GENERAL CONSIDERATION

By the time human being stepped into the 21st century, a large part of human population had moved away from nature and created a new ecosystem called urban ecosystem with the establishment of different type of concrete structures (Clergeau *et al.*, 1998). Vadodara is one of the metro city of the Gujarat State in India, that has several urban and non- urban microhabitats. This city provides good habitat for several common as well as native species of birds. The birds being one of the important biological marker (Koskimies, 1989) are the main component in the present study.

Chapter I, includes bird diversity of nine different terrestrial habitats categorized under Disturbed (DA), Moderately Disturbed (MD) and Undisturbed areas (UD) with reference to human activities. The species richness, density (D), Shannon-Wiener index (H'), evenness (E) and abundance (%) of avifauna of these nine different terrestrial habitats were considered. From total birds, observed some species considered as common birds and few other species considered under the threats of urbanization were considered for their densities and distribution. The densities of common birds like Blue Rock Pigeon (*Columba livia*), Rose-ringed Parakeet (*Psittacula krameri*), Common Myna (*Acridotheres tristis*) and Black Kite (*Milvus migrans*) were significantly high at Disturbed Areas (DA) and Moderately Disturbed areas (MD) but very low at Undisturbed Areas (UD). It was noted that among these Blue-rock Pigeon ranked first in the list of "Urban exploiters". Moreover the

density of House swift (*Apus affinis*) was significantly high at the area that has old type of housing pattern where they could get place to nests. Further, it was observed that these were several other species of birds like House Crow (*Corvus splendens*), Large-Billed Crow (*Corvus macrorhynchos*), Bank Myna (*Acridotheres ginginianus*), Brahminy Starling (*Sturnus pagodarum*) and House Sparrow (*Passer domesticus*) which were very common in recent past now have a very patchy distribution in the city and may under the threat of extinction of urbanization if care is not taken. Crows and Bank Myna were seen around water bodies, House sparrow around old housing patterned as well as near water and Brahminy starling in small gardens having moderate human disturbances. This indicated that urbanization favoured the density of common birds called "Urban exploiters" whereas gardens, vegetation as well as water bodies in urban area supported diverse native communities of birds. **Chapter II** included diversity of birds around the urban ponds (PS). Among the three ponds Species richness was significantly high at Lal baug Pond (LP) which has gardens with plenty of vegetation. However, density of birds was significantly high at Gotri Pond (GP) surrounded by residential area mainly due to urban exploiter the Blue Rock Pigeon (*Columba livia*). Diversity of birds was significantly high at LP as well as at Harni Pond (HP). Harni pond was also surrounded by the residential areas, industries as well as undisturbed patch of land. Evenness of birds was almost same at all the three ponds. The Blue Rock Pigeon, House crow, Bank myna, Common myna were very common with higher densities around three ponds. Moreover, densities of Rose-ringed

Parakeet, Pond heron and Cattle egret were moderate compared to urban exploitors. Besides, Long-billed Crow, House sparrow, Little cormorant, House swift, Brahminy Starling and Black kite were found in low densities around the pond. This indicated that urban ponds surrounded by large trees and with submergent and emergent vegetation and garden supported more native species of birds whereas disturbed ponds with less vegetation mainly supported "urban exploiters". Thus, in urban areas the ponds with diverse micro habitats inside the water and surrounding it are vulnerable and need protection for conservation of native species.

Food and shelter are the two basic necessities for all the living organisms. It is a fact that availability of food, shelter and nesting places can affect the population size (Perrins and Birkhead, 1983; Welty and Baptista, 1988). All these needs were provided to some species of birds in urban areas with varied magnitude. **Chapter III** discussed feeding guilds and roosting niches available for birds in urban microhabitats. The birds were categorized in to seven different groups: Graminivore, Omnivore, Carnivore, Insectivore, Frugivore, Birds of prey and Nectarivore. Graminivorous birds mainly included pigeons. In urban areas they were more common in DA and at PS compared to MD and UD. Several pigeon feeding spots were common in these DA and PS providing easily available food with concrete structures that provided highly secured shelter.

Next favourable feeding guilds in Vadodara were omnivorous and carnivorous mainly observed around ponds (PS). The density of frugivorous birds was high

at moderately disturbed areas as well as at LP that have plenty of vegetation. The density, out of two species of Birds of prey the Black Kite was high at DA and MD. Only two species of nectarivorous birds were observed during study period. They were not observed at CA which had minimum vegetation but they were present at other areas having flowering trees.

Large trees provided roosts to many species of birds like Parakeets, Common myna, Black Kite and Crows. Several roosts were present in urban city like Vadodara. Roosting flocks of the city, among resident species, were Rose-ringed Parakeets, Common Myna, House Crow, Large-billed Crow and migratory species like Rosy Starling with highest density of about 40,000 individuals. Urban habitat with diverse vegetation, small gardens and easy supply of food in Vadodara provide nesting and roosting places for large number of birds.

PART II

The wetlands are habitats at the interface between terrestrial and aquatic ecosystems that make them inherently different from, yet highly dependent on both (Mitsch & Gosselink, 1986). This study was a comparative study of avifauna of two water bodies, Savli Pond (SVP) being influenced of human disturbances due to urbanization and another without any human disturbances or pressures of urbanization the Jawala Irrigation Reservoir (JIR) which is only 1 kilometer away from the Savli town. Both the water bodies had similar climatic conditions. It is well known that urbanization or human disturbances affect both the terrestrial as well as aquatic habitats by degrading the .quality of its

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components. Ponds or any other water bodies exhibit a wide range of ecological, social and aesthetic values (Gledhill *et al.*, 2005). Over consumption, misuse, pollution, *etc.* degrades the quality of water bodies. High amounts of nutrients are unloaded into water bodies from human settlements via sewage (Khan and Ansari, 2005) or other industrial wastes. Hence, in this part of study included three chapters with annual as well as seasonal comparison of the avifaunal and plankton diversity as well as physico-chemical properties of water from two water bodies. The study was carried out to know the direct or indirect effects of the quality of water on the birds. **Chapter IV** included the seasonal variations in diversity of birds and categorized further as terrestrial and water birds. Moreover, correlation of density of birds and abiotic factors of water was carried out. From the results obtained it was evident that SVP supported residential terrestrial as well as water birds. The densities of common birds, "Urban exploiters" like Pigeon, Common Myna, Parakeet, Pond heron, Cattle egrets, Crows *etc.* were high around SVP as compared to the JIR. Whereas JIR supported more migratory water birds. Further, bird density was correlated with abiotic factors, showed significant negative correlation with the temperature, Nitrate and Nitrite at SVP and significant positive correlation with the pH, alkalinity and calcium hardness at JIR. These results indicated that the seasons, abiotic factors as well as anthropogenic pressures all together influenced the density as well as species richness of birds. The urban ponds provided diverse food in the form of additional unpredictable resources and shelter in form of buildings, houses and electric poles attracting mainly urban exploiters. However

irrigation reservoir with few trees and agricultural land provided habitat for migratory species.

Chapter V included the diversity of plankton in two water bodies. The known groups of plankton were I Phytoplankton; two groups of crustaceans: II Brachiopodes and III Copepods; and Group IV Rotifers. The density and the species richness of plankton were higher at SVP the due to high organic input in the form of cattle shed runoff and urban wastes. Rotifer are the indicators of the pollution whose density as well as species richness were high at SVP. The rotifers are known to play significant role in the food chain and biological productions of waters such as aqua pollution indicators or / and water quality monitor (Sladecek, 1983). Among rotifer *Brachionus calyciflorus* the pollution indicator species and *Brachionus plictilis* indicator of hard water were found only at SVP. The density of plankton significantly negatively correlated with the temperature and nitrite at SVP but was positively correlated with oxygen at JIR. It could be concluded that SVP with high anthropogenic pressures high organic inputs provided diverse microhabitat and influencing primary productivity. This probably produce a higher density of plankton. While JIR has very less anthropogenic pressures as well as organic input as compared to SVP and it is surrounded by agriculture matrix that has monoculture type of plantation attracting few species of resident birds.

The qualities of freshwater body exhibit characteristics of the climatic, geochemical, geomorphological and pollution conditions prevailing in the drainage basin and the underlying aquifer (Ramchandra *et al.*, 2002). These

characteristics with natural or manmade changes determine the quality of water (Anonymous, 2003). **Chapter VI** deals with the analysis of physico-chemical parameters. These are: physical and other aggregate properties like Temperature, Total Solids (TS), Total Dissolved Solids (TDS), Total Suspended Solids (TSS), pH, Acidity, Bicarbonate Alkalinity (HCO_3^-), Hydroxyl Alkalinity (OH^-), Salinity, Total Hardness, Calcium Hardness and Magnesium Hardness while Inorganic Non-metallic Constituents like Dissolved Oxygen (DO), Carbon dioxide (CO_2), Chloride (Cl^-), Nitrate (NO_3^-), Nitrite (NO_2^-) and Phosphate (PO_4^{-3}). Among all these parameters Temperature, Acidity, Bicarbonate Alkalinity, Salinity, Hardness, Carbon dioxide and Chloride were high at SVP as compared to JIR. Nitrite, Nitrate and Phosphate varied seasonally at both the water bodies. From the variations over the seasons and differences in between the two water bodies it can be said that though SVP is under anthropogenic pressures its condition has not totally deteriorated. SVP located adjacent to Savli, a developing town, is undergoing anthropogenic changes. If managed properly SVP can be developed and maintained as a healthy ecosystem.

The first part of present study provided the baseline information of distribution patterns of the avifauna of Vadodara city. The second part of study compared the avifauna, plankton and quality of water of two water bodies (SVP and JIR) that are under different level of anthropogenic pressures but same climatic conditions. This study also gave the idea about the urban areas that may needs protection for conservation of native species of the birds as well as areas that

provide roosting sites for huge flocks of few urban exploiters. The second part helped in taking management steps to protect wetlands in urban area and make them healthy ecosystems.

Future aspects of the study:

The results of the present study indicated the need for future work on :

- The pattern of the nesting species in urban areas.

- Co-relation of the different species of the birds with the type of vegetation and effect of building density, vehicular disturbances, human population *etc* on it.

- Analysis of pollution related physico- chemical parameters and their impact on the diverse flora as well as fauna.

On the basis of present study conservation of native species could be done by diluting anthropogenic pressures in various urban microclimates.

- Various steps to protect the native species of birds and conserve them in urban areas be planned.

- Gardens, parks, ponds and natural resources present within the city limits should be protected to conserve the diverse flora as well as fauna of the city and steps should be taken to reduce the population of urban exploiters which may produce same adverse effect on urban ecosystem.