Int. J. Exp. Res. Rev., Vol. 8: 29-38 (2016)

International Journal of Experimental Research and Review (IJERR)
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ISSN: 2455-4855 **Original Article**

DUMDUM AIRPORT: A NECESSITY AND LUXURY FOR HUMAN LIFESTYLE BUT A MENACE FOR AVIAN DIVERSITY

Sourattya Das, Srijita Dey and Asmita Samadder*
Department of Zoology, Dum Dum Motijheel College, Kolkata-700074, West Bengal, India.

*Corresponding Author

Abstract

Pollution has always been one of the major outcome of human activities to improve their lifestyle. This often results in imbalance in the ecosystem of biological species which makes their survival questionable. Kolkata airport area, i.e., Dum Dum airport, has become a zone of extreme noise and air pollution due to tremendous increase in traffic on roads and as well as flights, which has affected the survivality and diversity of many faunal species specially birds. Birds serve as a biological indicator of pollution and therefore were the subject of this study. The effect of noise and air pollution on relative abundance and richness of birds in the highly polluted area of connecting road of 1no. airport gate have been compared to two other areas, a non-polluted zone, Khalisha Kota Palli area and another area of intermediate pollution, Dum Dum Motijheel area; belonging to the same bio-geographic zone, by analyzing the diversity indices. The status of number of tress, natural resources available, rate of traffic were evaluated and compared in the course of our study. Results revealed that with the advent of traffic, there was an abrupt decrease in the species diversity and population density of birds in the airport area in spite of abundant number of trees present. The effect of pollution in bird richness and abundance status were determined by comparing the data of the highly polluted and intermediate polluted area with that of the non-polluted area using Student's t-test which proved to be highly significant.

Key words: Air pollution, noise pollution, bird, diversity indices, species evenness, species richness.

1. Introduction

Human lifestyle has gradually evolved from necessity to luxury over decades. With the advent of modernization of our society for a better life we often fail to notice the adverse effects of human-made imbalance in the viability of other biological species. Industrialization associated deforestation, increase in traffic, loss of natural water bodies, etc. has affected almost all species of the ecosystems.

India has already earned the infamous distinction of being the leading capital of uncontrolled pollution due to rapid industrialization. The rate of pollution has increased diversely affecting different zones of animal life including human health. The Scientific and Environmental Research Institute has already reported in their findings in 2009, that the level of atmospheric suspended particulate matter (SPM) in Kolkata was 511 which made Kolkata the most polluted metropolitan city in India, and probably the highest among eight polluted cities in Asia as well, followed by Mumbai, Delhi and Chennai respectively (Dasgupta, 2009). Furthermore, the city has non-permissible range of noise pollution which resulted in abrupt fall in diversity of animals. The cause of noise and air pollution in and around Kolkata airport may have been due to extreme high sound waves created by airplanes, choppers and honks of other transport system such as cars, buses, autos, heavy vehicles, etc, and associated air pollution have led to destruction of natural habitats like lack of water body, diminish in number of trees, open areas, decrease in food quantity, increase in residential buildings and mills, etc (Francis et al., 2009).

Among many other fauna affected by pollution, bird population and diversity have also been at stake over the last couple of years (Parris and Schneider, 2008). Birds are an important part of our natural ecosystem. They help us in a number of ways by destroying harmful insects, dispersal of seeds and consuming weed seeds. The effect of pollution influencing the disruption of our ecosystem may have commenced from the imbalance in natural diversity of bird population which still needs to be explored.

Therefore, in our present study, our prime concern was to determine the avian diversity indices in highly polluted zone of the connecting road of 1no. gate of Netaji Subhas Chandra Bose International Airport, Kolkata. These indices possibly would indicate the level/degree of air and noise pollution and other associated environmental factors for the incumbent hazards of natural ecosystems which might need prompt attention of mankind. Further, ascertaining these indices, in relation to two more selected zones; one having intermediate pollution, Dum Dum Motijheel area, and another, Khalisha Kota Palli area, being considered as “no-pollution” zone, based on our initial data survey, shall directly serve as bio-indicators of pollution of that particular area.

Thus, the major objectives of the present study were to: (i) select different location for data collection; (ii) evaluate the rate of traffic in different selected units; (iii) ascertain line transect to determine diversity indices and richness indices; (iv) analyze the data statistically by Student 't' test for calculating the relative significant level in each zone.

2. Materials and methods

2.1 Division of areas

Firstly, the landscape near airport was divided in three study areas for the purpose of our survey on the basis of distance from the airport. Based on initial trials and surveys of some simple parameters like traffic, no of trees and bird count, three zones were finalized. The first zone (A) connection road of 1 No. airport gate extends around 1 km of the airport; the closest zone near the airport. The second zone (B) Khalisha Kota Palli was selected which was located around 7.1 km away from the Airport. It is the intermediate zone in relation to distance from airport. Finally, another area (C) Dum Dum Motijheel area which was about 19 km away from the airport was selected.

2.2 Collection of data

All the observation was made for three days in each set. Each set was repeated thrice thereby accounting for a total of nine days observation/ three days observation in three set, whichever is applicable during calculation of different indices.

2.3 Line transect

Sampling of observed data were recorded by drawing line transect as per standard practice (Järvinen and Väisänen, 1975). A transect line was drawn by using a nylon rope marked and numbered 1 m intervals, all the way along the length of presence of tress for 5-6 km in their respective selected zone/areas. Densities of bird species were calculated on the basis of observations of line transect for further analysis.

2.4 Diversity indices

The Shannon index and Simpson index were calculated as per standard practice (Sharma 2009) considering first three days as one set and taking fourth to sixth day as second set and thereafter seventh to ninth day as third set. Mean, standard error and the significant level of differences were calculated respectively in relation to control zone.

2.5 Evenness index

Species evenness index for collected data was calculated as per standard practice and formula (Smith and Wilson, 1996).

2.6 Richness index

Species richness was calculated by following the standard protocol (Sharma, 2009) and they were then statistically analyzed.

2.7 Traffic count

The number of traffic in air, i.e., Kolkata airport, as airplanes, were not counted but rather the data was collected from the "Flight Stats of CCU arrivals and departures" which gave us a brief idea of total number of flights each day (Flight Stats of NSCBI Airport). The rate of ground traffic density were counted and recorded in all the three location and the mean, standard error and the level of significant differences of location A and Location C were calculated taking Location B as control.

2.8 Statistical analysis

All the data were collected at the end of nine days observation. The statistical analysis was made over three days in three independent sets. Mean and standard error of three independent observational data were statistically analyzed.

3. Results

3.1 Type and number of avian species in different areas

Only two types of avian species were found in Location A whereas nine avian species could be documented through Line Transect (LT1-LT9) from Location B followed by Location C consisting only four different species of birds (Table 1a-c).

3.2 Simpson index

The Simpson index value was calculated as 0.65 ± 0.013 which was the highest in location B considered as zero pollution zone (Khalisa Kota Palli). An intermediate value of 0.557 ± 0.029 were observed in location C (Dum Dum Motijheel) and lowest value of 0.095 ± 0.014 was found in location A, the most polluted zone (1 no Airport gate) (Table 2a). The significant differences between A and B was *** $p< 0.001$ which was greater than that between B and C which was *$p< 0.05$ which corroborated with our assumption that pollution hinder in bird diversity.

3.3 Shannon index

The results of Shannon index reveal that the value was highest, i.e., 1.439 ± 0.034 at location B (zero polluted zone) as compared to that of 0.993 ± 0.047 at location C (intermediate polluted zone) and lowest, i.e., 0.196 ± 0.024, at location A (highest polluted zone).

The level of significance between B and C was **p< 0.01 and that between B and A was ***p< 0.001 (Table 2b).

3.4 Evenness index

The results reveal that the species were more evenly distributed in Location C (0.716 ± 0.034) followed by Location (B (0.655 ± 0.015) and lowest in location A (0.283 ± 0.034).

Table 1a. Collection and identification of Avian species found in A Zone (1 No. Airport gate).

Sl. No.	Common name	LT1	LT2	LT3	LT4	LT5	LT6	LT7	LT8	LT9
1	Crow	31	24	27	34	30	29	27	34	29
2	Common Myna	1	0	2	0	4	1	1	4	1

Order, family & Genus:

Sl. No.	Common name	ORDER	FAMILY	GENUS
1	Crow	Passeriformes	Corvidae	Corvus
2	Common Myna	Passeriformes	Sturnidae	Acridotheres

Table 1b. Collection and identification of Avian species found in B Zone (Khalisha Kota Palli).

Sl. No.	Common name	LT1	LT2	LT3	LT4	LT5	LT6	LT7	LT8	LT9
1	Crow	27	38	36	32	35	40	29	31	40
2	Common Myna	18	8	11	11	10	16	20	19	10
3	Greater coucal	2	2	1	4	2	3	4	1	0
4	House sparrow	6	0	4	5	7	0	2	4	0
5	Black drongo	4	4	3	2	0	1	4	2	2
6	White Breasted Kingfisher	1	1	1	2	0	0	2	1	0
7	Yellow footed green pigeon	4	4	3	3	1	1	2	1	4
8	Black hooded oriole	4	2	4	4	4	1	2	4	1
9	Parakeet	2	0	0	2	1	0	1	2	2

LT= Line transect. LT1-LT9 represents day 1 to day 9

Order, family & Genus:

Sl. No.	Common name	ORDER	FAMILY	GENUS
1	Crow	Passeriformes	Corvidae	Corvus
2	Common Myna	Passeriformes	Sturnidae	Acridotheres
3	Greater coucal	Cuculiformes	Cuculidae	Centropus
4	House sparrow	Passeriformes	Passeridae	Passer
5	Black drongo	Passeriformes	Dicruridae	Dicrurus
6	White Breasted Kingfisher	Coraciiformes	Alcedinidae	Halcyon
7	Yellow footed green pigeon	Columbiformes	Columbidae	Treron
8	Black hooded oriole	Passeriformes	Oriolidae	Oriolus
9	Parakeet	Psittaciformes	Psittaculidae	Psittacula

Table 1c. Collection and identification of Avian species found in C Zone (Dum Dum Motijheel area).

Sl. No.	Common name	LT1	LT2	LT3	LT4	LT5	LT6	LT7	LT8	LT9
1	Crow	24	29	17	23	22	20	22	24	19
2	Common Myna	4	0	2	2	6	3	3	6	3
3	House sparrow	11	9	5	11	15	10	11	12	9
4	White Breasted Kingfisher	2	2	0	2	1	1	1	1	3

Order, family & Genus:

Sl. No.	Common name	ORDER	FAMILY	GENUS
1	Crow	Passeriformes	Corvidae	Corvus
2	Common Myna	Passeriformes	Sturnidae	Acridotheres
3	House sparrow	Passeriformes	Passeridae	Passer
4	White Breasted Kingfisher	Coraciiformes	Alcedinidae	Halcyon

While the evenness data showed high significance level of differences, ***p<0.001, between B and A, but the difference between B and C was however, non-significant (Table 3a).

3.5 Richness index

The richness index shows that the value at location B was 0.655 ± 0.002 which was highest among other location of C and A, i.e., 0.379 ± 0.007 and 0.208 ± 0.005 respectively. The statistically analyzed significance level differences were also satisfactory; ***p< 0.001 for both the cases, i.e., between B and C and between A and B (Table 3b).

3.6 Traffic count

The data for number of traffic in air per day was collected from “Flight Stats of CCU arrivals and departures” which was on an average of 185/day. On the other hand the rate of ground traffic in different zone for A, B and C were observed to be of 62 ± 2.66667, 6±0.5720 and 39 ± 1.4635 respectively; the order being A >C >B; a level of significant difference between A and B and between B and C was ***p< 0.001 in both the cases (Table 3c).

4. Discussion and Conclusion

Birds act as crucial link between plant and animal kingdom in natural ecosystem. Their existence in diversified form in different ecological niche is considered as one of the most important indicators of optimal ecological sustenance globally. Thus, any trivial change in avian diversity is considered to be an effect of loss of ecological balance. The initial data of our present study clearly indicate that the various avian diversity indices as observed in selected places had the impact of the surrounding environment and therefore had differences in their level. The area near to airport having highest number of traffic, both on ground (62/min) (Figure 1a) and in air (arrival and departure of ~185 aeroplanes daily), closely accounts for the high risk zone for air and noise pollution leading to congestion, lack of suitable space for nesting, dwindling number of trees, etc. On the contrary although the number of trees present was not remarkably different in the other two selected areas, but definitely a significant difference in average traffic were observed and analyzed statistically illustrating higher avian diversity. Thus, the result would clearly indicate a possible direct co-relation of avian diversity to that of rate of traffic, both on ground and in air, in these places which further has close association in maintaining ecological homeostasis and balance.

The change in avian diversity also corroborated with earlier findings (Reijnen and Foppen, 2006; Saha and Padhy, 2011) thereby implicating that human activities play a pivotal role in negative influence in avian community and ecology. Degree of dominance and richness in avian diversity varied considerably in proportion to degree of pollution encountered in that particular zone. Although the highest species evenness (equitability) was found in Location C, Location B was assessed to have highest species richness (number of different types of birds) and relative abundance (distributional uniformity) thereby representing dominating avian community in relation to other location A and C. Further, heterogeneous pattern of avian population distribution maintained in Location B, in comparison to the predominant homogeneity in other locations (A and C) could be considered as a good indicator of biodiversity, parallel to the concept of ecosystem productivity. Moreover our overall result also implicate a highest rate of stability in Location B in near future leading to highest rate of survivality or viability, reproductive potential or fitness, adaptive efficiency and lowest rate of extinction/mortality which would aid in maintaining an effective

Table 2a. Simpson index for avian diversity in different locations of A, B and C are represented in this table. Significant level of differences are mentioned as analyzed through Student's t-test as ***p < 0.001, *p < 0.05, *vs*. B.

LOCATION	LT1 - LT3	LT4 – LT6	LT7 – LT9	MEAN±SE
A	0.068907	0.09784	0.11843	0.095 ± 0.014***
B	0.6697	0.6267	0.65279	0.650 ± 0.013
C	0.499	0.58455	0.58826	0.557 ± 0.029*
***p < 0.001, *p < 0.05, *vs*. B				

Table 2b. Shannon index for avian diversity in different locations of A, B and C are represented in this table. Significant level of differences are mentioned as analyzed through Student's t-test as ***p < 0.001, **p < 0.01, *vs*. B.

LOCATION	LT1 - LT3	LT4 – LT6	LT7 – LT9	MEAN ± SE
A	0.1523	0.20151	0.23381	0.196 ± 0.024***
B	1.5016	1.38624	1.43	1.439 ± 0.034
C	0.8993	1.02718	1.05107	0.993 ± 0.047**
***p < 0.001, **p < 0.01, *vs*. B				

Table 3a. Evenness index for avian species in different locations of A, B and C are represented in this table. Significant level of differences are mentioned as analyzed through Student's t-test as ***p < 0.001, NS *vs*. B.

LOCATION	LT1 - LT3	LT4 – LT6	LT7 – LT9	MEAN ± SE
A	0.2197	0.29071	0.3373	0.283 ± 0.034***
B	0.6834	0.6309	0.6509	0.655 ± 0.015
C	0.6487	0.7410	0.7582	0.716 ± 0.034^{NS}
***p < 0.001, NS *vs*. B				

Table 3b. Richness index for avian species in different locations of A, B and C are represented in this table. Significant level of differences are mentioned as analyzed through Student's t-test as ***p < 0.001 *vs*. B

LOCATION	LT1 - LT3	LT4 – LT6	LT7 – LT9	MEAN ± SE
A	0.2169	0.2020	0.2041	0.208 ± 0.005***
B	0.6529	0.6581	0.6529	0.655 ± 0.002
C	0.3903	0.3714	0.3746	0.379 ± 0.007***
***p < 0.001 *vs*. B				

Table 3c. Traffic count on ground in different locations of A, B and C are represented in this table. Significant level of differences are mentioned as analyzed through Student's t-test as ***p < 0.001 *vs*. B.

DAY	LOCATON A	LOCATION B	LOCATION C
1	76	7	44
2	69	9	41
3	65	6	44
4	55	8	30
5	57	4	37
6	68	5	41
7	50	7	39
8	61	6	42
9	60	4	37
MEAN VALUE	62.3333= ~ 62	6.2222= ~ 6	39.4444= ~ 39
MEAN±SE	62±2.66667***	6±0.5720	39±1.4635***
***p < 0.001 *vs*. B			

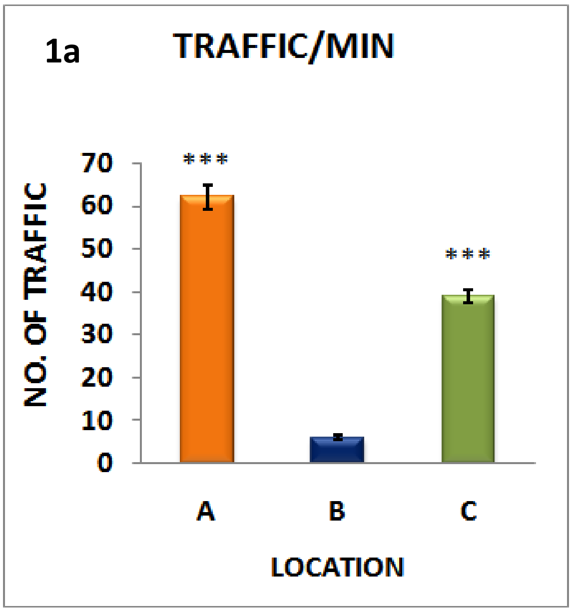

Figure 1a. Graphical representation of traffic rate; ***p < 0.001 *vs*. B.

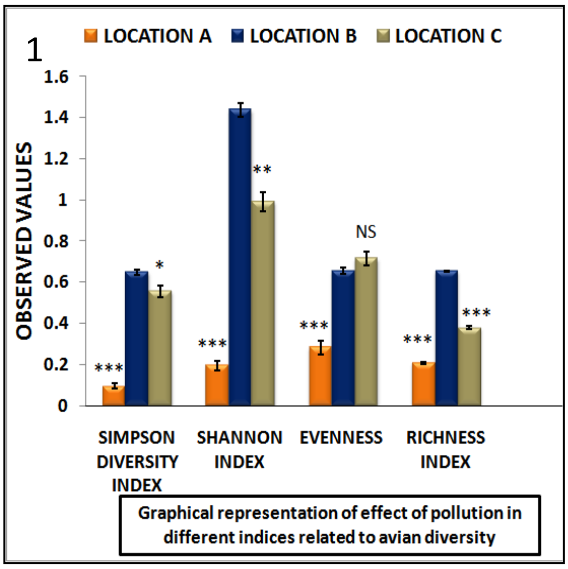

Figure 1b. Graphical representation of different indices for evaluating the avian diversity; ***p < 0.001, **p < 0.01, *p < 0.05, *vs*. B, NS *vs*. B

population size (number of potential reproductive mates) in the steadily diversifying environment in comparison to other locations belonging to same bio-geographic zone or the same ecological community (Figure 1b).

The result of our present study also illustrates the importance of examining the consequences of human-made anthropogenic disturbance from a community level perspective. The variety and viability in species, sub species or local groups populations in Location B may possibly be due to reduced intra-specific competition/ predation pressure, large availability of natural resources/foods, non polluted environment as well as availability of breeding

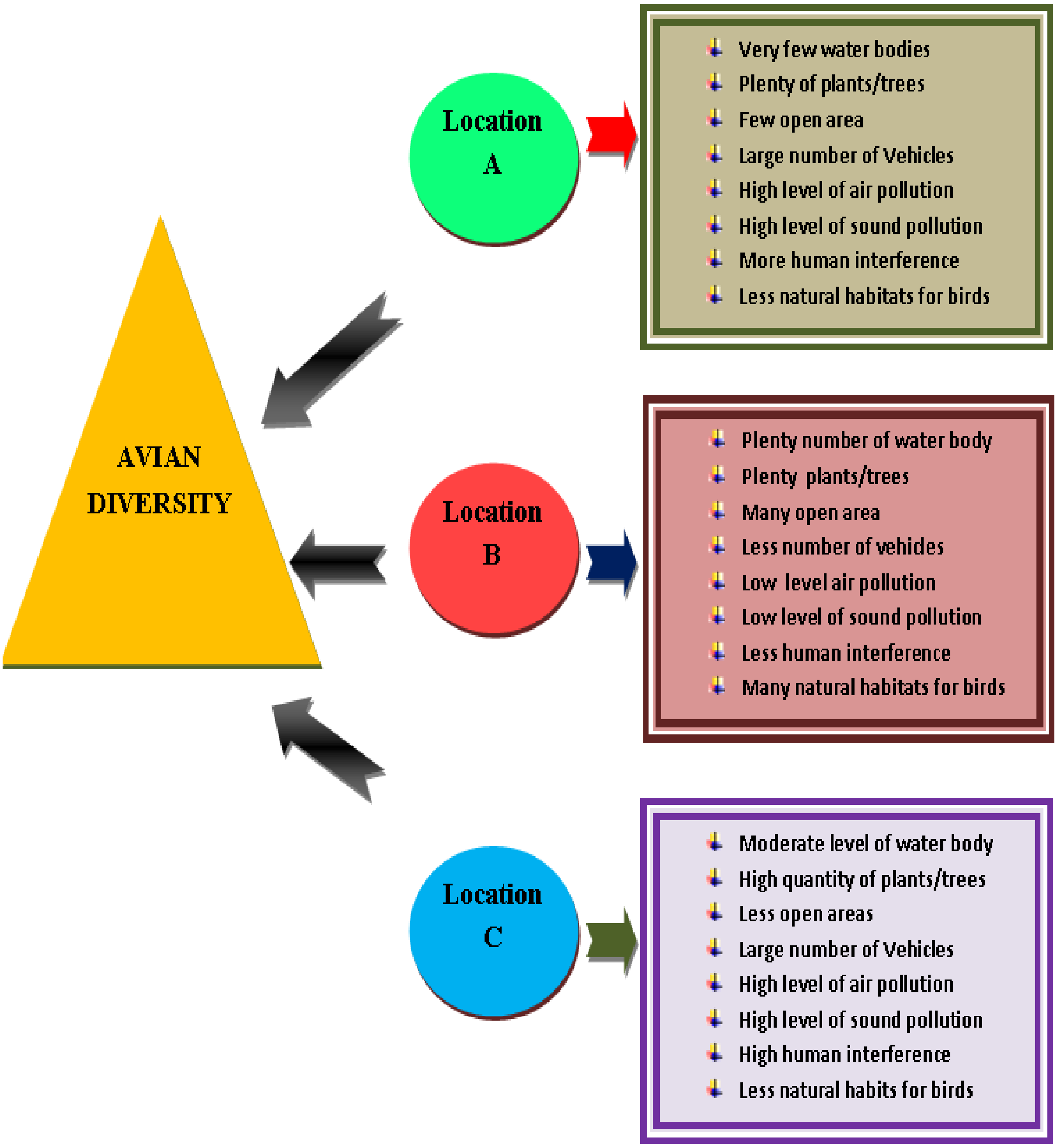

Figure 2. Representation of effect of pollution on the integrity of natural ecosystem.

Figure 3. Overall representation of the study.

/ open water bodies which aid as optimum favourable conditions for successful avian reproduction leading to transmission of gametes to the next generation (Figure 2).

Pollution plays a harmful role in bio-magnification and bio-accumulation of harmful chemical substances and associated anthropogenic factors like trees and open spaces replaced by mobile communication towers emitting electromagnetic waves leading to teratogenic effects in reproductive potential/fecundity resulting in ultimate fatality in avian population. The effect of noise pollution particularly by and large also results in reproductive failure and affect food availability in avian species due to lack of intra-specific communication (Francis et al., 2009) thereby affecting the integrity of natural ecosystem. Therefore, this particular study possibly directs us to consider the fact that avian diversity is inversely proportional to the presence of environmental pollution in a particular area (Figure 3). Thus, the knowledge of how avian species respond to environmental factors should be considered and an immediate firm step should be taken against human-altered landscape and industrial glamour which is a common problem worldwide. This would help in reducing the rate of pollution leading to stability in avian species and other community as well for successful nesting, courtship, foraging, parental care and finally in sustaining the crucial balance in the natural ecosystem by maintaining genetic constituency in different ecological niches for long term survival and diversified existence.

5. Acknowledgement

We are grateful to Dum Dum Motijheel College, Kolkata for providing us the basic facilities to carry out the Graduate level student's project work successfully. Acknowledgements are also extended to the traffic police of Kolkata for their kind co-operation and support as and when required at the time of our data collection.

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