsoon. The second dominant species of this group were the *Diaptomus sp.* and *Mesocyclops ssp.* (see Figure- 49). The *Centrocypris* sp. was the dominant Ostracoda (see Figure-52) and the lone Insecta, the *Chaoborus* sp. was found to distributed throughout the year, but the peak season was found during retreating monsoon (See Figure-53).

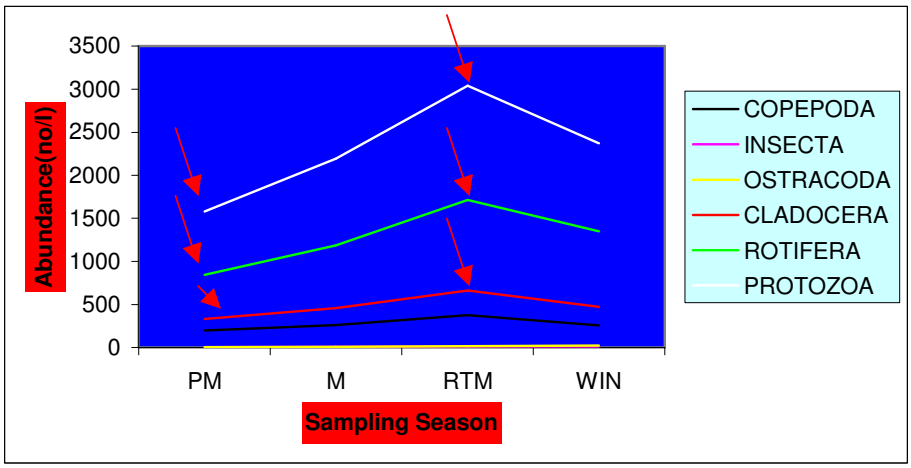


Figure: 48: Seasonal variation of abundance pattern in different Zooplankton groups in Deepor beel Ramsar site.

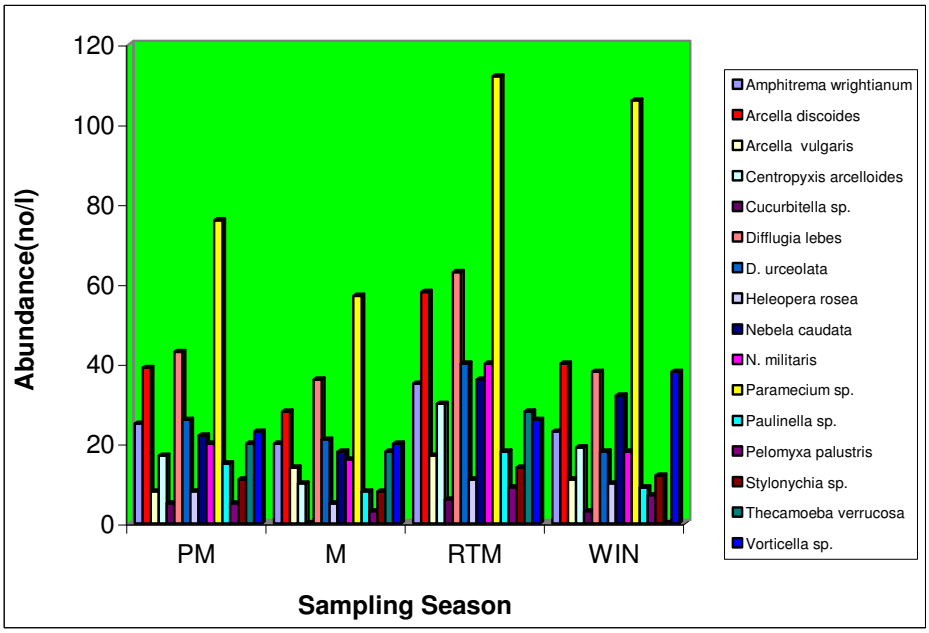


Figure-49: Seasonal variation in distribution and abundance of different **Protozoan species** in Deepor beel Ramsar Site.

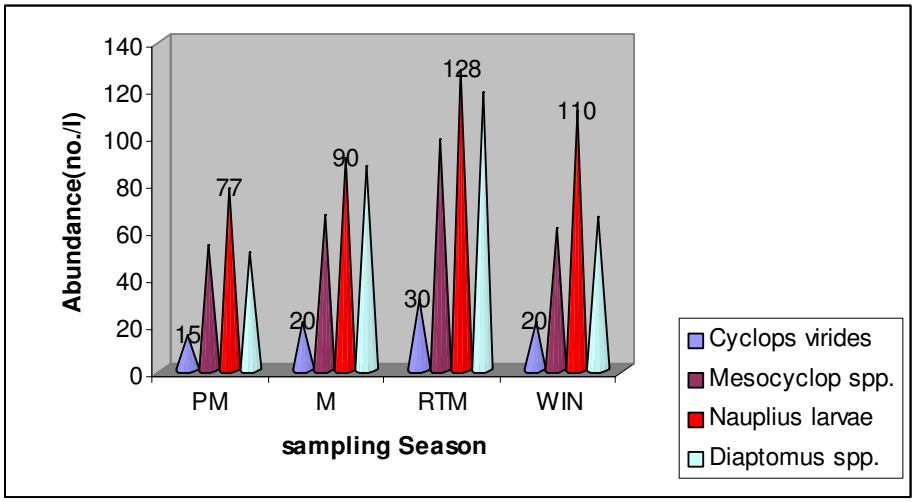


Figure-50: Seasonal variation in distribution and abundance of different **Copepodaspecies** in Deepor beel Ramsar Site.

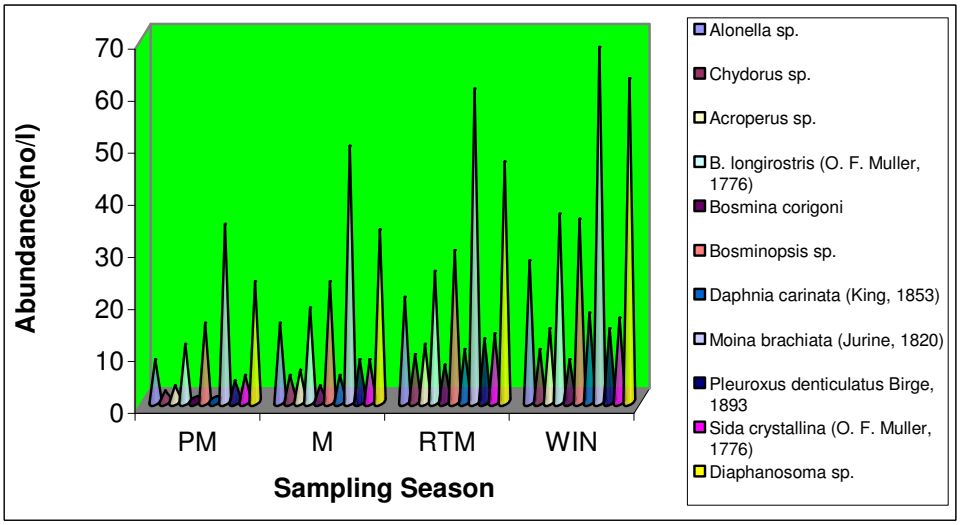


Figure-51: Seasonal variation in distribution and abundance of different **Cladoceran species** in Deepor beel Ramsar Site.

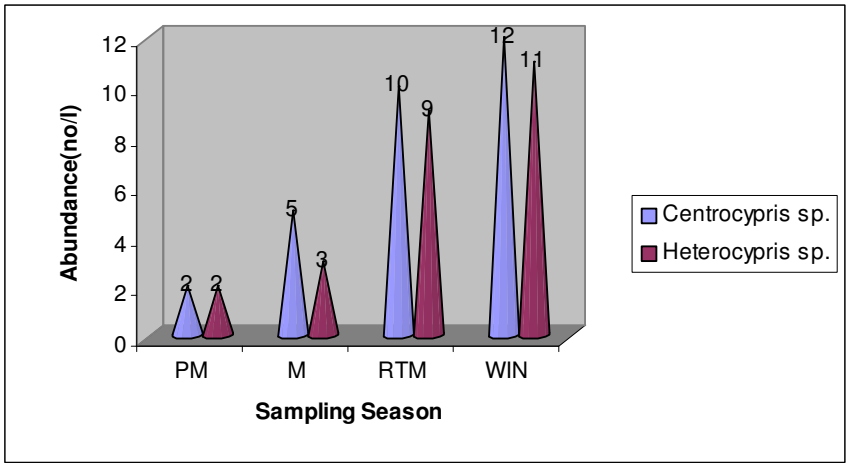


Figure-52: Seasonal variation in distribution and abundance of different **Ostracoda species** in Deepor beel Ramsar Site.

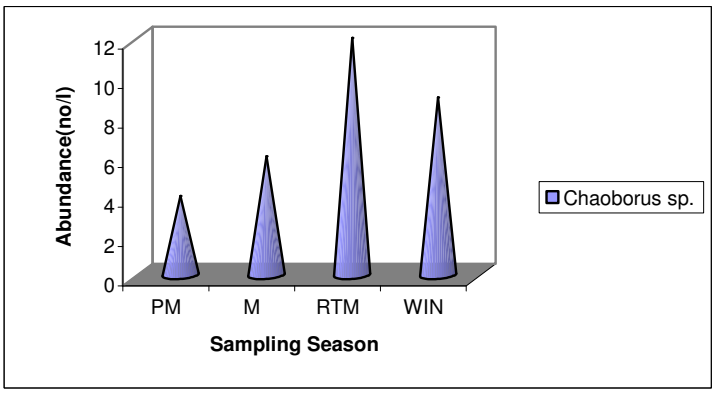


Figure-53: Seasonal variation in distribution and abundance of different **Insecta species** in Deepor beel Ramsar Site.

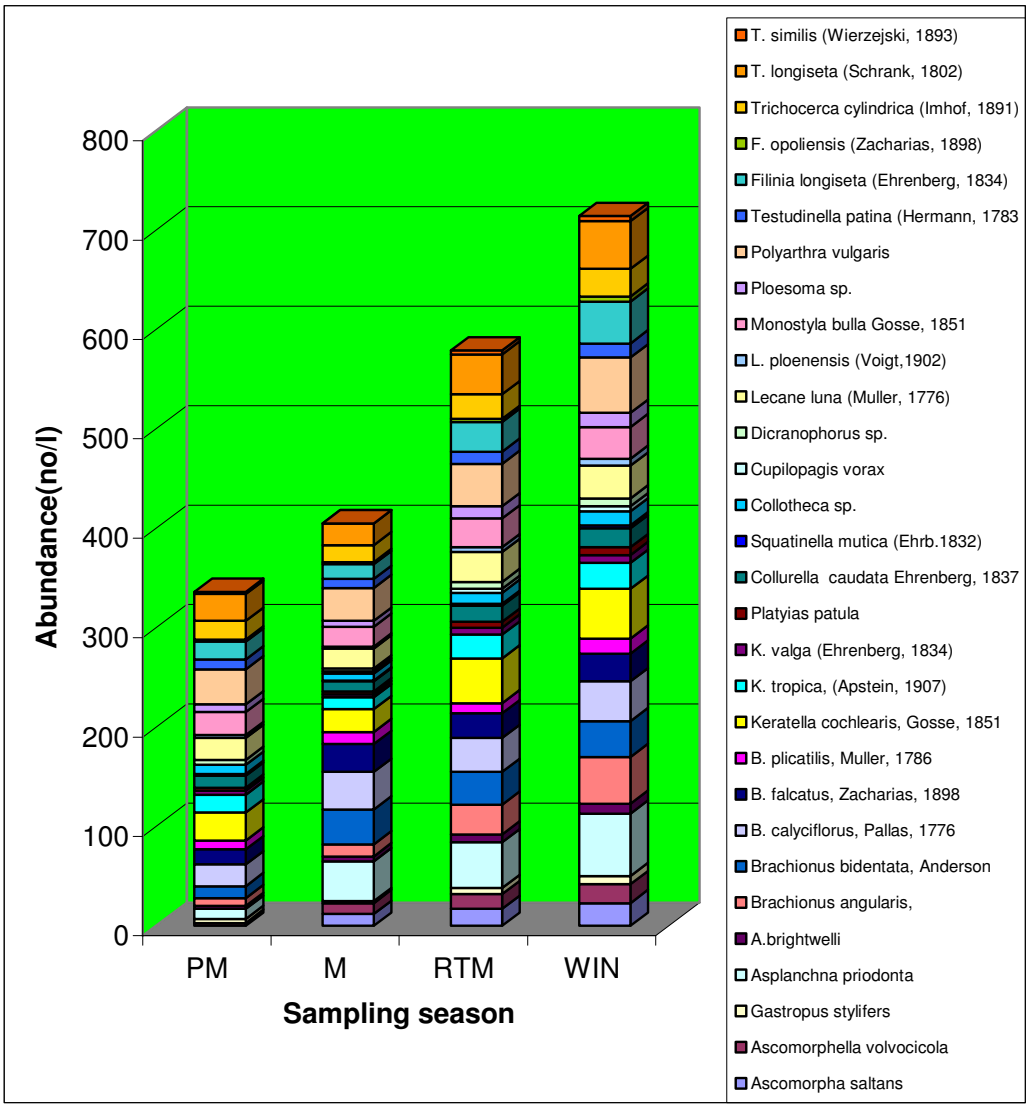


Figure-54: Seasonal variations in distribution and abundance of distribution and abundance of different **Rotiferan species** in Depor beel Ramsar site.

4.9.2. DIVERSITY

4.9.2.a. TOTAL DIVERSITY

The study sampled altogether 5605 numbers of planktons, belonging to 64 species of entire groups. Analysis of species diversity indexes showed that, the Shannon-Wiener Index of diversity was significantly higher during winter and retreating monsoon season than Pre-monsoon season at 5% level (**SIM**: **WIN**: H=3.84, **PM**: H= 3.7, Δ=0.138; **RTM**: H= 3.80, Δ=-0.10; pair wise randomization test based on 10,000 resample, bootstrap methods was used; see Table-18). Again, the analysis of Simpsons D diversity indexes showed that, the plankton diversity of winter season was significantly higher than the **PM**, **M**, and **RTM** at 5% level (**SIM**: **WIN** = 37.51 **PM** = 31.6, Δ= -6.0; **M** = 31.10, Δ = 6.45; see Table-18). The

results of the separate analysis of species diversity indices of six different plankton groups were as follows: -

Table-18: Diversity Index for total Zooplankton species in deepor beel Ramsar Site.

Sample	Shannon Wiener		Simpsons D Index	Margalef's D	Total Counted	Total species
	H	Variance H				
PM	3.7	0.0006851	31.6	8.533	1007	60
M	3.712	0.0006501	31.06	8.67	1137	62
RTM	3.789	0.0003917	33.48	8.425	1769	64
WIN	3.838	0.0003315	37.51	8.34	1692	63

1. Protozoa

Study sampled altogether 1672 individuals of Protozoan planktons belonging to 16 species in deepor beel Ramsar site (see Appendix-VII). Comparison of **Margalef's D index of** Diversity between seasons showed that, the diversity was higher during **PM** season and **RTM** than **winter (WIN)** season at 5% level (**MD**: **PM**: M_D=2.55, **WIN**: M_D=2.55, Δ=-0.19; **RTM**: H′ = 2.382, Δ= -0.163; Table-19). Whereas, the **SimpsonsD index** of diversity was more during monsoon and pre-monsoon season than winter at 5% level (**SIM**: **M** = 10.36, **Win** = 7.99, Δ=-2.37; **PM** =10.34, Δ= -2.35; Table-19). Again the **Shannon-Wiener** index **of diversity** showed that, the diversity of **PM** was higher than the **WIN** season at 5% level (**SI: PM:** H′ = 2.524, **WIN:** H′ = 2.364, Δ= -0.16).

Table-19: Diversity Index of **Protozoa** species in Deepor beel Ramsar Site.

Sample	Shannon Wiener		Simpsons D	Margalef'sD	Total Counted	Total species
	H	Variance H				
PM	2.524	0.0013	10.34	2.545	363	16
M	2.488	0.0015	10.36	2.481	282	15
RTM	2.526	0.0009	10.34	2.382	543	16
WIN	2.364	0.0020	7.99	2.353	384	15

2. Rotifera

Study sampled altogether 2068 individuals belonging to 30 Rotiferan species in Deepor beel Ramsar Site (see Appendix-VII; Table-19). The analysis of species diversity indices between sampling seasons showed that, the Shannon-Wiener Index of diversity was significantly higher during winter season (**WIN**) than pre-monsoon (**PM**) and mosoon season (**M**) at 5% level (**SI**: **WIN**: H = 3.18, **PM**: H = 3.07, Δ= -0.11; **M**: H = 3.06, Δ= 0.12). Analysis of Simpsons D index of diversity showed that, the diversity of **RTM** season was significantly higher than **PM** and **M** at 5% level (**SIM**: **RTM** = 21.3, **PM** = 19.03, Δ = 2.27; **M** = 18.46, Δ = 2.57; see Table-20 Figure-54)

3. Cladocera

Study sampled altogether 793 individuals of Cladoceran belonging to 10 species throughout the year (see **Appendix-VII**; Table-21). Analysis of Shannon-

Wiener Index of diversity showed that, the diversity of Cladoceran species was significantly higher during **WIN** and **RTM** season than **PM** and **M** season at 5% level (**SI: WIN**: H′ = 6.92, **PM**: H′ = 1.78, Δ = -0.31; **RTM: SI:** H′ **=** 2.068, Δ = 0.30; Table-21; **Figure-51**). Analysis of SimpsonsD index of diversity also showed that, the diversity of **WIN** and RTM season was significantly higher than the **PM** at 5% level (**SIM**: **WIN**= 6.94, **PM** = 5.10, Δ = 1.89; RTM =6.73, Δ = 0.68). The Margalef′sD index of diversity was also significantly higher during **WIN** season than **RTM** at 5% level (M_D: WIN= 1.60, RTM= 1.76, Δ = -0.17; See Table-21). Study also found that, the diversity of Insecta, Ostracoda and Copepoda had no differences between seasons.

Table-20: Diversity Index of **Rotifera** species in Deepor beel Ramsar Site.

Sample	Shannon-Wiener Index		Simpsons D	Margalef′sD	Total count	Total Species
	H	Variance H				
PM2	3.072	0.001482	19.03	4.806	399	29
M2	3.063	0.001296	18.46	4.818	411	30
RTM2	3.176	0.0007119	21.3	4.702	590	31
WIN2	3.18	0.0005872	21.04	4.552	728	31

Table-21: Diversity index of **Cladoceran** species in Deepor Beel Ramsar Site

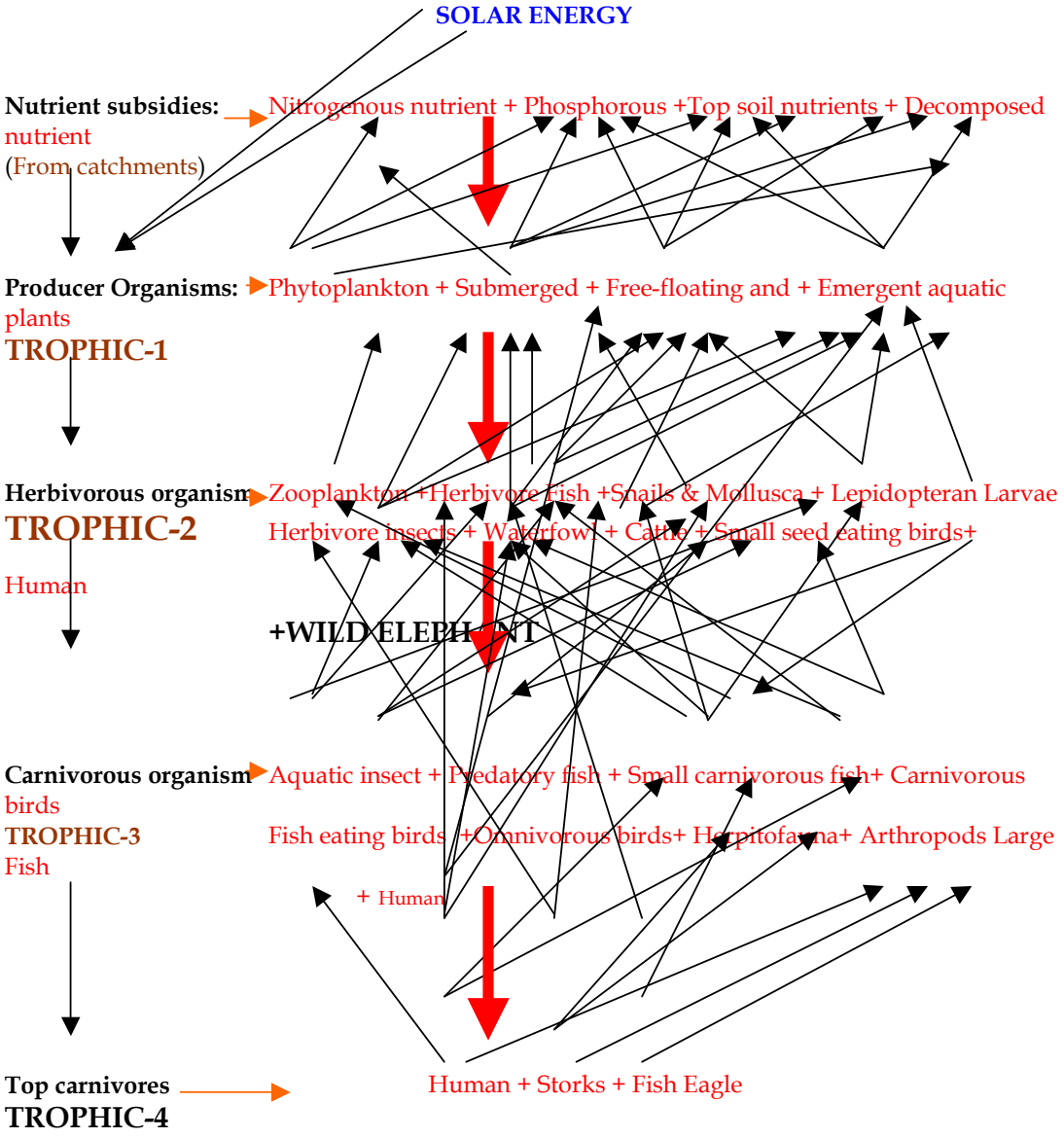
Sample	Shannon Wiener		Simpsons D	Margalef′sD	Total Counted	Total species
	H	Variance H				
PM3	1.776	0.005171	5.055	1.514	102	8
M3	1.983	0.003379	6.042	1.759	167	10
RTM3	2.068	0.001964	6.73	1.654	231	10
WIN3	2.082	0.001393	6.94	1.584	293	10

4.10. FOOD CHAIN & FOOD WEB

Deepor beel Ecosystem is a self-sustaining and self-sufficient ecosystem, which has continuous interactions with neighboring community and as well as biotic and a-biotic components. It is a dynamic ecosystem, and the energy drain and energy subsidy takes places annually. The catchments area of the wetland has continuously supplying the earth reservoir of phosphorous and other nutrient elements to the beel during monsoon through runoff and hill streams water. The excess nutrient of the system is draining by two basic ways such as (1) flowing of water through the channels and by biotic agents. Energy sink is also experienced at the deep parts of the ecosystem. Two channels energy flows are active in the system such as grazing food chain and detritus food chain. The microorganism growing in the systems are played an important role for the self-purification of the ecosystem, which is very dynamic in the deepor beel. The chemical pollution caused by the Oil refinery and nearby Industries is clearing annually by the self-purification process. Again, considerable amounts of nutrient materials come from the catchments area (in the form of top soil of hill forest) during monsoon, owing to heavy destruction of adjacent forest ad anthropogenic causes and resulting of fertile wetlands. The natural productivity of the wetland is very high, owing to diverse habitat types from shallow to deepwater ecosystem. Phytoplankton, Submurged plants, free-floating and emergent vegetations are the major producers, whereas, various herbivorous micro and

macro organisms are the components of Trophic level-II. Human being is placed in various positions of the food chain and food web locations, indicating the importance of deepor beel ecosystems in human livelihood. Human being, egales and storks are the three biotic agents which act as an active Top carnivore level of the ecosystem,s grazing food chain (See Figure-55, for details food chain and food web of the deepor beel ecosystem).

Fig-55: Food Chain and Food Web diagram of deepor beel Ramsar site based on gathered Data.



5.0. DISCUSSION

Deepor beel is a potential wetland within northeastern regions of India, who continuously suppots large numbers of wetland biota including 232 birds 24 mammals, 61 fish, 32 reptiles and 11 amphibian species etc. even though heavy destruction process of habitat is continuing since last few years. The wetland

supports considerable numbers of **IUCN** critically endangered, endangered and threaded species of the wildlife fauna in the beel ecosystem indicating the high potentiality of the wetland for biodiversity conservation. Again, the beel supports 18 globally threaten and 35 numbers of endangered vertebrate species under Indian Wildlife Protection Act, 1972. The beel also supported two numbers of critically endangered vulture species. The remarkable findings of the beel are the high abundance of large whistling Teal, and Asiatic wild Elephants. The beel continuoiusly supports the large herbivorous species inhabitat in Rani-Garbhanga reserve forest. In recent survey, it is come in to light that, the numbers of Asian Open bill stork population is increasing in compare to ten years before, when only occasional sighting records was available (Mid Winter water Fowl census report; personal observations). Although, the numbers of migratory bird populations are declining owing to extensive human disturbances, the overall diversity of avian species has not changed remarkably. Among migratory waterfowl, the wader population has declined drastically during survey period. This was happened, owing to extensive earth cutting, and heavy human disturbances in the shallow parts of the wetland and shoreline area of the beel.

5.1. CONSERVATION THREATS

The intensive fishing activities, prevalent throughout day and night, causes a considerable disturbance and also there is heavy hunting pressure on water birds. Large numbers of water birds are netted illegally during the winter months for consumption and as well as sale in the local markets. The adjacent forests areas are being felled to supply timber for the sawmills, leading to heavy erosion, which in turn is causing rapid siltation in the beel. Pesticides and fertilizers are widely used on adjacent agricultural land, and enter the lake in runoff. The fertilizers have accelerated eutrophication, and infestation with *Echhornia crassipes* is now becoming a serious problem. Settlements and permanent agriculture are steadily encroaching on the wetland and reducing the extent of the marsh vegetation. The recent digging of the beel bed in number of locations in northern boundaries and heavy enchroachments for settlements caused tremendous loss of wetland area. The major threats are summarized as follows:

(1) The construction of railway lines along the southern and eastern boundary of the deepor beel divide the deepor into two half, which leading to expedite the wetland enchroachments.

(2) Establishment of Industrial Estate within the northern and western periphery of the beel leading to pollution of the beel.

(3) Recent establishment of the City garbage center at the heart of eastern boundary at the Boragoan area leading to heavy pollution of the deepor beel water and spreading water borne contagious diseases and disease vectors.

(4) Large-scale encroachment of the government and as well as private owned low lying area of the deepor beel Ramsar site for settlements, institutions, and business shops, causes tremendous threats to the wetland ecosystem in immediate future.

(5) Govement allotments of the Ramsar site land to the private party for building construction tremendously threatened the ramsar for extinction.

(6) Growing Brick making factories and extensive soil cutting within the beel ecosystem proper threatened the ramsar site.

(7) Hunting, trapping and killing of wild birds and mammals within and adjoining areas of deepor beel also threatened the overall biodiversity.

(7) Unplanned fishing practice without controlling mesh size and using water pump etc.;

5.2. PAST CONSERVATION HISTORY

The individuals and NGO's had taken a mass movement of conservation initiation of deepor beel during 1989, when construction of railway line has been proposed by the Govement Authority. At the begining, a group of conservationist headed by Mr. P. K. Saikia (who initiate the programme by appealing the people by news paper), M. Raj and Mr. A. N. Bezbaruah (General Secretary, INSTER) and organized a press conference and gave appeal to the people of India for the conservation of Deepor Beel by publishing and distributing leaflets. With a good response from the people of Assam, the movement was started and ultimately Govement Authority formed a Deepor beel Committee headed by Mr. H. N. Das, earlier Chief Secretary of Assam. The Committee Chairman was Dr. A. K. Goswami, the then Member Secretary, Assam State Advisory Committee on Science & Technology, Science Technology & Environment Department, Dispur and other members were Dr. P. K. Bora, Dr. S. K. Sarma, Dr. D. C. Goswami, Dr. P. C. Bhattacharjee, Mr. Achintya N. Bezbaruah, Mr. P. Lahon and Mr. M. K. Sharma etc. The committee was successful to change the earlier route through middle of the Deepor Beel to southern periphery of the beel. This was the fist step to protect the beel, but no such developmental activities to protect the deepor beel initiated along the railway line, such as plantation programme along the railway line and stopping encroachment and allotment of settlement within the beel area. The Forest Department was able to declared only 4.14 Sq. Km. Area into Bird Sanctuary due

to intervention of the Govement authority. Later, a numbers of local political leaders intervened the issue of conservation and turned it to a political issue and the peoples were motivated for anti-conservation movement. The Conservation movement of Deepor beel was the fist issue of wetland conservation in Assam and has a great value that creates numbers of NGOS in Assam, like Aarnayak nature's Club.

5.3. MEASURES PROPOSED

(i) SPECIFIC MEASURES

The newly constructed railway line through the southern periphery of the Deepor beel is a major threat to the ecosystem particularly in view of encroachments, forest destruction, erosion and disturbance. Therefore the following measures should be taken: -

(a) Halting of trains should be avoided within the boundary of Deepor beel.

(b) Land adjacent to the railway line should be kept free from any encroachment.

(c) To keep the noise level down, suitable plantations should be raised on either side of the Railway line.

(d) Any form of settlements should not be allowed within the low-lying parts of the deepor beel Ramsar site (North, South, east and western boundary), even if it is a private owned land.

(e) Further destruction of adjacent hilly forest should not be allowed (destroyed during construction of railway line) and eco-restoration should be initiated immediately;

(ii) GENERAL MEASURES PROPOSED

(a) The existing area of the Deepor beel Bird Sanctuary should be increase from 4.14 km^2 to 40 km^2 by adding the highland and low-lying area up to Assam Engineering College Campus and Assam Police Radio Organization Campus in the Northern boundary and Garbhanga Reserve Forest in the Southern Bank. This additional inclusion of land will help to support the nesting and roosting habitat of most of the residential and migratory waterfowl as well as small and large mammals. Again it will helps to protect the entire bird sanctuary from various threat such as forest cutting, brick factory and stone quarries etc.

(b) The effectiveness of the Deepor beel system as a storm water detention basin for Guwahati city should be preserved and the increasing pressure of

storm runoff from the city to the beel should be lessened through creation of additional storage capacity in the naturally depressed areas within the greater metropolitan area.

(c) Considering the urgency for solution of the waterlogging problem of the city, the use of the Deepor beel system as a storm water reservoir should receive high priority and other uses of the beel system should be so planned as to compatible with this overriding objective.

(d) The city runoff, which includes sewage, should be treated before being discharged into the Deepor beel system.

(e) The Plantation Programme should be started in highland within the Bird sanctuary to create breeding ground of residential waterfowl.

(f) Plantation Programme along the Railway line by the side of the Deepor Beel Bird Sanctuary should be initiated immediately. The Plant species such as Bamboo species- *Bambusa tulda, B. balcooa, B. arundinacea* and tree species such as Kadam- *Anthrocephalus kadamba,* Simul-*Bombax ceiba etc should be included.*

(g) Extensive land cutting, brick making factory and industrial development should be stopped within and surrounding areas of the Deepor beel.

(h) All forms of government settlements should be stopped immediately and area should be preserved as a natural landscape.

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Appendix: I: Avifaunal Diversity and their proportional abundance during 2004 and 2005 at Deepor beel.

English Name	Family/Scientific Name	Proportional abundances of birds	
		Dry Season	Wet Season
Little Grebe	***Podicepedae*** *Tachybaptus ruficollis*	0.86	0.14
Great Crested Grebe	*Podiceps cristatus*	0.95	0.05
Red-Necked Grebe	*P. grisegena*	1.00	0.00
Spot-billed Pelican	***Pelicanidae*** *Pelecanus philippensis*	1.00	0.00
Little Cormorant	***Phalacrocoracidae*** *Phalacrocorax niger*	0.94	0.06
Indian Cormorant	*Phalacrocorax fuscicollis*	0.75	0.25
Great Cormorant	*Phalacrocorax carbo*	0.70	0.3
Darter	***Anhingidae*** *Anhinga melanogaster*	0.81	0.19
Little Egret	***Ardeidae*** *Egretta garzetta*	0.60	0.40
Intermediate Egret	*Mesophoyx intermedia*	0.80	0.20
Cattle Egret	*Bubulcus ibis*	0.73	0.27
Great Egret	*Casmerodius albus*	0.52	0.48
Indian Pond Heron	*Ardeola grayii*	0.63	0.37
Black-Crowned Night Heron	*Nycticorax nycticorax*	0.35	0.65
Grey Heron	*Ardea cinerea*	0.54	0.46
Purple Heron	*Ardea purpurea*	0.58	0.42
Chinese Pond Heron	*Ardeola bacchus*	1.00	0.00
Goliath Heron	*Ardea goliath*	0.00	1.00
Yellow Bitern	*Ixobrychus sinensis*	0.50	0.50
Black Bittern	*Dupetor flavicollis*	0.00	1.00
Cinnamon Bittern	*Ixobrychus cinnamomeus*	0.43	0.57
Little Bittern	*Ixobrychus minutus*	0.14	0.86
Black Stork	***Ciconidae*** *Ciconia nigra*	1.00	0.00
Black-necked stork	*Ephippiorhnychus asiaticus*	1.00	0.00
Asian Openbill	*Anastomus oscitans*	0.76	0.24
Lesser Adjutant Stork	*Leptoptilos javanicus*	0.51	0.49
Greater Adjutant Stork	*Leptoptilos dubius*	0.16	0.84
Fulvous Whistling-Duck	*Dendrocygnidae* *Dendrocygna bicolor*	0.90	0.10
Lesser Whistling-Duck	*Dendrocygna javanica*	0.77	0.23
Bar-Headed Goose	***Anatidae*** *Anser indicus*	0.13	0.87
Ruddy Shelduck	*Tadorna ferruginea*	0.78	0.22
Gadwall	*Anas strepera*	0.95	0.05
Mallard	*Anas platyrhynchos*	1.00	0.00
Spot-billed Duck	*Anas poecilorhyncha*	0.87	0.13
Common Teal	*Anas crecca*	0.99	0.01
Garganey	*Anas querquedula*	0.92	0.08
Northern Pintail	*Anas acuta*	0.95	0.05

Northern Shoveler	*Anas clypeata*	0.98	0.02
Red-crusted Pochard	*Rhodonessa rufina*	1.00	0.00
Common Pochard	*Aythya ferina*	0.98	0.02
Ferrruginous Poachered	*Aythya nyroca*	1.00	0.00
Baer's Pochard	*A. baeri*	0.98	0.02
Tufted Duck	*Aythya fuligula*	1.00	0.00
Cotton Pygmy-Goose	*Nettapus coromandelians*	0.14	0.86
White-breasted Waterhen	***Rallidae*** *Amaurornis phoenicurus*	0.33	0.67
Water Cock	*Gallicrex cinerea.*	0.81	0.19
Common Moorhen	*Gallinula chloropus*	0.70	0.30
Water Rail	*Rallus aquaticus*	1.00	0.00
Common Coot	*Fulica atra*	0.88	0.12
Pheasant-tailed Jacana	***Jacanidae*** *Hydrophasianus chirurgus*	0.74	0.26
Bronze-winged Jacana	*Metopedius indicus*	0.58	0.42
Paintd Snipe	***Rostratulidae*** *Rostratula bengalensis*	0.73	0.27
Common Snipe	***Scolopacidae*** *Gallinago gallinago*	0.60	0.40
Solitary Snipe	*Gallinago solitaria*	0.76	0.24
Eurasian Woodcock	*Scolopax rustica*	0.93	0.07
Wood Sandpiper	*Tringa glareola*	1.00	0.00
Common Redshank	*Tringa totanus*	1.00	0.00
Spotted Redshank	*Tringa erythropus*	1.00	0.00
Common Greenshank	*T. nebularia*	1.00	0.00
Nordman Greenshank	*T. guttifer*	1.00	0.00
Common Sandpiper	*Actitis hypoleucos*	0.63	0.37
Marsh Sandpiper	*T. stagnatalis*	1.00	0.00
Little Stint	*Calidris minuta*	0.50	0.50
Common Ringed Plover	***Charadridae*** *Charadrius hiaticula*	1.00	0.00
Little Ringed Plover	*Charadrius dubius*	1.00	0.00
Pacific Golden Plover	*Pluvialis fulva*	1.00	0.00
Red-wattled Lapwing	*Vanellus indicus*	0.61	0.39
Grey-headed Lapwing	*Vanellus cinereus*	0.71	0.29
Northern Lapwing	*Vanellus vanellus*	1.00	0.00
River Tern	***Laridae*** *Sterna aurantia*	0.31	0.69
Black-bellied Tern	*Sterna acuticauda*	0.14	0.86
Whiskered Tern	*Chlidonias hybridus*	0.00	1.00
White-winged Tern	*C. leucopterus*	1.00	0.00
Brown-Headed Gull	*Larus brunnicephalus*	0.79	0.21
Black-headed Gull	*Larus ridibundus.*	0.82	0.18
Mew Gull	*Larus canus*	1.00	0.00
Black-winged Stilt	***Himantopidae*** *Himantopius himantopus*	1.00	0.00
Osprey	***Accipitridae*** *Pandion haliatus*	0.00	1.00
Black Kite	*Milvus migrans*	0.64	0.36
Brahmni Kite	*Haliastur indus*	0.74	0.26

Pallas's Fish Eagle	*Haliaeetus leucoryphus*	0.48	0.52
Grey-headed Fish eagle	*Ichthyophaga ichthyaetus*	1.00	0.00
White-Ramped Vulture	*Gyps bengalensis*	1.00	0.00
Long-billed Vulture	*Gyps indicus*	1.00	0.00
Red-headed Vulture	*Sarcogyps calvus*	1.00	0.00
Crested Serpent Eagle	*Spilornis cheela*	1.00	0.00
Eurasian Marsh-Harrier	*Circus aeruginosus*	1.00	0.00
Pied Harrier	*Crcus melanoleucos*	0.67	0.33
Hen Harrier	*C. cyaneus*	1.00	0.00
Pallied Harrier	*C. macrourus*	1.00	0.00
Montagu's Harrier	*C. pygargus*	1.00	0.00
Shikra	*Accipiter badius*	1.00	0.00
Besra	*Accipiter virgatus*	1.00	0.00
Eurasian Sparrowhawk	*A. nisus*	1.00	0.00
Common Buzzard	*Buteo buteo*	0.67	0.33
Oriental Honey-Buzzard	*Pernis ptilorhyncus*	1.00	0.00
Long-legged Buzzard	*Buteo rufinus*	1.00	0.00
Lesser Spotted Eagle	*Aquila pomarina*	1.00	0.00
Greater Spotted Eagle	*A. clanga*	1.00	0.00
	Falconidae		
Red-necked Falcon	*Falco chicquera*	1.00	0.00
Lesser Kestrel	*Falco naumanni*	1.00	0
Oriental Hobby	*Falco severus*	1.00	0.00
Peregrine Falcon	*Falco peregrinus*	1.00	0.00
	Alcidinidae		
Common Kingfisher	*Alcedo atthis*	0.00	1.00
Blyth's Kingfisher	*Alcedo hercules*	1.00	0.00
Blue-eared Kingfisher	*Alcedo meninting*	1.00	0.00
White-throated Kingfisher	*Halcyon smyrnensis*	0.43	0.57
	Dacelonidae		
Stork-billed Kingfisher	*Halcyon capensis*	0.30	0.70
	Cerylidae		
Pied Kingfisher	*Ceryle rudis*	0.47	0.53
	Passeridae		
Baya Weaver	*Ploceus philippinus*	0.04	0.96
House Sparrow	*Passer domestica*	0.61	0.39
Tree Sparrow	*Passer montanus*	0.65	0.35
Blackheaded Munia	*Lonchura malacca*	0.90	0.10
White-rumped Munia	*Lonchura striata*	0.00	1.00
White Wagtail	*Motacilla alba*	0.69	0.31
Yellow Wagtail	*Motacilla flava*	0.85	0.15
Grey Wagtail	*Motacilla cinerea*	0.66	0.34
Paddyfield Pipit	*Anthus rufulus*	0.85	0.15
Richard's Pipit	*Anthus richardi*	1.00	0.00
Citrine Wagtail	*Motacilla citriola*	0.87	0.13
Rosy Pipit	*Anthus roseatus*	1.00	0.00
Olive-backed Pipit	*A. hodgsoni*	1.00	0.00
	Irinidae		
Golden Fronted Leafbird	*Chloropsis auriforns*	1.00	0.00
Orange Billed Lefbird	*Chloropsis hardwiskii*	0.50	0.50

Eurasian Golden Oriole	***Corvidae*** *Oriolus oriolus*	0.67	0.33
Blck-hooded Oriole	*Oriolus xanthornus*	0.41	0.59
Rufous Treepie	*D endrocitta vagabunda*	0.57	0.43
House Crow	*Corvus splendens*	0.54	0.46
Large-billed Crow	*Corvus macrorhynchos*	0.22	0.78
Black Drango	*Dicrurus macrocercus*	0.67	0.33
Crow-billed Drongo	*Dicrurus annectans*	0.51	0.49
Bronzed Drongo	*Dicrurus aeneus*	0.13	0.87
Spangled Drongo	*Dicrurus hottentottus*	1.00	0.00
Ashy Drongo	*Dicrurus leucophaeus*	0.52	0.48
Lesser Racket-tailed Drongo	*Dicrurus ramifer*	0.39	0.61
Greater Racket-tailed Drongo	*Dicrurus paradiseus*	0.33	0.67
Common Iora	*Aegithina tiphia*	0.33	0.67
Black-naped Monarch	*Hypothymis azurea*	0.33	0.67
Scarlet Minivet	*Pericrocotus flammeus*	0.67	0.33
Large Cuckoo-shrike	*Coracina macci*	0.76	0.24
Ashy Wood Shallow	*Artamus fuscus*	0.96	0.04
Blue Throated Barbet	***Megalaimidae*** *Megalaima asiatica*	0.21	0.79
Coppersmith Barbet	*Megalaima haemocephala*	0.46	0.54
Lineated Barbet	*Megalaima lineata*	0.39	0.61
Golden-throated Barbet	*Megalaima franklinii*	0.26	0.74
Blue-eared Barbet	*Megalaima australis*	0.55	0.45
Great Barbet	*Megalaima viren*	0.50	0.50
Asian Pied Starling	***Sturnidae:*** *Sturnus contra*	0.74	0.26
Common Maina	*Acridotheres tristis*	0.57	0.43
Bank Maina	*Acridotheres giginianus*	0.76	0.24
Jungle Myna	*Acridotheres fuscus*	0.24	0.76
White vented Myna	*A. grandis*	0.37	0.63
Greyheaded Myna	*Sturnus malabaricus*	0.76	0.24
Hill Myna	*Gracula religiosa*	0.78	0.22
Creg Martin.	***Hirundinidae*** *Hirundo rupestris*	1.00	0.00
Barn Swallow	*Hirundo rustica*	0.88	0.12
Northern House Martin	*Delichon urbica*	0.88	0.12
Sand Martin	*Riparia riparia*	0.76	0.24
Nepal House Martin	*Delichon nipalensis*	1.00	0.00
Red-Whiskered Bulbul	***Pycnonotidae*** *Pycononotus jocosus*	0.67	0.33
Red-Vented Bulbul	*Pycononotus cafer*	0.68	0.32
Blue-tailed Be-eater	***Meropidae*** *Merops philippinus*	0.10	0.90
Green Bee-eater.	*Merops orientalis*	0.57	0.43
Chestnut-headed Bee-eater	*Merops leschenaulti*	0.76	0.24
Purple Sunbird	*Necterinidae: Nectarinia asiatica*	0.00	1.00
Purple-throated Sunbird	*Necatrinia seperata*	0.55	0.45
Mrs Gould's Sunbird	*Aethopyga gouldiae*	0.71	0.29
Crimson Sunbird	*Aethopyga siparaja*	0.50	0.50
Plain Flowerpacker	*Dicaeum concolor*	0.50	0.50

Common Tailor Bird	***Sylvidae*** *Orthotomus sutorius*	1.00	0.00
Jungle Babbler	*Turdoides striatus*	1.00	0.00
Marsh Babbler	*Pellorneum palustre*	0.40	0.60
Black Redstart	***Muscicapidae*** *Phoenicurus ochruros*	1.00	0.00
Oriental Magpie Robin	*Copsichus saularis*	1.00	0.00
Blue Whistling Thrush	*Myophonus horsfieldii*	0.26	0.74
Dark-sided Flycatcher	*Muscicapa sibirica*	1.00	0.00
Blackheaded Shrike-Babbler	*Pteruthius rufiventer*	1.00	0.00
Bluethroat	*Luscinia svecica*	1.00	0.00
Pied Buchchat	*Saxicola caparata*	1.00	0.00
Common Stonchat	*Saxicola torquata*	1.00	0.00
Verditer Flycatcher	*Eumyias thalassina*	1.00	0.00
Grey-breasted Prinia	***Cisticolidae*** *Prinia hodgsonii*	0.27	0.73
Great Tit	***Paridae*** *Parus major*	0.50	0.50
Graybacked Shrike	***Lanidae*** *Lanius tephronotus*	0.75	0.25
Indian Roller	***Coracidae*** *Coracias benghalensis*	0.38	0.62
Dollar Bird	*Eurystomus orientalis*	0.50	0.50
Oriental Skylark	***Alaudidae*** *Alauda gulgula*	0.84	0.16
Crested Lark	*Galirida cristata*	0.47	0.53
Rufous-winged Bushlark	*Mirafra assamica*	1.00	0.00
Common Swift	***Apodidae*** *Apus apus*	1.25	0.20
House Swift	*Apus affinis*	1.00	0.00
Alpine Swift	*Tachymarptis*	1.00	0.00
Fork-tailed Swift	*Apus pacificus*	1.00	0.00
Asian Palmswift	*Cypsturus balasiensis*	0.11	0.89
Rose-ringed Parakeet	***Psittacidae*** *Pisttacula karmeri*	0.60	0.40
Alexandrine Parakeet	*Psittacula eupatria*	0.83	0.17
Blossom-headed Parakeet	*Psittacula roseata*	0.78	0.22
Vernal Hanging Parrot	*Loriculus vernalis*	0.75	0.25
Spotted Dove.	***Culombidae*** *Streptopelia chinensis*	0.52	0.48
Red Collared Dove	*Streptopelia tranquebarica*	1.00	0.00
Eurasian Collared Dove	*Streptopelia decaocto*	1.00	0.00
Oriental Turtle Dove	*Streptopelia orientalis*	1.00	0.00
Emerald Dove	*Chalcophaps indica*	1.00	0.00
Yellow-footed Green Pigeon.	*Treron phoenicoptera*	0.48	0.52
Wedge-tailed Green Pigeon	*Treron sphenura*	0.89	0.11
Orange-breasted Green Pigeon	*Treron bicincta*	0.92	0.08
Black-rumped Flameback.	***Picidae*** *Dinopium bengalensis*	0.63	0.37
Yellow-crowned Wood pecker	*Dendrocopos mahrattensis*	0.71	0.29
Grey-capped Pygmy Woodpecker	*Dendrocopos canicapillus*	0.71	0.29

Greater Coucal	***Centropodidae*** *Centropus sinensis*	0.13	0.88
Lesser Caucal	*Centropus bengelensis*	0.50	0.50
Asian Koel	***Cuculidae*** *Eudynamys scolopacca*	0.50	0.50
Common Hawk Cuckoo	*Hierococcyx varius*	0.76	0.24
Hodgson's hawk Cuckoo	*Hierococcyx fugax*	0.42	0.58
Large Hawk Cuckoo	*Hierococcyx sparverioides*	0.67	0.33
Indian Cuckoo	*Cuculus micropterus*	0.67	0.33
Oriental Cuckoo	*Cuculus canorus*	0.80	0.20
Lesser Cuckoo	*Cuculus poliocephalus*	0.50	0.50
Chestnut-winged Cuckoo	*Clamator coromandus*	0.50	0.50
Pied Cuckoo	*Clamator jacobinus*	0.50	0.50
Plantative Cuckoo	*Cacomantis merulinus*	0.50	0.50
Drongo Cuckoo	*Surniculus lugubris*	0.50	0.50
Green-billed Malkoha	*Phaenicophaeus tristis*	0.50	0.50
Common Hoopoe	***Upopidae*** *Upupa epops*	0.33	0.67
Spotted Owlet	***Strigidae*** *Athene brama*	0.22	0.78
Collared Scops Owl	*Otus bakkamoena*	0.63	0.38
Asian Barred Owlet	*Glaucidium cuculoides*	0.62	0.38
Jungle Owlet	*Glaucidium radiatum*	0.69	0.31
Great Eared Nightjar	*Eurostopodus macrotis*	0.54	0.46
Brown Fish Owl	*Ketupa zeylonensis*	0.67	0.33
Tawny Fish Owl	*Ketupa flavipes*	0.53	0.47
Barn Owl	*Bubo bubo*	0.22	0.33

Appendix:II. Diversity and relative density of various fish species at deepor beel Ramsar sites during study period.

Local Name	*Scientific Name*	Relative Density (No/km²)
Bahu	*Catla catla*	20.20
Mirika	*Cirrhinus mrigala*	233.40
Bhangon.	*Cirrhinus reba*	91.80
Malimash	*Labeo calbasu*	19.60
Kurhi	*Labeo gonious*	13.60
Rohu	*Labeo rohita*	139.20
Hafu mash.	*Osteobrama cotio cotio*	32.00
Puthi	*Puntius conchonius*	121.80
Puthi	*Puntius chola.*	120.80
Puthi	*Puntius phutonio*	43.80
Morothi.	*Puntius sarana*	31.00
China Puthi.	*Puntius javanicus.*	130.40
Silver carp	*Hypophthalmichthys molitrix*	124.00
Dighol Daricona	*Parluciosoma daniconius*	58.40
Daricona.	*Bracidri verio*	158.00
Phul Doricona	*Brachidenio rario*	7.20
Common carp.	*Cyprinus carpio*	116.80
Grass carp.	*Ctenopherongodon idella*	61.20
Selcona mash.	*Salmostoma bacalia*	9.40
Moa mash.	*Ambllypharyngoden mola*	122.80
Lowpotia	*Danio deverio*	131.00
Batia.	*Nemacheilus botia*	107.40
Kukur Batia.	*Botia derio*	110.00
Ari	*Aorichthys seenghala*	168.00
Shingora.	*Mystus bleekeri*	105.80
Singora.	*Mustus cavasius*	11.20
Katia Singora.	*Mystus tengara*	4.20
Lalua Singora.	*Mystus vittatus*	110.80
Bordua mash	*Psudotrophis aetheronoides*	38.00
Pabha.	*Ompok bimaculatus*	11.40
Pabha.	*Ompok pabda*	25.60
Barali.	*Wallago attu*	36.80
Besa.	*Eutropiichthys vacha*	194.60
Magur	*Clarias batrachus*	225.40
Singi.	*Heteropneustes fossilis*	103.80

Kakila	*Xenentodon cancila*	98.60
Kuchia.	*Monopterus cuchia*	35.20
Sanda (elongated)	*Chanda nama*	84.20
Chanda	*Chanda ranga*	122.40
Sanda (Red)	*Pseudombasis ranga*	40.40
Vedhengi	*Nandus nandus*	314.80
Japani Kawoi.	*Oreochromis mossambica*	47.20
Pati mutura.	*Glossogobius giuris*	87.80
Kawoi.	*Anabas testudineus*	133.40
Khalihana.	*Colisa fasciatus*	85.40
Khalihana.	*Colisa lalia*	14.20
Randhoni mash	*Badis badis*	20.60
Sal.	*Channa marulius*	90.80
Goroi	*Channa punctutas*	239.80
Sol	*Channa striatus*	26.80
Senga.	*Channa gachua.*	87.20
Sengeli	*Channa sp*	58.60
Rukumoi Senga	*C. barca*	20.2
Bami.	*Mastacembelus armatus*	1.20
Tura	*Macrognathus pancalus*	38.00
Kai-bai	*Macrognathus sp.*	117.80
Ganga toup.	*Tetraodon cutcutia*	58.60
Chital	*Notopterus chitala*	7.20
Kandhuli.	*Notopterus notopterus*	20.60
Koarati Massh.	*Gudusia chapra*	89.20
Aleng	*Rasbora alenga*	30.5

*__Bold__ letters indicates the exotic species

Appendix-III: Diversity and Relative density of Reptilian fauna In Deepor beel Ramsar Site, observed during study period.

Common Name	Family/Scientific Name	Relative Density
SNAKES		
	Typhlopidae Merrem, 1820	
Diard's Worm Snake	*Typhlops diardii* Schlegel, 1839	0.08
	Pythonidae Fitzinger, 1826	
Burmese Python	*Python molurus bivittatus* Kuhl, 1820	1.12
	Colubridae Oppel, 1811	
Indian Rat Snake (Mochura)	*Ptyas mucosa* (Linnaeus 1758)	0.72
White-barred Kukri Snake	*Oligodon albocinctus* (Cantor, 1839)	0.72
Painted Bronzeback tree snake (Karsola)	*Dendreaphis pictus* (Gmelin, 1789)	0.96
Common Wolf Snake	*Lycodon aulicus* (Linnaeus, 1758)	2.32
Checkered Keelback (Dhura sap)	*Xenochrophis piscator* (Schneider, 1799)	1.76
Red-necked Keel back	*Rhabdophis subminiatus* (Schlegel, 1837)	0.8
Striped Keel back	*Amphiesma stolatum* (Linnaeus, 1758)	0.96
Himalayan Mountain Keel back	*Amphiesma platyceps* (Blyth, 18540)	0.08
Common Smooth-scaled Water Snake	*Enhydris enhydris* (Schneider, 1799)	1.2
	Elapidae Boie, 1827	
Monocled Cobra	*Naja kaouthia* Lesson, 1831	1.52
Common Krait	*Bungarus caeruleus* (Schneider, 1801)	0.48
LIZARDS	***Agamidae***	
Khasi Hill Garden Lizard	*Calotes jerdoni* Gunther, 1870	0.32
Indian Garden Lizard	*Calotes jversicolor* (Daudin 1802)	3.44
	Gekkonidae	
Ticticky House Gecko	*Hemedactylus frenatus* Schlegal 1836	1.52
Assam Greyish-brown Gecko	*Hemedactylus garnoti* Dum. And Bibr. 1836	11.68
Common India Takshak	*Gekko gecko* (Linnaeus 1758)	0.48
Spotted House Gecko	*Hemedactylus brooki* Gray, 1845	12.48
	Scincidae	
Common Indian Skink	*Mabuya carinata* (Schneider, 1801)	1.76
Bronzy Grass Skink	*Sphenomorphys maculatus* (Blyth, 1853)	1.68
Dotted Garden Skink	*Riopa punctata* (Linnaeus, 1766)	1.84
	Anguidae	
Indian Monitor	*Varanus bengalensis* (Linnaeus, 1758)	1.04
Indian Water Monitor	*V. salvator* (Laurenti, 1768)	0.32
TORTOISES and *TURTLES*		
Indian Roofed Terrapin	*Kachuga tecta* (Gray)	2.8
Smith's Terrapin	*Kachuga smithi* (Gray)	0.32
Khasi Hill Terrapin	*K. sylhetensis* (Jerdon)	0.24
Spotted Black Terrapin	*Geoclemys hamiltoni* (Gray)	0.16

Brahmini Terrapin	*hardella thurgii (Gray)*	0.24
Indian Mud Turtle	*Lissemys punctata* Lacepede	1.2
Peacock Soft-shell	*Trionix hurum* (Gray)	1.84
Chitra Turtle	*Chitra indica* (Gray)	0.8

Appendix–IV. Comprehensive list of Mammalian Fauna in deepor beel Ramsar site.

Sl. No.	English Name	Order/Family/ Scientific Name	Total sampled
1	Himalayan Hoary-bellied Squirrel	**Order: Rodentia** ***Fam: Sciuridae*** *Callosciurus pygerythrus*	106
2	House Shrew	***Fam: Soricidae*** *Suncus murinus*	7
3	Pigmy shrew	*Suncus etruscus*	2
4	House Mouse	***Fam: Muridae*** *Mus musculus*	34
5	Large Bandicota -rat	*Bandicota indica*	.
6	Lesser bandicota-rat	*Bandicota bengalensis*	47
7	Black Rat	*Rattus rattus*	14
8	Chinese Porcupine	***Fam: Hystricidae*** *Hystrix brachyura*	3
9	India Hare	**Order: Lagomorpha** ***Fam: Leporidae*** *Lepus nigricollis*	12
10	Indian Elephant	**Order: Proboscidea** ***Fam: Elephantidae*** *Elephas maximus*	110
11	Domestic Pig	**Order: Artiodactyla** ***Fam: Suidae*** *Sus sp.*	346
12	Barking Deer	***Fam: Cervidae*** *Muntiacus muntjak*	3
13	Sambar	***Cervus unicolor***	1
14	Domestic Buffalo	***Fam: Bovidae*** *Bubalus sp.*	2217
15	Domestic Cattle	*Bos sp.*	8895
16	Domestic Goat	*Capricornis sp.*	1512
17	Indian flying fox.	**Order: Chiroptera** **Fam: *Pteropodidae*** *Pteropus gigenteus*	20
18	Long-winged tom bat	***Fam: Emballonuridae*** *Taphozous longimanus*	4
19	Rhesus Macaque	**Order: Primate Fam: Cercopithecidae** *Macaca mulatta*	42
20	Asiatic Jackel	**Order: Carnivora** ***Fam: Canidae*** *Canis aureus*	12

21	Common Otter	*Fam: Mustelidae* *Lutra lutra*	1
22	Large India Civet	*Fam: Viverridae* *Viverra zibetha*	18
23	Small India Civet	*Viverricula indica*	19
24	Indian Mongoose	***Fam: Herpestidae*** *Herpestes javanicus*	3

Appendix-V: Distribution and abundance of Arthopodan species in deepor bell Ramsar site in six different study zones.

Species/Family	**Z1**	**Z2**	**Z3**	**Z4**	**Z5**	**Z6**
Order: Insecta						
Fam: *Ochteridae*						
Ochterus marginatus marginatus (Latreille)	2	10	0	3	20	1
Fam:Corixidae						
Corixa spp.	2	8	1	2	26	3
Micronecta quadristrigata Breedin	2	8	1	2	12	3
Fam: Notonectidae						
Enithares ciliata(Fabricius)	1	5	1	2	8	0
Anisops bouvieri Kirkaldy	0	1	1	2	2	0
Fam: Nepidae						
Nepa apculata	2	8	1	2	14	3
Empoasca fabae	2	8	1	2	8	3
Sphaerodema maletus	2	8	1	2	9	3
Eusar eoris	0	1	0	0	2	0
Ranatra filiformis Fabricius	2	10	0	0	120	6
Fam: Belostomatidae						
Belostoma indica	0	2	0	2	8	1
Belostoma sp.	0	1	0	0	4	1
Fam: Gerridae						
Limnogonus nitidus (Mayr)	0	1	0	0	4	0
Neogaris parvula (Stal)	0	0	0	0	2	0
Family: Vellidae						
Rhagovelia nigricans (Burmeister)	0	0	0	0	1	0
Fam: Gomphidae						
Nymph (*Ictinus rapax*)	0	4	0	0	3	1
Nymph(*I. Anglosus*)	0	1	0	0	10	1
Nymph (*Gomphidia nigrum*)	2					
Family: Agridae						
Nymph (*Bayadera indica* (Selys))	0	4	0	0	3	1
Nymph (*B. hyalina* Selys)	0	1	0	0	10	1
Nymph (*Anisopleura lestoides* Selys)	0	4	0	0	3	1
Nymph (*A. comes* Selys)	0	1	0	0	7	1
Nymph (*Neurobasis chinensis*(Linn.))	0	2	0	0	4	1
Nymph (*Rhinocypha unimaculata* Seys)	0	1	0	0	5	1
Family: *Agrionidae*						
Nymph (*Agrion splendens*)	0	1	0	0	5	1
Class: Crustacea (Crabs)						
Fam: Paratelphusidae						
Paratelphusa eduntula Alcock	5	12	8	1	16	45
P. guirini, A. M. Edw.	35	40	7	0	230	1
Fresh Water Prawn						
Fam: Palinomidae						
Macrobrauchium dayanum	200	400	200	10	560	50
M. assmensis	250	400	300	0	760	50
M. lamerrie	200	350	150	23	560	50

Appendix: VI: Distribution and abundance of Molluscan species in Deepor beel Ramsar site.

Species	Z1	z2	z3	z4	z5	z6
Pila globosus	132	40	32	40	24	92
Bellamy bengalensis	256	204	442	530	72	954
Lymnea acuminate	158	58	42	44	36	120
Indopianorbis exustus	316	396	358	208	28	290
Corbiculus assamensis	0	0	2	0	0	4

Appendix-VII: Proportional abundance of Zooplankton species in deepor beel during different seasons of the year.

Species/Group	Proportional Abundance			
	PM	M	RTM	WIN
PROTOZOA				
Amphitrema wrightianum	0.24	0.19	0.34	0.22
Arcella discoides	0.24	0.17	0.35	0.24
Arcella vulgaris	0.16	0.28	0.34	0.22
Centropyxis arcelloides	0.22	0.13	0.39	0.25
Cucurbitella sp.	0.36	0	0.43	0.21
Difflugia lebes	0.24	0.2	0.35	0.21
D. urceolata	0.25	0.2	0.38	0.17
Heleopera rosea	0.24	0.15	0.32	0.29
Nebela caudata	0.2	0.17	0.33	0.3
N. militaris	0.21	0.17	0.43	0.19
Paramecium sp.	0.22	0.16	0.32	0.3
Paulinella sp.	0.3	0.16	0.36	0.18
Pelomyxa palustris	0.21	0.13	0.38	0.29
Stylonychia sp.	0.24	0.18	0.31	0.27
Thecamoeba verrucosa	0.3	0.27	0.42	0
Vorticella sp.	0.21	0.19	0.24	0.36
ROTIFERA				
Ascomorpha saltans	0	0.23	0.33	0.44
Ascomorphella volvocicola	0.06	0.23	0.31	0.4
Asplanchna priodonta	0.06	0.25	0.29	0.4
A.brightwelli	0.12	0.19	0.31	0.38
Brachionus angularis	0.08	0.12	0.31	0.48
Brachionus bidentata	0.1	0.3	0.28	0.31
B. calyciflorus	0.16	0.28	0.25	0.3
B. falcatus	0.16	0.29	0.26	0.29
B. plicatilis	0.2	0.26	0.22	0.33
Collotheca sp.	0.22	0.17	0.27	0.34
Collurella sp.	0.21	0.18	0.28	0.33
Cupilopagis vorax	0	0.18	0.36	0.45
Dicranophorus sp.	0.22	0.13	0.3	0.35
Filinia longiseta	0.17	0.14	0.29	0.4
F. opoliensis	0.17	0.17	0.25	0.42
Gastropus stylifers	0.2	0.1	0.3	0.4
Keratella cochlearis	0.19	0.16	0.31	0.34
K. tropica	0.23	0.15	0.3	0.33
K. valga	0.18	0.14	0.32	0.36
Lecane luna	0.21	0.19	0.29	0.31
L. Ohiensis	0.18	0.12	0.29	0.41
Monostyla bulla	0.22	0.19	0.28	0.31
Platyias patula	0.15	0.15	0.3	0.4
Ploesoma sp.	0.2	0.15	0.3	0.35
Polyarthra vulgaris	0.21	0.2	0.26	0.34
Squatinella mutica	0.25	0.13	0.25	0.38
Testudinella patina	0.22	0.2	0.27	0.31
Trichocerca cylindrica	0.21	0.19	0.28	0.31

T. longiseta	0.2	0.16	0.29	0.35
T. similis	0.18	0	0.36	0.45
Acroperus sp.	0.09	0.18	0.32	0.41
CLADOCERA				
Alonella sp.	0.11	0.21	0.29	0.39
Bosmina corigoni	0	0.17	0.39	0.44
B. longirostris	0.12	0.2	0.28	0.4
Bosminopsis sp.	0.15	0.23	0.28	0.34
Chydorus sp.	0.08	0.19	0.35	0.38
Daphnia carinata	0	0.16	0.31	0.53
Diphanosoma sp.	0.14	0.2	0.28	0.38
Moina brachiata	0.16	0.23	0.28	0.32
Pleuroxus denticulatus	0.11	0.21	0.32	0.37
Sida crystallina	0.12	0.19	0.31	0.38
OSTRACODA				
Centrocypris sp.	0.07	0.17	0.34	0.41
Heterocypris sp.	0.08	0.12	0.36	0.44
COPEPODA				
Cyclops virides	0.18	0.24	0.35	0.24
Diaptomus spp.	0.16	0.27	0.37	0.2
Mesocyclop spp.	0.19	0.24	0.35	0.22
Nauplius larvae	0.19	0.22	0.32	0.27
INSECTA				
Chaoborus sp.	0.13	0.19	0.39	0.29

Fajervariya synhendense.

Fajervariya piari.

Rana leptoglosus

Fajervariya terai

Polypedates leucomystes

Polypedates leucomystes

Rana typiensis

Mycrohyla ornata

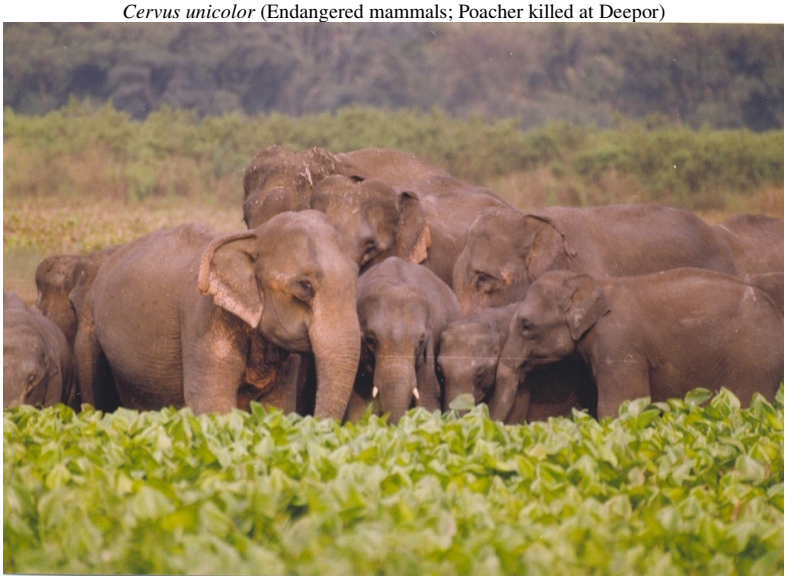
Plate: Amphibian species of Deepor beel ramsar sites.

PLATE-1: Endangered, IUCN threatened and Globally threatened Higher Animals of Deepor beel Ramsar Site (all threatened animals are not included here).

Rana tytleri (IUCN RDB species)

Leptoptilos dubius (Globally Endangered Species

Cervus unicolor (Endangered mammals; Poacher killed at Deepor)



Elephus maxmus (Elephant herd foraging at Deepor)

Plate: II. *Wallago attu* Captured at Deepor beel

(A) Community fishing

(B) people returned to home after fishing

(C) Big Common Carp (8 kg wt.)

Plate:IIa. Local people Collected various fish from Deepor beel during Winter(Community Fishing)