SUMMARY

PART I: Study of Urban Birds

Vadodara (Long 73° 15" 18' E and Lat. 22° 17" 59' N) is one of the metro city of Gujarat State. This city has many small gardens, ponds and patchy vegetation forming varied microhabitats that supported diverse flora and fauna. One of the major fauna of urban area was Birds, the important bioindicators of any ecosystem. The present study deals with the population of birds under varied levels of human disturbances in various microhabitats of Vadodara city.

Chapter I: Terrestrial Bird Population of Vadodara City

This Chapter includes avifauna of nine terrestrial urban habitats that were categorized as Disturbed (DA), Moderately Disturbed (MD) and Undisturbed areas (UD). The population attributed like species richness, density, Shannon-Wiener index (H'), evenness and abundance (%) of avifauna in these areas indicated that in the disturbed areas density of few birds that exploited urban resources successfully was high whereas undisturbed areas still retained native species of birds. On the basis of this, two categories of birds- common birds, the urban exploiters as well as birds under the threats of urbanization were further evaluated for their densities in different areas. The densities of common birds, the urban exploiters 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 area (MD) that supply additional food supplies or shelter but was very low at Undisturbed Areas (UD) that had native vegetation. At UD

species richness was high. The density of House swift (*Apus affinis*) was high in disturbed area with traditional type of housing. This indicated that this species depended on traditional houses where they had nesting spaces.

The birds like House Crow (*Corvus splendens*), Large-Billed Crow (*Corvus macrorhynchos*), Bank Myna (*Acridotheres ginginianus*), Brahminy Starling (*Sturnus pagodarum*) and House Sparrow (*Passer domesticus*) were considered as urban adaptors, that were trying to adapt to urban condition. These species that were very common in past had patchy distribution in the city and in the areas which still provided their basic needs. Crows and Bank Myna were observed around water bodies and House sparrow in the areas with traditional type of housing. Brahminy starlings were found around small gardens where the human disturbances were moderate. The present chapter indicateed that urbanization favoured the density of common birds often designated as "Urban exploiters". Besides, because of the presence of gardens, vegetation as well as concrete structures the bird community were of diverse types in different urban habitats.

Chapter II: Bird diversity around urban ponds

This chapter deals with diversity and density of birds in and around the urban ponds (PS). Species richness was significantly high at Lal baug Pond (LP) being surrounded by garden and plenty of vegetation. However, density of birds was significantly high at Gotri Pond (GP), surrounded by residential area, because of presence of "urban exploiters" like pigeon. Diversity index of birds was significantly high at LP as well as at Harni Pond (HP). Both these habitats had

either emergent or submergent type of vegetation (HP) and trees around pond (LP). Harni pond is also surrounded by residential area. Evenness of birds was significant at all the three ponds. The densities of Blue Rock Pigeon, House crow, Bank myna, Common myna were very high around three ponds. Moreover, densities of Rose-ringed Parakeet, Pond heron and Cattle egret were moderate compared to common birds around ponds but the densities of Long-billed Crow, House sparrow, Little cormorant, House swift, Brahminy Starling and Black kite were low around the ponds. This indicated that urban ponds surrounded by large trees and with submergent, emergent vegetation (HP) and garden (LP) supported more native species of birds whereas disturbed ponds with less vegetation mainly supported "urban exploiters". Thus, urban ponds with diverse microhabitats are vulnerable and need protection to support native species.

Chapter III: Urban birds: their feeding guilds and roosting niches

Food and shelter are two basic necessities of any organism for their survival. This chapter deals with feeding guilds and roosting niches available for birds in urban areas. The species observed in Chapter I and II were categorized into seven different feeding guilds: Graminivore, Omnivore, Carnivore, Insectivore, Frugivore, Bird of Prey and Nectarivore. In the urban areas of Vadodara, Graminivorous birds form the major group of birds that mainly included pigeons. Graminivores were more common in DA and at PS compared to MD and UD. Higher densities of omnivore and carnivore birds were observed around ponds (PS). The density of frugivorous birds was high at moderately disturbed

areas and at LP due to plenty of vegetation. The density of Birds of prey was high at DA and MD. Only two species of nectarivore birds were observed during study period. They were not observed at CA but were present at other areas with flowering vegetation.

Large trees in Vadodara provided roosting sites for some residential species of birds like Parkeets, Common myna, Black Kite and Crows. Three roosts of migratory species, the Rosy starling, with huge densities also occurred in the city. Thus, urban habitats with large trees, small gardens and additional food provided resting and nesting places mainly to urban exploiters.

PART II: A Comparative Study In and Around Two Water Bodies In Relation To Different Anthropogenic Pressures

It is well known that urbanization or human disturbances not only affect the terrestrial habitat but also affect the aquatic habitat by degrading the quality of water. The wetland is a habitat "at the interface between truly terrestrial and aquatic ecosystems, inherently different, yet highly dependent on both" (Mitsch & Gosselink, 1986). This part of study includes a comparative study of two water bodies Savli Pond (SVP) being under the influence of urbanization and high human disturbances and Jawala Irrigation Reservoir (JIR) about 1 kilometer away from the Savli village not affected much due to human activities. Both the wetlands faced similar climatic conditions. Comparison of two wetlands is carried out with respect to avifauna, plankton and physico-chemical characters of water and details are given below.

Chapter IV: Influence of urban pressures on bird diversity

This chapter deals with the differences in densities and diversity of birds at two wetlands under same environmental conditions but different anthropogenic pressures. It deals with the seasonal variations in diversity of total, terrestrial as well as water birds. Further, an attempt has been made to correlate the influence of various abiotic factors of water which might influence diversity and density of birds. The results obtained showed that JIR supported more migratory water birds whereas SVP supported more residential terrestrial as well as water bird species. High densities of common birds "Urban exploiters" like Pigeon, Common Myna,

Parakeet, Pond heron, Cattle egrets, Crows *etc.* were observed in and around SVP when compared to JIR.

When bird density was correlated with abiotic parameters of water, the density of birds 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 various seasons affected the density as well as species richness of birds but no single abiotic parameter influenced bird density at both the ponds. Moreover, urban ponds provided diverse type of food from human sources and shelter in form of buildings, houses and electric poles whereas irrigation reservoir with few trees and agricultural matrix supported birds mainly at the time when huge populations of migratory species were visiting the region during winter. A single abiotic factor may not influence the bird diversity but variations with stages of human activities and seasonal differences affected bird diversity.

Chapter V: Influence of urban pressures on Plankton diversity

The plankton are primary producers as well as primary consumers of the aquatic food chain. This chapter includes a comparative study of seasonal variations in the diversity and density of plankton in two water bodies (Chapter IV). The plankton were categorized into four groups. They were: I Phytoplankton; two groups of crustaceans *i.e.,* II Brachiopods and III Copepods and IV Rotifers. The density and the species richness of plankton were higher at SVP when compared to JIR. This was mainly due to higher densities and species richness of rotifers. Among zooplankton the rotifer play a significant

role in the food chain and biological productions of waters such as aqua-pollution indicators and/or water quality monitors (Sladecek, 1983). Among rotifer, *Brachionus calyciflorus* is a pollution indicator and *Brachionus plictilis* is an indicator of hard water, were found only at SVP. The density of plankton was significantly negatively correlated with the nitrite content and temperature at SVP whereas positively correlated with oxygen at JIR. The data indicated that among the two water bodies SVP, which had anthropogenic pressures and provided various microhabitat, had higher density of plankton, whereas JIR with no disturbances and agricultural matrix around it had lower density of plankton. The quality of water depended on the surrounding habitat such as anthropogenic pressures which directly or indirectly affected the quality of water.

Chapter VI A Comparative study of Physico-chemical parameters of two water bodies

Chapter VI deals with the analysis of physico-chemical parameters of the said water bodies. As Physico-chemical parameters are the indicators of the water quality, the study was carried out to know if any correlation existed between various physico-chemical parameters and diversity of birds. The physico-chemical parameters included, the 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 included

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 in both the water bodies. From the variations over the seasons and differences between the two water bodies it can be said that though SVP was under anthropogenic pressures its condition was not totally deteriorated. It should be managed properly there by it could be developed and retained as a healthy ecosystem.