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Species diversity and abundance of resident and migratory bird fauna of a North-Western Peri-Urban Area, Karachi

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Abstract

Peri-urbanization involves forms of land altered resulting in a complete restructuring of vegetation and composition of species. The study aims to describe the species richness, evenness, species diversity through the identification, abundance of resident and migratory avifauna in relation to seasonal variation in a northwestern peri-urban area of Karachi. The study was conducted in Gulshane Maymar, Ahsanabad, Abdullah Gabol Goth, Gadap town, and adjacent raw areas such as Super Highway link road upto Mokhi Nala. The status of each bird species was recorded. The total number species were found to be 26 with a total count of individuals of N=6515. The study was based on a time frame of 10 months from February - November 2014. Shannon – Weiner Diversity Index was found to be 2.273, Simpson Index of Diversity was calculated to be 0.97, Margalef's Index 2.847 and Pielou's Index 0.698. Birds were identified using field guides by Z. B. Mirza (2007) and Richard Grimmett, Tom Roberts and Tim Inskipp (2008).

Keywords: Peri-urban, richness, index, diversity, abundance.

Introduction

Over 10,000 varied species of birds reside presently on the Earth. Out of which about (83%) dwell in the continental regions whilst the remaining in islands ^[1]. Birds dispersed unequally and variably in expressions of numbers and population in the various biogeographic realms. Neotropical region is the richest of all asset 36% of all recognized land bird species. The second is Afrotropical having 21% species which is followed by Indomalayan with 18% species, Australasian containing 17% species, and Palearctic with 10% species, Nearctic 8% species and Oceanic realms having 2% species ^[1,2].

Fauna of Pakistan consist of Palearctic and Oriental origins ^[3]. As stated by Roberts (1991), there are 660 species of birds in Pakistan. The bird's number of species according to ^[4] is 670 species. From Sindh 356 species of birds have been recorded of which globally threatened are 17 species ^[5]. In addition 329 Species of birds have been recorded from the region of Indus Delta in Pakistan ^[6].

Much of the studies have been conducted on avifauna of coastal, urban and rural areas of Karachi but adequate information is not available on different peri urban areas of Karachi. According to a recent study from the year 2008 to 2012, a total of 172 bird species are recorded comprising of seventeen orders, and fifty families ^[7].

In this research, the focus is on procedures that obtain estimates of population size or density. The focal point is on the identification of different birds species found in an area with mixed conditions of urban and natural environment and that peri-urban areas attract more avifauna as compared to urban sites because these areas have more innate vegetation and conditions which are natural as well as varied surroundings to support different birds. Equipped with such information over a figure of years, one can track down the changes in population levels and, wherever suitable, compare population levels between diverse sites.

3. Materials and Methods

The location of Gulshan e Maymar, Karachi is selected for study, along with the adjacent wild areas. The sites include four sectors including eight subsectors and three parks, including roads and surrounding raw and untouched areas. The sites are visited at regular monthly intervals for over a time period of 10 months, that is, from February 2014 to November 2014.

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3.1. Area of study/ Site selection

The largest city with more population and business capital of Pakistan is Karachi. The location of the city was 130 km west of the Indus estuary and located on the northern coast of the Arabian Sea. In 1941, the population was reported to be 430,000 [8]; by 1946 the city covered about 8.3 sq.km [9]. Karachi occupying (with its suburbs) more than 3530 km² and having an estimated population of 18 million [10].

Gulshan e Maymar covered an area of 1023 acres. Gulshan-e-Maymar, situated just off the Super Highway (main highway between Karachi and Hyderabad) in KDA Scheme 45 in Karachi, almost ten kilometers northeast of Sohrab Goth / F.B. Area and approximately 15 kilometers from the Expo Center. The Sectors U, V, Z and P were situated south east of Gulshan-e-Maymar. Sector U and V were situated near to Northern Bypass link road and neighbors surrounding natural habitats. All three sectors incorporated central parks with a wide variety of flora housing various animal species.

Gadap town, Abdullah Gabol Goth, Ahsanabad, Northern Bypass link road, Gulshan e Maymar and Mokhi Nala area all were adjacent to each other, which had been studied for avifauna census, situated northwest of Karachi along the Hub River on its western restrictions formed the provincial border between Sind and Balochistan with at north and the east having Dadu District and Kirthar Mountains.

3.2. Adjacent Areas

The adjacent areas of sector U included two barren and wild lands with a couple of roads along with the land which was the Northern Bypass link road. On the other side of the link road a huge land mass was present, which tend to be totally untouched consisting of deserted and wild vegetation.

Adjacent areas to Sector V included Northern bypass link road on the north with a wider and untouched area. Sector Z was a total urban area. As in the case with Sector P, it was an undeveloped land area surrounded by roads.

3.3. Bird Survey

3.3.1. Census schedule

The area is visited for 10–14 days on monthly basis from February to November 2014 to record the bird fauna. Early morning and evening visits are made to the selected areas as these two are the peak time periods for observing birds. Different species are identified by using binoculars and Canon's digital single lens camera (DSLR) with 35mm and 55mm lens. Survey time is from 6 am to 9 am and in the evening from 4 pm to 6 pm. Point transect and Line transect techniques are used in the study. Double counts in selected locations and any doubts in counting are avoided.

3.3.2. Identification of birds

Ground surveys are conducted, as for counting they are the most reliable ones [11]. For bird identification, observations, and recordings optical equipment such as binoculars, Canon EOS 1100D with 18mm to 55mm lens is employed. "A field guide to Birds of Pakistan" by Z. B. Mirza (2007) [12] and "Birds of Pakistan" by Richard Grimmett, Tom Roberts and Tim Inskipp (2008) [13] are used for identification.

3.3.3. Avifauna Census

Different points are set up to carry out the point count procedure. A starting point at random has been chosen following all other points at 100 meters apart. All sample points along transect are marked either by flags or by

highlighter paints. The points in transect for point count method have been marked through flagging and those in line transect method by highlighter paints.

Each set of points is assigned different numbers in order to be entered in maps and to differentiate between sets. All transects are surveyed in different orders. At the start of first dawn light, before sunrise, bird counts are carried out. This is the time when most of bird's vocalization is heard and also they can be seen moving through for feeding. The observations are made up to 3 to 4 hours after first light. All birds seen or heard on each transect (points) are recorded. Bird species are recorded and individuals are counted of each species along transect on either sides up to 100 m. Details of each day survey are recorded on the data sheet including date, time, temperature, area and habitat. The birds flying over the area are recorded as an opportunistic sighting as well the birds that flees at the arrival of censurer at the point is also included according to its take-off position.

3.3.4. Mapping

Data taken at points is of two types: the location information and the census data. Also there are two types of recommended data forms; one is mapping and other one is direct recording. The location data information includes location and vegetation details and characteristics.

The mapping of point counts included placing the location of each bird on a map. Species codes are used to plot species location on map. The circle on the map includes 100m radius to keep the tracking of individuals easily. The assigned points within transect are combined on a single map for each month, to summarize the distribution of birds, forming 1,000 m transect. All monthly maps includes different sets of transects (each containing 10 points of 100 m forming 1,000 m transect) of diverse areas.

In Direct recording point counts method the observations or individuals observed are directly added to the point count data forms by using codes to separate out singing vs. visual (S vs. V) and resting vs. flying birds (R vs. F).

3.4. Bird Abundance

In accordance of field surveys, bird's counting was made at different and all points. Double counts were avoided as intense and careful surveys were made each month. The counting was done twice and the average was taken and recorded from each survey. From February to November N= 6515 total abundance of birds was obtained from all selected sites.

3.5. Habitat Description

Gulshan e Maymar covers an area of 1023 acres. The area supports a variety of plant species such as *Azadirachta indica*, *Aclotropis procera*, *Carica papaya*, *Capparis decidua*, *Bougainvillea glabra*, *Euphorbia species*, *Euclaptous*, *Delonix regia*, *Ficus species*, *Hibiscus rosa sinensis*, *Guaiacum afficinale*, *Syzygium cumini*, *Polyalthia longifolia*, *Tithuja species*, *Thespesia populanea*, *Pphonix dactylifera*, *Zizyphus numularia*, *Zzyphus jajoba*, *Cocos nueifera*, *Musa perdisic* and *Manikara zapota*. Including many other plant species as the residential houses support many fruits and vegetable flora life.

3.6. Relative Abundance

Besides finding the most abundant species in between counts, the relative abundance of individual species was also calculated.

$$\text{Relative Abundance} = \frac{\text{Total no. of individuals of one species}}{\text{Total no. of individuals of all species}} * 100$$

3.7. Species Diversity Indices

3.7.1. Shanon’s Diversity Index

It is the most popular diversity index in the field of ecology. Species diversity in natural communities could be described through this index [14].

$$\text{Diversity index} = H' = - \sum p_i \ln (p_i)$$

Where ‘H’ stands for the diversity amount in a particular ecosystem, ‘Pi’ stands for the relative abundance of species to the total of the population and ‘ln Pi’ represents the natural logarithm of it.

3.7.2. Simpson’s Index

The Simpson index was formulated in 1949 by Edward H [15]. An evaluation that reports of both richness and proportion (percent) of each species is known as Simpson's diversity index. It had been a helpful device to terrestrial and aquatic ecologists for many years and would assist to understand the profile of biofilm organisms.

The index, first developed by Simpson in 1949, had defined three different ways in published ecological research. The first step for all three was to calculate Pi, which would be the number of a given species divided by the total number of organisms observed.

- Simpson's index: $D = \sum(P_i^2)$ The probability that two aimlessly elected individuals in the community belongs to the same category (e.g., species).
- Simpson's index of diversity: $1 - D$ The probability that two haphazardly selected individuals in a community belongs to diverse categories (e.g., species).
- Simpson's reciprocal index: $1/D$ The quantity of equally

common categories (e.g., species) that would create observed Simpson's index.

D was affected by two parameters - the equitability of percent of individual species present and richness. For known species richness, D would decline as the percent of the species becomes more equitable.

$$D = 1 / \sum (p_i^2)$$

3.7.3. Species Richness

Species richness was simply measuring the diversity or different species present. It meant measuring the no. of species that are found in a community. A well known index for richness, the Margalef’s Index (1958) [16], was used, as follows:

$$R = S - 1 / \ln (n)$$

3.7.4. Species Evenness

It was the measurement of similarity between the abundance of different species. With similar proportions of species, the evenness would be one, but in case of dissimilar abundance, the value of evenness increases. The evenness of a community can be regarded by Pielou's evenness index, 1966 [17]:

$$J' = H' / H'_{max}$$

Where H’ was the number derived from the Shannon diversity index and H'max was the maximum value of H’, equal to:

$$H'_{max} = - \sum_{i=1}^S \frac{1}{S} \ln \frac{1}{S} = \ln S.$$

$$J = H / \ln (S)$$

Table 1: Bird Species recorded in the area of study

S. No.	Common Name	Family	Scientific Name
1	Little Egret	Andreidae	<i>Egretta garzetta</i>
2	Pond Heron	Andreidae	<i>Ardeola grayii grayii</i>
3	Pariah Kite	Accipitridae	<i>Milvus migrant govinda</i>
4	Red Wattled Lapwing	Charadriidae	<i>Vanellus indica</i>
5	Blue Rock Pigeon	Columbidae	<i>Colombia livia intermedia</i>
6	Little Brown Dove	Columbidae	<i>Streptopelia senegalensis senegalensis</i>
7	Red Collared Dove	Columbidae	<i>Streptopelia tranquebarica</i>
8	Rose Ringed Parakeet	Psittacidae	<i>Psitaculla krameri borealis</i>
9	White breasted king fisher	Alcedinidae	<i>Halcyon smyrnensis smyrnensis</i>
10	Little green bee eater	Meropidae	<i>Merops orientalis beludschius</i>
11	Hoopoe	Upapidae	<i>Upupa epops</i>
12	House crow	Corvidae	<i>Corvus splendens zugmayeri</i>
13	Black drongo	Dicruridae	<i>Dicrurus adsimilis albirictus</i>
14	White wagtail	Motacilidae	<i>Motacilla alba dukhunensis</i>
15	House Sparrow	Passeridae	<i>Passer domesticus</i>
16	Red vented bulbul	Pycnonotidae	<i>Pycnonotus cafer humayuni</i>
17	White eared bulbul	Pycnonotidae	<i>Pycnonotus leucogenys leucotis</i>
18	Common myna	Sturnidae	<i>Acridotheris tris tris</i>
19	Indian robin bird	Turnidae	<i>Saxicola fulvicata cambaiensis</i>
20	Asian Koel	Cuculidae	<i>Eudynamys scolopaceus</i>
21	Variable Wheatear	Muscicapidae	<i>Oenanthe picata</i>
22	Small Minivet	Campephagidae	<i>Pericrocotus cinnamomeus</i>
23	Indian Roller	Coraciidae	<i>Coracias benghalensis</i>
24	Purple Sunbird	Nectariniidae	<i>Cinnyris asiaticus</i>
25	Striated Babbler	Leiothrichidae	<i>Turdoides earlei</i>
26	Indian Cormorant	Phalacrocoracidae	<i>Phalacrocorax fuscicollis</i>

Table 2: Sum of Individual Species

S. No.	Names of Birds (Species)	Study Area 1	Study Area 2	Study Area 3	Study Area 4	Study Area 5	Species wise Sum of individuals
1	Black Drongo	27	15	5	0	0	47
2	House Crow	175	152	65	267	368	1027
3	House Sparrow	202	183	29	114	240	768
4	Pariah Kite	229	173	165	134	149	850
5	Rock Pigeon	643	543	166	247	392	1991
6	Common Myna	162	102	15	68	79	426
7	Green Bee – eater	98	98	0	0	0	196
8	Small Minivet	11	5	0	0	0	16
9	Indian Pond Heron	8	8	0	0	0	16
10	Indian Roller	3	3	0	0	0	6
11	Variable Wheatear	65	64	0	0	0	129
12	Rose Ringed Parakeet	15	9	0	0	0	24
13	White Eared Bulbul	84	64	0	0	0	148
14	Red Vented Bulbul	67	25	0	0	0	92
15	Red Wattled Lapwing	35	2	0	0	0	37
16	Asian Koel	11	7	0	0	7	25
17	Little Brown Dove	17	22	0	0	0	39
18	Common Hoopoe	18	13	0	0	0	31
19	White Breasted Kingfisher	8	6	0	0	0	14
20	Red Collared Dove	10	3	0	0	0	13
21	Little Egret	11	7	0	0	0	18
22	Indian Robin	50	18	0	0	0	68
23	White Wagtail	20	6	0	0	0	26
24	Purple Sunbird	70	65	0	27	4	166
25	Striated Babbler	140	0	0	0	0	140
26	Indian Cormorant	101	101	0	0	0	202
	Total						6515

Table 3: Representing the calculations for Diversity Indices.

Measure	Value	Formulae
Total number of species (S)	26	
Total number of individuals (N)	6515	
Natural log of Species (ln S)	3.258	
Natural log of Individuals (ln N)	8.782	
Margalef's Index for species richness (R)	2.847	$M = (S - 1) / \ln N$
Simpson's Index (D)	0.02	$D = \sum(P_i^2)$
Simpson's Index of Diversity (1-D)	0.97	1 - D
Simpson's Reciprocal Index (1/D)	7.52	$D = 1 / \sum(p_i^2)$
Shanon-Wiener Index (H')	2.273	$H' = - \sum p_i \ln(p_i)$
Pielou's Evenness (E)	0.698	$E = H/\ln(S)$
Maximum Value	1991.000	
Minimum Value	6.000	
Average	257.208	
Standard Deviation	450.213	
Variance	202691.374	

4. Results

In the present study, bird count of the undertaken research area incorporating, Abdullah Gabol Goth, Ahsanabad, Gadap Town, Gulshan-e-Maymar, Northern Bypass Highway Link Road and area up to Mokhi Nala, was carried out for ten months that was from February 2014 to November 2014. The species of birds varied in quantity and diversity. A total of twenty six species were found in the study area with having different counts during the monthly census. The avifauna census resulted in the identification of nineteen families of birds from area of study including Andreidae with two members, Columbidae with three members, Psittaridae with one, Alcedinidae with two, Pyconotidae with two, families Sturnidae, Turnidae, Accipitridae, Upapidae, Meropidae, Charadriidae, Corvidae, Muscipidae, Dicuridae, Campephagidae, Motacilidae, Passeridae, Coraciidae and Nectariniidae (Table. 1) all were found with one member in each family.

The total numbers of 6515 individuals were observed from the study site with different individual species total count. Black Drongo had a total count of 47 individuals that were observed from February 2014 to November 2014 that was the study time period. House Crow had 1027 individual count, House Sparrow 768, Pariah Kite 850, Rock Pigeon 1991, Common Myna 426, Green Bee Eater 196, Small Minivet and Indian Pond Heron had 16 number of individuals each, Indian Roller had 6, Variable Wheatear 129, Rose Ringed Parakeet 24, White Eared Bulbul 148, Red Vented Bulbul 92, Red Wattled Lapwing 37, Asian Koel 25, Little Brown Dove 39, Common Hoopoe 31, White Breasted Kingfisher 14, Red Collared Dove 13, Little Egret 18, Indian Robin 68, White Wagtail 26, Purple Sunbird 166, Striated Babbler 140 and Indian Cormorants 202 as shown in Table 2.

Diversity Indices were calculated including indices for species richness, species evenness, and Shannon's Index and Simpson's Index (Table. 3). Shannon – Weiner Diversity index (H') was calculated to be 2.273. The minimum value of Shannon – Weiner diversity index was 1.5 and maximum 3.5. Simpson's Index (D) was calculated to be 0.02 depicting the probability that randomly selected individuals belong to the same category, although Simpson's Index of Diversity (1-D) was found to be 0.97 giving the probability of erratically selected individuals fit into different categories, and Simpson's Reciprocal Index (1/D) was calculated to be 7.52 giving the number of equally common species that gave the observed Simpson's Index.

The Margalef's Index for Species richness was found to be 2.847, the index increased as variations were found on the site, and it had no limits, although higher index values depicted higher species richness whereas the minimum value was 1 [12]. The Pielou's Index for species evenness was calculated to be 0.698. Species evenness referred to how closely each species in an environment was, in numbers. The maximum and minimum values for Pielou's Index were 1 and 0 [13]. The maximum number of individuals of all species was 1991 which was of rock pigeon and minimum number of individuals observed was 6 of Indian Roller. The Average was found to be 257.208, Standard Deviation was 450.213 and Variance was calculated to be 202691.374 (Table. 3).

5. Discussion

Urbanization necessitates one of the most intense forms of land-use alteration, and usually it assists in the absolute

reorganization of vegetation and species composition. Urbanization is documented as one of the foremost threats to biodiversity on the global scale [14]. In addition, urban environments vary in many habits from more natural ecosystems; such as, they hold up more anthropogenic food resources and the microclimate in urban areas can be more constructive for wintering species [15, 16]. Urban areas are also categorized by high levels of disturbance and environmental reconstructions, which can influence bird populations and community patterns [15, 17, 18].

During the study Little Egret is found to be a passage migrant. Indian Pond Heron was found the solitary resident of the area and covered a range of two sectors that is sector U, V, Abdullah Gabol Goth and Gadap town. Change in the plumage of Pond Heron was observed. The plumage changed from non-breeding to breeding plumage during the time period of months from June to October. White breasted Kingfisher was found to be a migrant during the onset of monsoon season. Small Minivet was observed only during the months of February, March and April. The calculation for relative abundance of each species was done. Rock Pigeons were found to be the most abundant specie with relative abundance of 32.586 respectively. Because of their ability to colonize the man made environments, they flourish well in urban areas that were residential areas, making nests in crevices of walls of houses and buildings. The sub dominant species included House crow, Pariah, Kite and House Sparrow with relative abundances 13.429, 14.285 and 10.76. The least common species observed in the study area included Little Egret, Small Minivet, Indian Pond Heron, Indian Roller, White Breasted Kingfisher, and Red Collared Dove. Species including common Myna, Green Bee Eater, Variable Wheatear, White Eared Bulbul and Purple Sunbird are present in moderate numbers. Other species observed include Black Drongo, Rose Ringed Parakeet, Red Vented Bulbul, Red Wattled Lapwing, Little Brown Dove, Common Hoopoe, Indian Robin, White Wagtail.

Pond Heron was found resident in the study area. By observing its feeding habits, it was found to be a carnivore. Little Egret, White breasted Kingfisher, Hoopoe, Indian Cormorant were also found to be carnivores. White breasted Kingfisher was found to be a summer breeder (arrives in monsoon season) as it was seen in pairs during the months of April, May and June, appearing mostly near ponds. Little Egret was found to be a passage migrant. They were seen at different seasonal ponds which formed due to heavy rains during the season of monsoon. Hoopoe was mostly seen Sectors U and V of Gulshan e Maymar. A flock of Indian Cormorant was seen flying over the study areas during the month of February. Black Kite was found to be a resident and its feeding habits demonstrates that it was carnivorous, insectivorous and scavenger. Blue Rock Pigeon, Little Brown Dove, Red Collared Dove, House Sparrow were all granivores, that was, they feed on grains. Rose Ringed Parakeet was a herbivore where as Red Vented Bulbul and White Eared Bulbul were also found to be herbivores but were also insectivorous. Little green bee eater, Black Drongo, Small Minivet, Indian Roller were insectivorous. White Wagtail was found to be invertivorous and insectivorous. Red Wattled Lapwing was found to be insectivorous, invertivorous and granivorous. House Crow feeding habits concludes that it was a carnivore, granivore and invertivore. Omnivorous feeding habits were found in Common Myna. Indian Robin

was an insectivore but also fed on lizards and frogs. Variable Wheatear was found to be an invertivore whereas Purple Sunbird was the only nectivorous bird found in the area.

The factors affecting birds and their habitats included land reclamation for housing and development, habitat degradation, drought, and pollution. As compared to urban areas, during study, it was observed that peri-urban areas support more avifauna diversity and other animal species (amphibians, reptiles, mammals).

During the research, it was observed that new buildings were under construction as well as making of roads and tracks which threatened avifauna straightforwardly or ultimately. Due to excess wild vegetation, many insects were found which were source of food for the birds. But they cause harm and create trouble for the residents of peri-urban areas, so natives burn the wild vegetation in between houses that causes loss of insects and it ultimately threatened the bird species and also in some cases results in suffocation of birds, due to which birds avoid such habitats.

6. Conclusion

From the research undertaken it had been concluded that peri-urban area supported more avifauna as compared to urban areas. The areas with more vegetation cover had more families. The areas with more vegetation cover had more richness of species and species richness declined where there was less vegetation with no bird species in areas that were barren. It had been concluded that research should be supported to fill gaps in data that focus on declines of avifauna diversity. The structural diversification of trees within green spaces, a significant aspect, in supporting increased level of species abundance of avifauna. And the green spaces in urban areas should be designed for both social needs and for conservation purposes.

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