CHAPTER II

BIRD DIVERSITY AROUND URBAN PONDS

INTRODUCTION:

Human population has always been growing around water sources. In the recent past this growth has taken place at an alarming rate. To solve this problem man has started moving from rural to urban areas and building concrete jungles. With the advancement of technologies, the cities have started expanding and adjoining small towns/villages are brought within the city limits. This process of Urbanization is a long process (Marzluff, 2001) and is considered as one of the major threats to biodiversity worldwide (Ricketts and Imhoff, 2003). Because of urbanization, natural resources like forests are cut and lakes, rivers and ponds are washed away. Even lower level of urban development can cause significant degradation of natural habitats which are sensitive, thereby reducing the level of their functions throughout the system as a whole (Booth and Jackson, 1997). With urban development man had forgotten the nature and its gifts (flora and fauna). However, in recent years the green patches (parks and gardens) and blue spaces (rivers and ponds) in urban areas have gained ecological, social and aesthetic values (Gledhill *et al.*, 2005). Ponds in urban area support diversity of avifauna, especially those that try to adapt to urban conditions. In urban areas too, ponds and the green spaces in their vicinity with the patches of soft spaces; separated from each other by hard surfaces such as roads, pavements and buildings, are subjected to the standard ecological effects associated with fragmentation of habitats (Leather and

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Helden, 2005). These urban ponds, the aquatic habitats, are under great threat due to exploitation, pollution, disturbances and habitat modifications. Knight and Cole (1995) have pointed out that four primary ways of human activities, exploitation, pollution, disturbance and habitat modifications brings impact on animals.

The ponds in urban area are essential as nesting, feeding, roosting and wintering habitats for large number of bird species (Mathias and Moyle, 1992). Birds respond to secondary changes resulting from primary causes and can be monitored relatively inexpensively (Koskimies, 1989). It is known that sensitivity of birds to human disturbance can vary considerably between species (Burger, 1981; Bratton, 1990). Some species get adapted to some forms of disturbances where humans are regularly present without posing an immediate threat of harm (Weller, 1999). However, natural wetlands are still one of the world's most productive ecosystems which support valuable biodiversity, including habitat diversity or heterogeneity (Laishangbam *et al.*, 2005; Ramachandra *et al.*, 2002).

Vadodara is one of the metro cities of Gujarat state having several patches of green spaces of vegetation and small gardens as well as several ponds. Because of infrastructure development, land use changes and urbanization; out of 60 ponds existing in and around old Vadodara a century ago, only 30 ponds are present today (Patel *et. al.*, 2008). In one of these ponds *i.e.* Harni Pond, about 131 species of birds were listed a decade ago by Padate and Sapna (1996).

Because of their high mobility birds react very rapidly to changes in their habitats and hence are considered as one of the most important indicators of health of an ecosystem (Morrison, 1986). During present study the status of avifauna in three selected ponds is considered. These ponds are Lal baug Pond (**LP**) fully covered with vegetation and surrounded by garden as well as residential areas, Gotri Pond (**GP**) covered partially with vegetation but totally surrounded by human habitation and the third Harni Pond (**HP**) with submergent and emergent vegetation as well as pressure of expanding human habitation. Species richness, density, diversity indices like Shanon-Wiener and evenness of birds are evaluated at these three ponds to find out the effects of human disturbances on the birds. Abundance of birds the so called "Urban exploiters" by Kark *et al.*, (2007) are also calculated as these species occur in large numbers in the urban areas. In addition, some species of birds those were common a decade ago but now their number is believed to have declined are also considered.

METHODOLOGY:

The three selected ponds 1. Lal baug Pond (LP) 2. Gotri Pond (GP) and 3. Harni Pond (HP) were visited once in a month from October 2005 to September 2007 in the morning for 2 hours from sunrise. Birds were observed by using 8×50 or 7×35 binoculars and identified using standard books by Ali (2002) and Grimmett *et al.*, (2001). Birds in and around the ponds (water birds as well as terrestrial birds) were counted using transect and / or point count method (Rodger, 1991).

Species richness, diversity indices like Shannon Weiner index, ($H' = \sum$ pilogpi), Evenness (E= H′/ H max) (Kreb, 1985) and Density (D = n/ 2W*L) (Rodger, 1991) were calculated for all the birds and the abundance (%) (Javed and Kaul, 2002) was calculated for the common birds and those whose numbers is believed to have declined (Details are in Chapter I). The data of 3 sites were pooled to consider monthly data. From this monthly data mean% abundance and total monthly density of birds was calculated. The results are expressed as Mean ± SEM where n = 24 (×3). The data is analyzed with the help of ANOVA by using various software packages (SPSS 12 for windows, Graph-pad Prism-3, Ecological Methodology, and Excel). The positive and negative impacts of human disturbances on avifauna are discussed. All together 72 visits were made during the study period. The p value is non significant if $P > 0.05$ (ns), significant if $P < 0.05$ (*), significantly significant (**) if P is < 0.001 and highly significant (***) if $p < 0.0001$.

RESULTS:

Table 2.1 shows approximate vegetation cover and transect area covered around three ponds.

Species richness and density (fig 2.1, Table 2.3)

Total 55 species including both aquatic and terrestrial birds were observed at LP, 47 at GP and 44 at HP (Fig 2.1, Table 2.3) with about 40% common species to all (Table 2.2). The mean species richness was highest at LP (25.87 ± 0.47) followed by HP (21.03 ± 1.11) and GP (18.25 ± 0.67) with highly significant differences ($P<0.0001$, $F_{2, 69}$ 23.14) among the three ponds. However, the density of birds was highest at GP (6635.55 ± 360.11 birds/Km^2) followed by LP (5908.88 ± 466.74 birds/Km^2) and HP (3226.66 ± 323.20 birds/Km^2). The differences in the density were also highly significant ($P<0.0001$, $F_{2, 69}$ 21.40).

Shannon-Weiner index (H') and Evenness (E) (Fig 2.1, Table 2.3)

Species diversities (H') of birds were high at three ponds; 3.51 ± 0.09 at HP, 3.48 ± 0.07 at LP and 2.84 ± 0.10 at GP ($P<0.0001$, $F_{2, 69}$ 18.83). Similarly the evenness were also on higher side with 0.8 ± 0.01 at HP, followed by 0.73 ± 0.01 at LP and 0.66 ± 0.02 at GP ($P<0.0001$, $F_{2, 69}$ 14.35).

Density and abundance of Common birds (Urban exploiters): (Fig 2.2)

When density and abundance are considered a different trend is observed around ponds as compared to terrestrial species (Chapter I). The **Blue rock Pigeon** (*Columba livia*) the so called "top urban exploiters" of terrestrial habitat was also the most common bird around the ponds with highest density

around GP (1933.33 ± 187.74 birds/Km^2), followed by LP (1001.11 ± 187.37 birds/Km^2) and minimum around HP (280 ± 44.54 birds/Km^2) with overall abundance of 20.68 ± 1.35 % and density of 1071 ± 88.65 birds/Km^2. The difference in the pigeon density among the ponds was highly significant ($P<0.0001$, $F_{2, 69}$ 28.49). The next species in dominance around ponds was **House Crow** (*Corvus splendens*) with maximum density again around GP (1411.11 ± 84.87 birds/Km^2), followed by LP (245.69 ± 30.9 birds/Km^2) and minimum around HP (89.16 ± 19.22 birds/Km^2) ($P<0.0001$, $F_{2, 69}$ 183.5). Its % abundance was 11.57 ± 0.72 and total density 582.0 ± 30.02 birds/Km^2. **Bank Myna** (*Acridotheres ginginianus*) ranked third as urban exploiter around ponds. Its highest concentration was observed around GP (1077.77 ± 143.86 birds/Km^2), followed by LP (150.00 ± 20.41 birds/Km^2) and minimum around HP (45.55 ± 38.94 bird/Km^2) ($P<0.0001$, $F_{2, 69}$ 42.80). The total density of Bank Myna around three ponds was 424.4 ± 47.7 birds/Km^2 and total abundance 8.1 ± 0.86 %. Three species of mynas are commonly seen in Vadodara. Next in the abundance was **Common Myna** (*Acridotheres tristis*) with highest density around LP (669.99 ± 83.56 birds/Km^2), followed by HP (34.16 ± 8.38 birds/Km^2) and GP (30 ± 8.07 birds/Km^2) Its total abundance was 4.59 ± 0.51 % and the total density 244.7 ± 28.96 birds/Km^2. The differences were significantly significant ($P<0.001$, $F_{2, 69}$ 57.17). A huge roosting site of **Rose-ringed Parakeet** (*Psittacula krameri*) is present behind Vadodara Railway Station (Chapter III). They disperse in all directions of the roost in the morning and hence are found in all parts of the city including

around ponds. At the time of transect these birds had already dispersed in all direction hence their density was comparatively low. Among the three ponds maximum density of Rose-ringed Parakeet was observed around LP (421.11 ± 36.56 birds/Km^2), followed by GP (131.33 ± 47.26 birds/Km^2) and HP (40 ± 13.24 birds/Km^2) ($P<0.0001$, $F_{2, 69}$ 31.72) with total abundance 3.98 ± 0.39 % and total density 197.4 ± 17.42 birds/Km^2.

Among the water birds highest density was noted for **Pond Heron** (*Ardeola grayii*) at GP (235.6 ± 45.53 birds/Km^2), followed by HP (204.2 ± 25.99 birds/Km^2) and LP (44.44 ± 18.42 birds/Km^2) ($P<0.0001$, $F_{2, 69}$ 10.20) with total density 161.4 ± 20.9 birds/Km^2 and abundance 2.97 ± 0.31 %. The second common water bird was **Cattle egret** (*Bubulcus ibis*) whose total density was 129.6 ± 26.0 birds/Km^2 and abundance 2.59 ± 0.52 %. Highest density of Cattle egrets was noted at HP (163.3 ± 57.79 birds/Km^2) followed by LP (152.2 ± 46.48 birds/Km^2) and GP (73.33 ± 22.71 birds/Km^2) with non-significant differences ($P>0.05$, $F_{2, 69}$ 1.201).

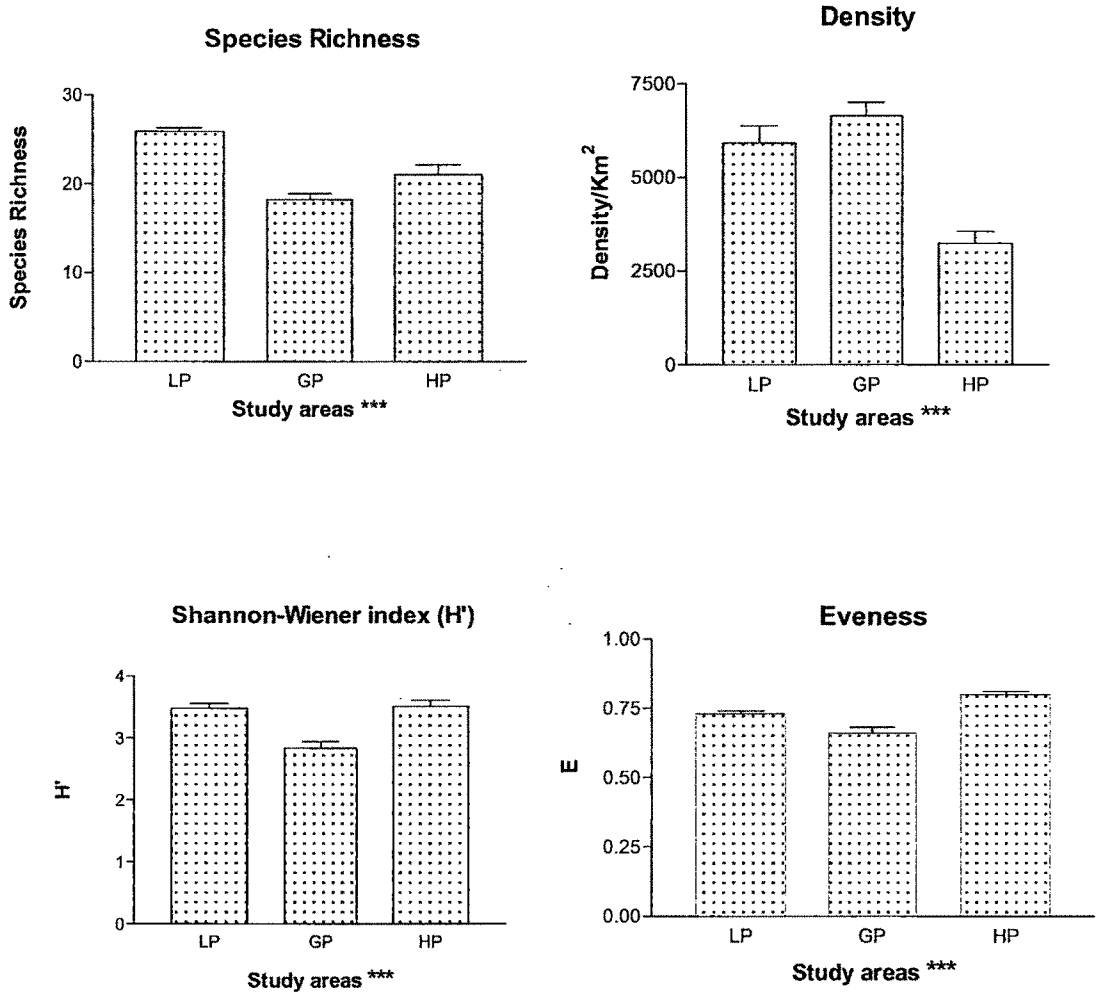
Common birds considered as under the threat of decline in urban areas: (Fig 2.2)

The density of **Large-billed Crow** (*Corvus macrorhynchos*) was 150 ± 21.64 birds/Km^2 around LP, 66.66 ± 17.06 birds/Km^2 around GP and 2.5 ± 1.83 birds/Km^2 around HP ($P<0.0001$, $F_{2, 69}$ 21.51) with total density 73.06 ± 9.24 birds/Km^2 and abundance 1.39 ± 0.17 %. Next was **House Sparrow** (*Passer domesticus*) the species whose population is declining very fast in urban conditions. It was observed with a mean density of 138.88 ± 27.42 Km^2 around

GP, followed by LP (31.11 ± 9.71 Km^2) and HP (11.67 ± 3.97 birds/Km^2) ($P<0.0001$, $F_{2, 69}$ 16.33). Total density of House sparrows was 60.56 ± 10.05 birds/Km^2 and abundance 1.17 ± 0.18 % around ponds. Next in the abundance list was **Little Cormorant** (*Phalacrocorax niger*). Its higher density was observed at HP (82.5 ± 15.05 birds/Km^2), followed by GP (36.66 ± 16.67 birds/Km^2) and LP (25.55 ± 13.19 birds/Km^2) ($P<0.05$, $F_{2, 69}$ 4.031) with total density of 48.24 ± 9.09 birds/Km^2 and abundance 0.99 ± 0.19 % among the birds under the threat of urbanization. The density of **House Swift** (*Apus affinis*) was maximum around GP (64.44 ± 26.47 birds/Km^2) followed by HP (17.5 ± 7.15 birds/Km^2) and minimum around LP (8.88 ± 4.44 birds/Km^2) ($P<0.05$, $F_{2, 69}$ 3.476) with total density 30.28 ± 8.96 birds/Km^2 and abundance 0.59 ± 0.17 %. **Brahminy Starling** (*Sturnus pagodarum*) was not observed around GP and HP but its density was 72.22 ± 15.84 birds/Km^2 around LP. Hence its total density was also 24.07 ± 5.28 birds/Km^2 ($P<0.0001$, $F_{2, 69}$ 20.77) and abundance was 0.45 ± 0.11 %. **Black kite** (*Milvus migrans*) is reported to be an urban species. Huge congregations of Black Kite do occur in Vadodara. However, during present study the abundance of Black Kite was 0.31 ± 0.07 % and the density was 14.63 ± 3.77 birds/Km^2 with 20 ± 5.38 birds/Km^2 at LP, 18.33 ± 7.97 birds/Km^2 at HP and 5.55 ± 2.25 birds/Km^2 around GP with insignificant differences ($P>0.05$, $F_{2, 69}$ 2.071).

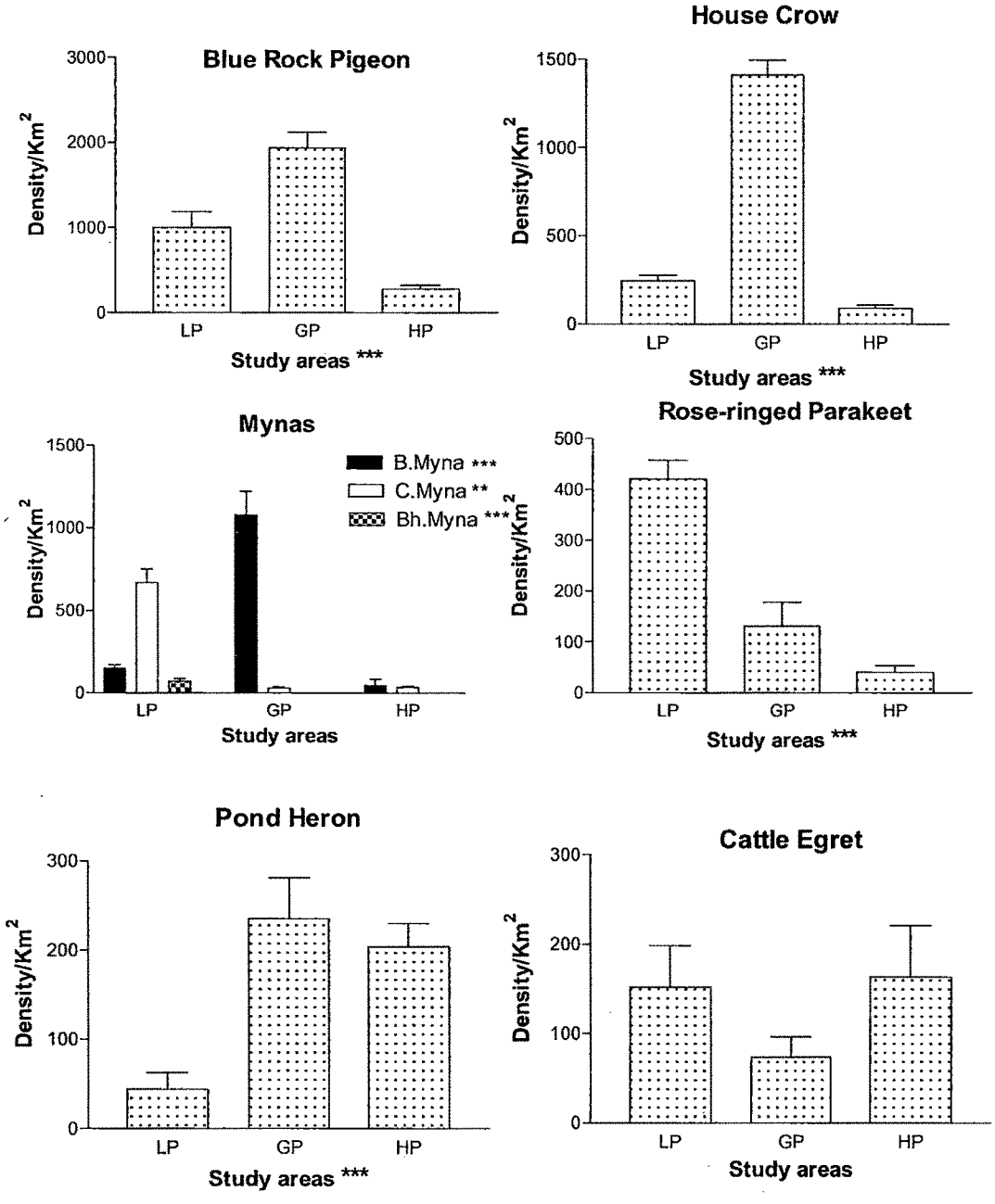
All the three ponds share almost 40% of birds with each other (HP-LP 41%, HP & GP 40% and LP & GP 39%) Table 2.2.

Fig 2.1 Species richness, density, Shannon-Weiner index (H′) and evenness of the birds at three ponds.



*for ANNOVA * (P<0.05), ** (P<0.001) and *** (P<0.0001)

Fig 2.2 Density of Common birds as well as those under threats of urbanization at three ponds in Vadodara city.



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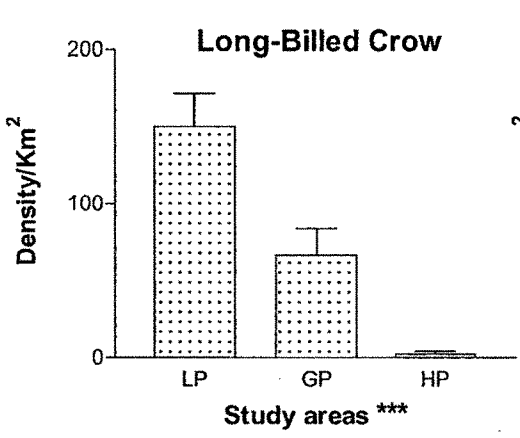

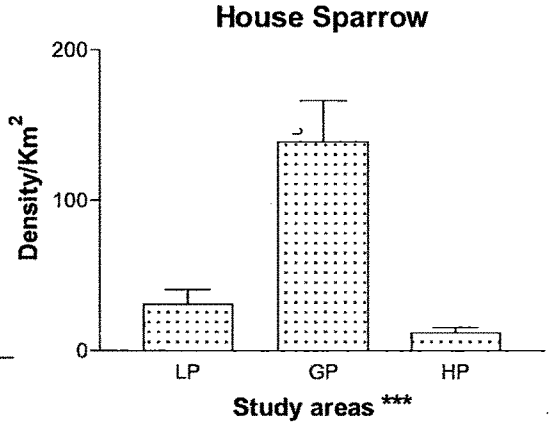

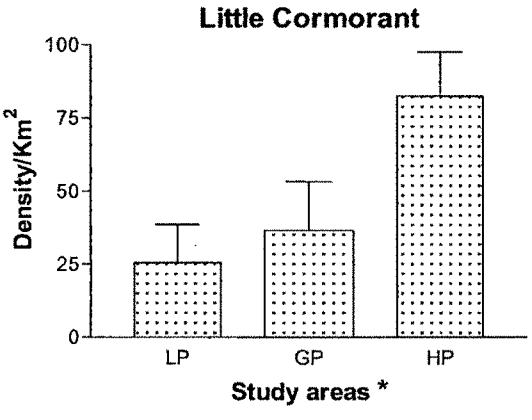

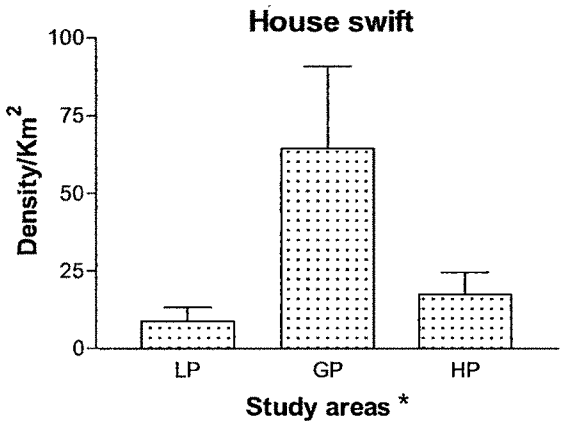

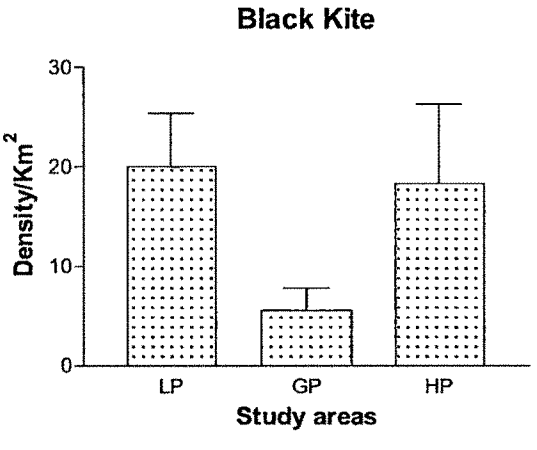

*for ANNOVA * (P<0.05), ** (P<0.001) and *** (P<0.0001)

Table 2.1 Transect area, building cover and vegetation cover of three ponds of Vadodara city.

Study areas	Transect area (Km^2)	% cover (Approximate)		
		Buildings	Vegetation around pond	Vegetation in pond
LP	0.03	40 %	60 %	100 %
GP	0.03	90 %	10 %	5 %
HP	0.05	95 %	05 %	60 %

Table 2.2 Jaccard's index of three ponds at Vadodara city.

Site	HP	GP
LP	0.41	0.39
GP	0.4	

Table 2.3 Average species richness, Density, Diversity index, Evenness of total birds of three ponds of Vadodara city.

Study areas	Total Species	Species richness	Density/ Km^2	Shannon-Weiner Index (H')	E
LP	55	25.87± 0.47	5908.88 ± 466.74	3.48 ± 0.07	0.73 ± 0.01
GP	47	18.25 ± 0.6	6635.55 ± 360.11	2.84 ± 0.1	0.66 ± 0.02
HP	44	21.03 ± 1.1	3226.66 ± 323.20	3.51 ± 0.09	0.8 ± 0.01

Table 2.4 Species abundance and the density of few common birds at the three ponds of Vadodara city.

Common species	Species abundance (%)	Density birds/Km^2
Blue rock Pigeon	20.68 ± 1.35	1071± 88.65
House Crow	11.57 ± 0.72	582.0 ± 30.02
Bank Myna	8.10 ± 0.86	424.4 ± 47.70
Common Myna	4.59 ± 0.51	244.7 ± 28.96
Rose-ringed Parakeet	3.98 ± 0.39	197.4 ± 17.42
Pond Heron	2.97 ± 0.31	161.4 ± 20.9
Cattle Egret	2.59 ± 0.52	129.6 ± 26.0
Large-billed Crow	1.39 ± 0.17	73.06 ± 9.24
House Sparrow	1.17 ± 0.18	60.56 ± 10.05
Little Cormorant	0.99 ± 0.19	48.24 ± 9.09
House Swift	0.59 ± 0.17	30.28 ± 8.96
Brahminy Starling	0.45 ± 0.11	24.07 ± 5.28
Black Kite	0.31 ± 0.07	14.63 ± 3.77

DISCUSSIONS:

The influence of good vegetation that includes garden, large trees and aquatic vegetation can be seen at LP that is surrounded by park and large trees. Maximum 55 species of birds were observed in and around LP during the study period. The mean species richness as well as mean diversity indices were highest at LP. As the urban areas are developed with small gardens and vegetation the species richness can increase. Marzluff (2001) has discussed the influence of these modern habitats that can serve as reservoirs for native species especially in densely populated areas. However, the moderate density of birds at LP can be related to the roosting sites for the species like Common Myna, House Crow, Large-billed Crow, Cattle Egret and Rosy Starling (migratory seasons). Among the three ponds, moderate evenness index at LP indicated uneven distribution of birds.

The influence of low vegetation can be noted at **GP** that is surrounded by human settlements where minimum 47 bird species were identified but with the maximum densities. This pond is under continuous human disturbances and hence the hardy species adapted to human activities congregate here in huge number increasing bird densities. Several reports indicate that urbanization favours a few species but selects against most such species that the urban avian community composition differs dramatically from local natural environments (Beissinger and Osborne, 1982; Rosenberg *et al.*, 1987; Mills *et al.*, 1989; Jokimaki and Suhonen, 1993). At GP the total density of birds was influenced by the density of urban exploiters like Blue rock pigeon, House crow, House

swift, Bank myna and Pond heron. The density of House crow was highest around GP while that of Large-billed Crows around LP due to the presence of their respective roosting sites. The crow population is said to be declining in the urban areas. However, among the three ponds and 9 terrestrial habitats surveyed (Chapter I) Crow density was found to be highest around GP, the most disturbed pond with minimum aquatic vegetation and surrounded by residential area. Few trees surrounding the pond provide good roosting site whereas the garbage thrown by local provide additional food supplies. The population of crows is also observed to be higher around polluted ponds in Thane (Tekale, Unpublished observation).

Further, GP also supports high density of Pond Heron. The pond being shallow and open the visibility is high and being garbage dump, the high productivity could increase the prey base for pond herons attracting them towards it. According to Traut, (2003) certain bird species are adaptable to urban conditions well enough to be benefited from aquatic urban habitats and may actively seek them out. Species like Pond heron, House crow, Large-billed crow; Bank myna, *etc.* can be the examples of such species in Indian urban conditions. Further, number of Black-winged Stilt was higher at GP. Higher number of Black-winged Stilt with lower number of other species is correlated with polluted water and/or the degraded ecosystem. This seems to be true for GP too. Little cormorant and Black winged stilt are known to be the pollution tolerant species (Patwardhan *et al.*, 2001). Various human activities carried out in and around this pond include domestic washing, cattle bathing and

immersion of Lord Ganesha idols after Ganesh Chaturthi festival, one of the main religious festivals of India.

House Sparrow (*Passer domesticus*) a species of concern, also occurred with highest density around GP that is situated at Gotri Village, now a part of Vadodara city. Among the terrestrial urban habitats density of sparrows was highest at the crowded city area (Chapter I). High density of sparrows around GP supports the presumption that old types of building with slanting roof on wooden beam covered by tin and exposed or covered with earthen tiles is favoured by House Sparrows. Some species like Breeding Starlings (*Sturnus vulgaris*), House Sparrows and Pigeons are reported to be unevenly distributed in the city area, being more concentrated in those specific areas that have buildings with design of quality features favourable to these species (Geis, 1976). Urban habitats favour generalist species that are more adaptable and tolerant to human activities and eventually out-compete native species (Bloom *et. al.*, 2002). Lower Shannon-Wiener index (H′) as well as evenness for birds at GP when compared to the other two ponds indicated uneven distribution of birds in the area. GP is surrounded by residential buildings. Large numbers of buildings reduce the number of bird species and species diversity of the urban area (Tilghman, 1987). One best observation during the study period was nesting of Black ibis on a Banyan tree near GP.

HP is surrounded by residential areas, airport and one small temple. Very less terrestrial vegetation is present around the pond but it is covered with submergent as well as floating vegetation. 44 species of birds were observed

here. HP supports more number of migratory as well as aquatic species of birds as compared to the other two ponds. Further, at HP, the overall density of birds was low, but the density of Black Kites, Cattle Egrets and Little Cormorant were highest. Though, the overall density was low, species diversity as well as evenness were almost similar to those of LP. Few trees present around HP provided nesting habitat for species of birds like Cattle egret, Little egret, White ibis and House crow whereas emergent vegetation provided nesting habitats for marsh birds like Swamp hens, Coots and Jacanas. According to Deshkar (2008) the vegetation exposed at HP due to decline in water level during summer provides important hiding places for the swamp hens which are abundant almost all throughout the year. Vegetation is known to directly or indirectly affect the abundance of species of birds (Bancroft *et al.*, 2002). About a decade ago 131 species were listed in and around HP which included good number of migratory species (Padate and Sapna, 1996). However because of urban pressures the pond is reducing in size as well as getting polluted due to urban waste. Hence, very few migratory species of water birds were observed recently (Deshkar, 2008). Studies have reported greater sensitivity of winter migrants to human disturbances (Van der Zande *et al.*, 1980).

Abundance and density of selected birds species (Urban exploiter and adaptors) (Table 2.4)

Looking at the species abundance and density of common birds around urban ponds, Blue rock pigeon again emerged as top urban exploiter with highest density. This was mainly because of its population around GP where it is fed

with grains by humans. GP has more concrete structures where they get shelter too. However, compared to terrestrial habitats (Chapter I) next in abundance around urban ponds was House Crow followed by Bank Myna. These species are the omnivore species that are known to feed on diversity of food provided by human being in garbage. Common Myna and Rose-ringed Parakeet were the next species in abundance mainly because of the roosting sites available around LP. Among the water birds, the species that were common at all the three ponds were Pond Heron, Cattle Egret and Little Cormorant. The density of Pond Heron was high at GP, the open disturbed pond. Abundance as well as density of Cattle egret was high at both LP and HP which have emergent as well as submergent vegetation and the density of little cormorant was high at HP where it could dive into deeper water to catch fish. The Large-billed Crow and House Sparrow, the species that are considered to be under the threat of urbanization, were present around all the three ponds in good number. The rank of House Swift around urban ponds was very low compared to the terrestrial habitats (Chapter I). However, at both the habitats they were maximum around the areas with old patterned housing (CA and GP). Brahminy Starling occurred with low species abundance and density around ponds. It was present around LP which has large trees that give shelter. The top carnivore of the area, the Black Kite was present in low number around three ponds. The species that were observed in and around all the three ponds but in low number are Intermediate Egret (*Mesophoyx intermedia*), Little Egret (*Egretta garzetta*), Red-wattled Lapwing (*Vanellus indicus*), Black-winged Stilt (*Himantopus*

himantopus), Yellow Wagtail (*Motacilla flava*), and White Wagtail (*Motacilla alba).*

CONCLUSION:

Urban ponds surrounded by large trees and with submergent and emergent vegetation as well as small garden support more native species of birds whereas disturbed ponds with less vegetation mainly support urban exploiters. In urban areas ponds with diverse microhabitats inside the water and surrounding it are vulnerable and need protection to support native species.