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Examining the Effect of Complementary feeding on Avian Biodiversity: A Comprehensive Analysis of Bird Species

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Abstract

One of the most common interactions between humans and the environment is feeding birds, which has significant social and environmental implications. Utilizing a CVIP 2018 Birds Species test dataset, we gathered 27,000 individual birds from 51 species for our study. It examines the impact of extra food on avian biodiversity using an extensive species analysis of birds. Our goal is to explore the possible links between observed shifts in bird diversity and additive-related behaviors. It provides illumination on the ecological consequences of human activity in bird habitats and offers perspectives on methods for conservation.For statistical analysis we use the methods Mann-Whitney tests, and the Shannon-Wiener index. The article presents a description of seven different bird feeding methods: handout (HO), waste bins (WB), green places (GP), livestock feed (LF), automatic seed feeder (ASF), animal fat (AF), and freezing food (FF). We provide both urban and rural bird feeders together with information on their distribution.

Keywords: Food, Anima fat, Mann- Whitney Tests, Species, Feeding Birds, habitat, Urban and Rural.

INTRODUCTION

The number and geographical range of urban settlements are expanding worldwide due to socio-demographic factors and population expansion (1). Intentional individual provisioning of food, drink, shelter, and nesting sites to animals is a global phenomenon that is growing and worth billions of dollars. It is common in western societies (2). It is predicted that there has been a decline in the bird population, and avian biodiversity has been decreasing at disturbing rates of the last few decades, the fall of grassland bird populations exceeds other bird guilds (3). Hill dipterocarp forests and their lowland counterparts have comparable bird communities. Hill dipterocarp forests are susceptible to logging because, like lowland dipterocarp forests, they are densely packed with species of high commercial-value timber trees (4).Urban green spaces offer a variety of ecological services, such as habitats for different species. It applies to birds, and city inhabitants can gain from avian biodiversity in a number of additional cultural and legal avenues (5). Many bird species are attracted to the food available, but considering a significant portion of anthropogenically produced, it is questionable that they gain anything from the extra nutrients. When there is an excess of food available for the birds to eat, it can contaminate the waterways and attract other creatures like rodents (6). An essential part of the ecology vultures are obligate scavengers. They inhibit the transmission of illness, aid in the disposal of garbage, and cycle nutrients by eating carcasses (7).

The study (8) demonstrated by means of faecal metabarcoding how commonplace additional items are in a wild bird's diet and how exploiting these significant additional resources has a positive impact on the bird's nesting density and phenology. It is also demonstrated even in a species that is sedentary during a season when movement is

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believed to be restricted, the distances traveled to access these resources are greater than believed. Theyshow that species that utilize additional resources are probably to be experiencing population growth, whereas species that do not probably to be experiencing population decline, perhaps as a result of changing ecosystem dynamics and competitive balances. The research (9) investigated the application of bird behavior to quantify the effect on the biodiversity of an Indian working landscape. The land used and bird assemblage were the focus of the research, they evaluated species richness and compared the results to bird behavioral patterns. The findings validate the application of behavior to evaluating the viability of working landscapes, finding additional wildlife habitats, and analyzing the effects of anthropogenic habitat on animals. The article (10) evaluated that biodiversity is influenced by the environment and how it affects the provision of various ecosystem services to various animal groups in a particular agroecosystem. They imply agricultural and landscape management techniques to support versatile animal biodiversity and the environmental services it generates in relation to their outcomes. The author (11) developed the landscape scale panel data collection covering the associated for more than ten years by combining phylogenetic trees, detailed ecological data, and annual bird survey data. It was partially true and the economic research demonstrates that increased local food crop heterogeneity boosts local avian diversity. The study (12) carried out the first comprehensive investigation to separate the effects of the competing processes on the variety of farmland birds in Polish communities. They demonstrated that in comparison to comparable older communities, modernized settlements, and agricultural lands had fewer birds. Their modern comprehension of agricultural ecosystem ecology and the most effective way to carry out conservation measures that cost billions of dollars are called into question by these discoveries. The research (13) assessed the degree of urbanization at each location and conducted a spring assessment of bird diversity and principal component analysis (PCA) on a number of habitat structures. Using generalized linear mixed models (GLMMs), the article examined the effects on bird diversity of the use of land, distances to the city edge, and distances to the corridor. The diversity of rare species was greatly enhanced by the green corridor, highlighting its significance in fostering bird biodiversity. The article (14) assessed Complementary feeding sites (CFS) managers about how they manage their CFS to assess the possible conservation effects of various actions. Livestock farming was a factor in the assessment of half of the SFS. It can be crucial to strengthen the connection between managers of CFS and ecologists, to boost the data flow on optimal adjustment methods, and to impose strict, unambiguous regulations that reduce any dangers to vultures to reduce unintentional negative effects from CFS. The author (15) described the outcomes of the initialfinancial assessment of educational and recreational opportunities provided by scavengers of birdtourists, namely at vultures CFS within the Pyrenees, and their significant impact on the local population's incomes. The estimation is that the local population receives an average of direct economic advantages from photography and bird watching at CFS.

The following are the remaining papers. In Section 2, the data gathering is described.In Section 3Various aspects pertaining to the impact of extra food on avian biodiversity are analyzed. Section 4 discusses the impact of complementary feeding of avian biodiversity as it pertains to efficiency, and Section 5 provides several conclusions.

MATERIALS AND METHODS

Bird feeders were located by observing birds in fly and directly recording their behaviors. When the weather was good, birds were observed. We collected the amount of bird feeders that were filled and empty. The types of feeders have extra food sources that the birds can accessand subsequently, the birds themselves. A distance was observed to determine the birds at the feeder and those resting to ensure and to not disturb them.

Dataset

We used the dataset from the CVIP 2018 (16) Bird Species test for our research. The test dataset has 158 images, and the training dataset has 150 images featuring 16 different kinds of birds. The high-resolution images in the

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dataset span from 800 x 600 – 4000 × 6000. There are five images from one species and twenty from other species in the class-imbalanced dataset. Various environments, occlusions, and perspectives were used to capture those bird images. These circumstances make it impossible to identify birds from images without their localization.

Selection criteria

Inclusion criteria

Research assignments, observations, and field investigations that investigate into complementary feeding affects avian biodiversity will be included in this project. It addressing different kinds of birds and they react to complementary feeding methods will be taken into consideration. Significant details regarding the ecological effects of additional feeding on bird populations, including species variety, abundance, and distribution, needs to be provided by the included research.

Exclusion criteria

This analysis will not include any research that does not discuss how extra food affects avian biodiversity. Inadequate data exclusively analyze the behavior of a single bird without considering its implications for biodiversity as a whole cannot be accepted. To ensure the validity and dependability of the results, conference abstracts, non-peer assessed research, and research with unstable methodology will all be excluded.

Different types of feeding

HO, WB, and GP observations are the emphasis of the investigated comparative examination of bird feeding practices in urban and rural conditions. A variety of birds feeding systems are included in the study, including FF, LF, AF, and ASF. The intent of this research is to explain the differences in feeding behaviors between these bird species in various environments and feeding techniques through calculated observations carried in rural and urban environments. Figure (1) demonstrates the bird breeding types.

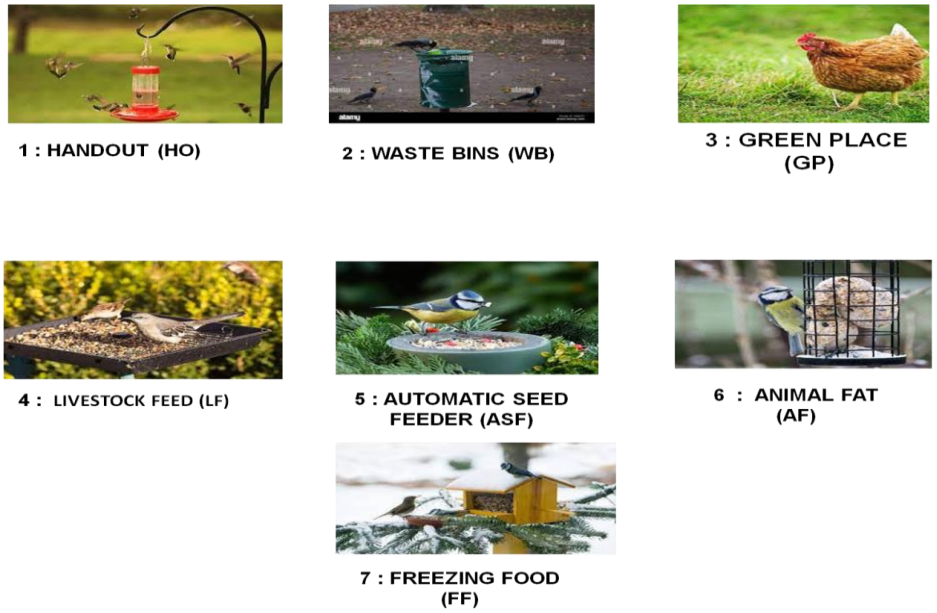

Figure (1). Different types of feeding birds (Source: Author)

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Statistical analysis

Mann-Whitney tests

The Mann-Whitney tests are utilized to assess functional data, using random projections.

Given a random process with a median function $\theta(s)$for$j\epsilon S,$ established in the area $D(J)$ of real constants on the compacted interval$J$, let $W_1(s),\dots,andW_m(s)$ be samples from the process. The relevant principles are provided by equation (1-9)

$$G_0\colon \theta(s) = \theta_0(s) versus G_0\colon \theta(s) \neq \theta_0(s) \quad (1)$$

Where, a specific function is denoted by$\theta_0(s)$. To conduct the examination

$$\text{Describe } Y_j(s) = W_j(s) - \theta_0(s), forj = 1..,m \quad (2)$$

Produce a Brownian motion $u, fors \in S$

$$\text{Obtain arbitrary projections } Y_j = \int_S Y_j(s)u(s)dt, forj = 1,\dots,m \quad (3)$$

Let,θ represent Y' median. Next, for $Y_j, Forj = 1,..,m,$ test the assumptions provided and based on W_j

$$G_0\colon \theta = 0\ versus G_1\colon \theta \neq 0, \quad (4)$$

For every $s$in$S$, the paired function sample $(W_{11}(s), W_{12}(s),\dots, W_{m1}(s), W_{m2}(s))$ is derived from bidirectional functional vectors$(W_1(s), W_2(s))$ having averages$\theta_1(s) and \theta_2(s)$, respectively.

$$G_0\colon \theta_1(s) = \theta_1(s)\ versus G_1\colon \theta_1(s) \neq \theta_2(s), \quad (5)$$

$$\text{Establishing } Y_j = |\int_S Y_{j2}(s)u(s)dt - \int_S Y_{j1}(s)u(s)dt| \ and\varphi_j as \quad (6)$$

$$\varphi_j = \begin{cases} 1, if \int_S Y_{j2}(s)u(s)dt > \int_S Y_{j1}(s)u(s)dt; \\ 0, if \int_S Y_{j2}(s)u(s)dt \leq \int_S Y_{j1}(s)u(s)dt; \end{cases} \quad (7)$$

Standardizing the statistics enables the use of an extensive sample estimation using the Gaussian distribution.

Let $W_1(s),\dots,W_n(s) and Z_1(s),\dots,Z_m(s)$be two separate random samples drawn from the functional parameters$W(s) and Z(s)$, with corresponding medians of$\theta_w(s) and \theta_z(s)$.

$$G_0\colon \theta_W(s) = \theta_Z(s)\ versus G_0\colon \theta_W(s) \neq \theta_Z(s), \quad (8)$$

The arbitrary projections provided by

$$W_j = \int_S Y_j(s)u(s)dt, j = 1,..,n, \quad (9)$$

$$Z_j = \int_S Y_i(s)u(s)dt, i = 1,..,m, \quad (10)$$

Equation (10) utilized another time to evaluate these hypotheses with the Mann-Whitney.

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Shannon-Wiener Index (H)

Using the following formula, the Shannon-Wiener diversity index H was determined.

Where:

The diversity index of Shannon is denoted by$H$. The proportion of individuals within a species$'j'$ is indicated byPi. The total species amount is denoted byl'.

A higher number denotes greater diversity. The Shannon-Wiener index H measures diversity by including consideration of the corresponding proportion of each species.

RESULT

A powerful hardware configuration powers the experimental environment for this investigation of examining the Effect of Complementary feeding on Avian Biodiversity, including an Intel(R) Core(R) i9-12900 KF 3.90 GHz CPU, 64 GB of RAM. The Windows 11 64-bit operating system has been used. Python 3.8.10 is the language used in the software environment, and CUDA 11.6 is used to enable use of GPU acceleration for improved computational performance.

The number of feeders for birds and feeding locations that provide extra food

The quantity of bird feeders available varied between urban and rural locations Table (1) the percentage of food feeders is comparable in both urban and rural. There were significant variations in specific quantity types of bird feeders in rural and urban locations. The slight variation in other feeder types was mostly caused by urban-rural variations in feeder types 1 (HO), 2 (WB), 3 (GP), 4 (LF), 5 (ASF), 6 (AF), and 7 (FF).

Table (1). Research areas in both rural and urban regions (Source: Author)

Variable	Rural	Urban	P	t value
Quantity of food-filled bird feeders	4.42±0.39	7.90±0.39	<0.001	−3.431
Quantity of bins	1.11±0.29	5.93±0.29	<0.001	−6.267
The number of feeders for birds	8.98±0.62	15.92±0.62	<0.001	−0.761
% of food-filled bird feeders	51.13±1.81	54.87±1.80	0.144	−0.484
Number of extra food establishments	0.52±0.10	1.20±0.10	<0.001	−3.147

Avian

27,000 individual avian from 51 species (18,076 at bird feeders, 8,924 at control a point) were counted (42 and 43 at feeders and control points). There were specific avian feeder and control point kinds that were linked to birds. Types of bird feeders and their distribution are illustrated in Figure (2) and Table (2).

Urban birds can be used to observe people and can take HO of food, such as fruits, seeds, or bread crumbs. Some birds in towns gather food from WB, consuming food that people put away. Natural food of GP sources including bugs, berries, and seeds can be found by birds in urban gardens, parks, and other green areas. In rural areas, ASF birds can eat grains and insects that are components of the avian feed. Sparrows and finches are drawn to bird

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feeders with automated dispensing systems, which are used by automatic seed feeders. Bird observation and the welfare of birds in towns and cities are supported and offer a reliable and accessible source of seeds. An explosive food source, particularly during cold weather, can be given to birds by feeding them AF, such as suet. Suet attracts many different species of birds to backyard bird feeders and provides them with vital nutrients and calories for a more effective existence, especially in the winter.Certain birds use the cold to store food when living in colder climates. An example, it would be a bird impaling a meal piece in a fissure or on a thorn and letting it freeze there. This gives an opportunity to have FF.

Table (2): Comparison feeding bird in urban and rural areas (Source: Author)

Types of Bird Feeding	Comparison of urban and rural areas	
	Rural	Urban
HO	165	140
WB	15	50
GP	103	122
LF	120	125
ASF	75	83
AF	58	43
FF	10	13

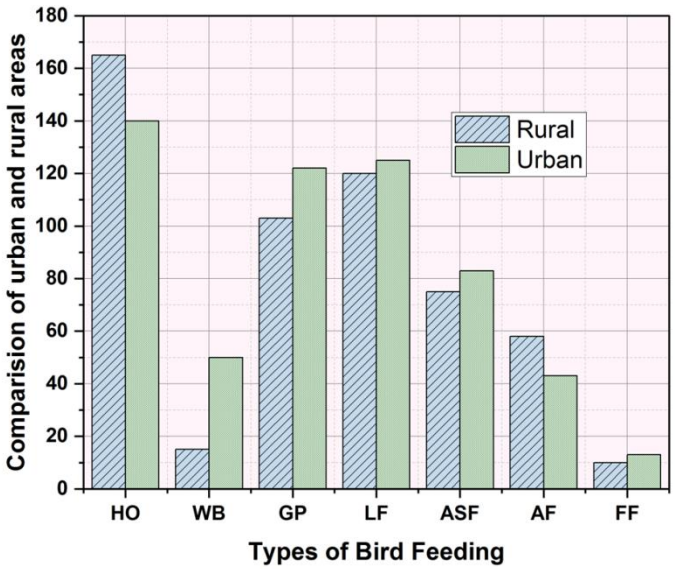

Figure (2). Types of bird feeders and their distribution(Source: Author)

DISCUSSION

This investigation uses an extensive list of bird species to examine the effects of extra food on avian biodiversity. Through researching feeding habits, we want to gain insight into how these habits affect the ecological dynamics and diversity of bird populations that will help with ecosystem management and avian conservation. There is a difference between urban and rural places, even though the more linked and urbanized the world grows. There were many causes that the human feeding habits of birds differed in urban and rural locations. The proportions of people

living in cities and the design of their housing and large residences have an impact on the amount people and birds interact. People's financial circumstances can be significant. Because rural regions tend to be poorer, they offer cheaper bird food, like animal fat. We demonstrated that the feeders are appealing to birds and could provide food for individual wintering birds in both urban and rural locations. Certain species prefer having the winter in rural regions, and others prefer urban environments. Large species, including ducks, corvids, and gulls are known for winter.Cities offer plenty of possibilities for birds. The species is more common in rural areas people set converge animal flesh and fat on trees with fruitthat occur to an essential wintering place for the bird. This species is paradoxically associated with fieldfare. The varied food offered in different feeder types is probably leads to the usage of different bird feeders. Various food sources and types of bird feeders can influence bird communities in both rural and urban settings by behaving a mediator in species relationships and winter preservation of particular species.

CONCLUSION

Finally, our extensive examination of the impact of complementary food sources on avian biodiversity demonstrates complex relationships with different bird species. Extra feeding can attract a variety of species, but to minimize adverse consequences, proper management is required. For effective bird preservation measures in the framework of complementary feeding practices, establishing a balance between maximizing ecological damage and developing biodiversity is essential. Examining persistent changes in avian biodiversity after complementary feeding, estimating possible ecological effects, and creating sustainable feeding techniques comprise every part of the future scope. For the objective of preserving sustainable bird populations in a variety of habitats, this research can assist in affecting conservation plans and regulations.

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