Publiscience Vol. 5 Issue 1

The relationship between urbanization indicators and the *Passer montanus* bird count in urban and urban sprawl areas in Iloilo and Bacolod, Philippines

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Article Info

Submitted: Jun 02, 2022
Approved: Jul 13, 2022
Published: Jul 27, 2022

Keywords:
bird survey
Passer montanus
urbanization
citizen science
urban adapter

Abstract

Urbanization leads to the depletion of vegetation that provides food, habitat, and breeding grounds for *Passer montanus*. Data was collected from Bacolod City and Iloilo, Philippines, using citizen science to assess the *P. montanus* bird count in relation to urbanization indicators. The distances of the participants' residences from the city center and nearest main road were determined. Point count was performed while observing *P. montanus* that perched, people, moving vehicles, and predominant vegetation type seen during the observation period. Through R-4.1.2 Programming, the Eta coefficient test showed a weak association between *P. montanus* and the predominant vegetation type. The Spearman correlation indicated that the species and vehicles were moderately correlated while the rest of the data pairs had no significant correlation. In urban environments, urban adapters, *P. montanus*, persist. The species is tolerant of humans and moving vehicles and has no specific vegetation that serve as forage sites.

Introduction. - *Passer montanus*, also known as Maya, originated from the common day West Germany and is considered one of the most common birds in the Philippines by The Haribon Foundation [1]. This species is often seen in thick hedgerows and bushy parks [2]. Habitat sites for *P. montanus* are located in residential areas, suburban areas, parks, and gardens [3,4].

In the Philippines, urbanization resulted from the merging of urban and agricultural land use due to the continuous development of topography [5]. It has been linked to the construction of pavements and buildings, depleting vegetation that may serve as food, habitat, and breeding grounds for birds, in turn contributing to the decline of their kind in urban areas [6]. Urban sprawl is indicated by the changes in the land-use pattern toward urban development [7]. It can be low-density residential development wherein houses are suddenly present in areas that were previously rural landscapes [8]. In this study, it signifies the growth of urbanization from lower city densities and undeveloped areas.

Research conducted in countries such as China [4], Israel [8], the Czech Republic [3], and Poland [9] on *P. montanus* imply the decline of the species population in highly urbanized areas. Because these birds rely on vegetation for food and habitat, their abundance is high in residential and suburban areas, low buildings, parks, and university campuses with a low degree of urbanization [3,4]. Skorka et al. [9] found that their abundance was high in areas away from the city center and with many streets. The species might be associated with diverse and mixed habitat composition, where they can find suitable foraging and nesting conditions [3]. Urban adapters, inclusive of both native and non-native animals, are predominant in intermediate urbanization level communities [10] because of humans and the many elements that come with their presence such as cultivated plants and garbage that they make available in the environment [11].

In this study, citizen science was used to gather data regarding the bird count of *P. montanus* by enlisting volunteers localized within the sampling sites. Citizen science targets the public across a wide range of localities to participate in data collection for projects [12]. Thus, the bird to be surveyed should essentially be familiar to the public. *Passer montanus* was chosen because it fits this criteria [1]. Citizen science is actively used in ecological projects and has been quite successful in providing information for bird monitoring projects, as bird-watching is popular with the general majority.

As far as can be determined, there have been no studies concerning the *P. montanus* bird count in urban and urban sprawl areas in Iloilo Province and Bacolod City. The mentioned sampling sites were chosen because they undergo urbanization and consist of a mixture of urban and urban sprawl areas. It is hypothesized that the number of *P. montanus* is positively correlated to the distance of the residence from the main road and city center and the predominant vegetation type, while it is negatively correlated to the number of people and moving vehicles.

The findings of this study can be used in bird-related studies concerning ecological habitats

How to cite this article:
CSE: Robles JAM, Sumagaysay SAG, Young ERB, Oberio Z. 2022. The relationship between urbanization indicators and the *Passer montanus* bird count in urban and urban sprawl areas in Iloilo and Bacolod, Philippines. *5*(1): 8-13.
APA: Robles, J.A.M., Sumagaysay, S.A.G., Young, E.R.B, & Oberio, Z. (2022). The relationship between urbanization indicators and the *Passer montanus* bird count in urban and urban sprawl areas in Iloilo and Bacolod, Philippines, *5*(1). 8-13.

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in response to urbanization. It could be used as a basis for projects focusing on preserving the habitat of birds by providing details on the type and characteristics of areas where birds would thrive and the possible important food and nest sites for birds within the city. Information regarding the association of animals and urban areas is essential to finding ways to manage wildlife in cities.

This study aims to assess the *P. montanus* bird count in residences of selected urban areas and urban sprawl areas of Iloilo Province and Bacolod City using citizen science. It specifically aimed:

(i) To determine the maximum number of *P. montanus* that perched within the participants' range of sight for thirty (30) minutes during the late afternoon (4:00 - 6:00 PM).

(ii) To determine the predominant vegetation type in the participants' observation area.

(iii) To determine the correlation between the maximum number of *P. montanus* observed in different sampling sites and the distance of the residence from the city center, the distance from the nearest main road, the number of people, and the number of moving vehicles using Spearman's rank correlation coefficient, and.

(iv) To determine the association between the maximum number of *P. montanus* in different sampling sites and the predominant vegetation type in the observation area using the Eta coefficient test.

Methods. - Data was collected using citizen science. Each participant performed a point-count bird survey. The researchers acquired each participant's residence coordinates used in calculating the distance of each residence to the nearest main road and city center. The participants provided the predominant vegetation type in their observation area.

Citizen Science Management. The researchers recruited participants through social media and partnered with the Department of Education. Citizen scientists voluntarily participated and were chosen through the following established criteria: (1) Participants were nine to 49 years old, (2) resided in Iloilo Province and Bacolod City, and (3) scored four out of five in the evaluation that assessed their skills in identifying *P. montanus*. The researchers distributed a copy of supplemental guides with a photo and description of the characteristics of the species based on the Birds in The City field guide created by The Haribon Foundation [13], and additional instructions. Optional orientation sessions were conducted through Zoom Meetings. Data was submitted to the submission link or other provided contact details.

Sampling Sites. The chosen sampling sites were Iloilo Province and Bacolod City. Each location was classified into two categories, namely urban areas and urban sprawl areas based on urbanization indicators, available data from the 2018 Iloilo Province Profile, and the Enhanced Provincial Development and Physical Framework Plan from the Province of Iloilo, containing a map identifying each municipalities' urbanization level. Bacolod City was classified as urban based on the Bacolod City Profile on the PhilAtlas website.

Passer montanus. *P. montanus*, a resident species in the Philippines, is known to locals as Maya and is one of the most common birds in the country [1]. An adult *P. montanus* is a "chunky sparrow with a chestnut crown, black throat, and a distinctive white cheek and black ear patch" [20]. Both male and female species share these characteristics and are similar in appearance. The species forages food on the ground, trees, and plants, usually in the form of gleaning and picking. In the Philippines, they may feed on rice [21].

Point Count Survey. The bird survey was conducted on any day of the week for 30 minutes between 4:00 P.M. to 6:00 P.M. The point count method is a purposeful bird survey method adapted from Paker et al. [8] where the point counts' surroundings are included in the study. In each residence, a single stationary observation point was determined. The participants stood on the point of observation with the best vantage point, where their range of sight is maximized. *P. montanus* was observed quietly in the observation point for thirty (30) minutes at a 180° angle or a half-circle. Other than the option of doing the survey outdoors, the participants were allowed to do it indoors, by looking out a window or by standing on a balcony, as long as they could have a good vantage point. Only the maximum number of perched birds that landed at any one time within the timeframe was noted. Perched means "to alight, settle, or rest on a perch, a height, or a precarious spot" [14]. Once the bird rested on a spot, it is considered perching. During observation, the number of individuals and moving vehicles that were seen in the observation area was accounted for.

Vegetation Type. The participants provided the predominant vegetation type of their observation area which refers to the plant type that covers most of the vicinity or is bountiful within the area. In the case of an equal distribution of plant types, the type recorded is the largest in size and is capable of outcompeting other plants by "controlling the availability of light, water, and other resources" [22].

Data Analysis. Two variables were correlated with each other at a time, these are: (1) the number of birds and distance of the residence from the city center, (2) the number of birds and distance of the residence from the nearest main road, (3) the number of birds and the number of people, and (4) the number of birds and the number of moving vehicles using Spearman's rank correlation coefficient. Moreover, the Eta Coefficient test was used to associate the predominant vegetation type with the number of birds. All statistical analyses were performed using R-4.1.2 Programming software.

Safety Procedure. The participants did not perform the activity: (1) when it rained, (2) during calamities, and (3) when participants were not in the proper condition. They were advised to apply sunscreen, wear caps, and check their surroundings. Moreover, the study complied with the Data Privacy Act of 2012 or RA 10173 when dealing with the

personal information of the participants.

Results and Discussion. - There were fifty-eight (58) participants who submitted complete data. Thirty-four are from Bacolod City and 24 are from all throughout Iloilo Province, such as Iloilo City (10.702561, 122.568579), Guimbal (10.667642, 122.299627), Miagao (10.668020, 122.197836), and Calinog (11.144736, 122.514609). Moreover, 13 of the participants from Iloilo Province are from urban sprawl areas, while the rest are from urban areas as shown in Figure 1.

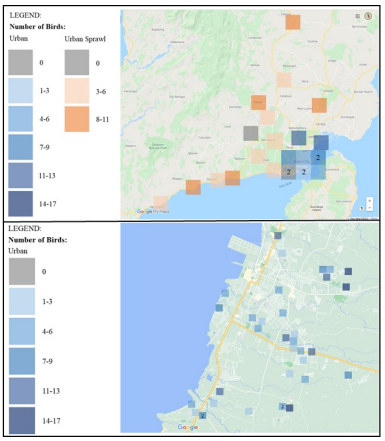

Figure 1. Map of the *P. montanus* bird count in urban areas and urban sprawl areas in Iloilo Province (above) and Bacolod City (below).

In urban areas, as many as seventeen (17) were counted, while in urban sprawl areas, eleven (11) birds were the highest bird count. Both areas included participants with no birds counted. The squares with "2" represent two data points, having two different participants' observation areas (Figure 1).

The Eta correlation coefficient, between the two variables: number of birds and predominant vegetation type, resulted in η=0.27 Eta Coefficient test statistic indicating a weak association (Table 1). Thus the null hypothesis, stating that there is no association between the number of *P. montanus* and the predominant vegetation type, is rejected.

Table 1. The calculated Spearman rank correlation coefficient and Eta coefficient test statistic for the number of *P. montanus* and urbanization indicators.

Variables	Calculated coefficient
Predominant vegetation type and the number of *P. montanus*	Eta coefficient test statistic (η): 0.27
Distance of the residence from the city center and the number of *P. montanus*	Spearman rho (r_s): 0.04 (P=0.75)
Distance of the residence from the nearest main road and the number of *P. montanus*	r_s: 0.02 (P=0.86)
Number of people and the number of *P. montanus*	r_s: 0.19 (P=0.16)
Number of moving vehicles and the number of *P. montanus*	r_s: 0.31 (P=0.02)

Accordingly, the number of birds observed in the observation areas having trees as the predominant vegetation type is more variable compared to the other types (Figure 2). The upper quartile and median of trees are higher than the other types, indicating that there is a higher number of birds observed in areas with trees as the predominant type. However, since the Eta Squared, which is 0.07, represents only 7% of the variance of the number of birds can be attributed to the vegetation type, the spread of the data is not highly associated with the vegetation. This further shows the weak association between the two variables.

Forty-five people reported having trees as their predominant vegetation type, while the other 13 reported other types including shrubs, herbs, grass, ferns, and succulents.

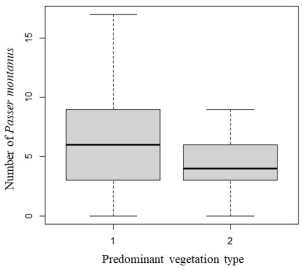

Figure 2. Correlation between the predominant vegetation type and number of *P. montanus* (1=trees, 2=other vegetation types).

Among all the pairs of variables, only the number of birds and the number of moving vehicles have a moderate relationship with a Spearman rho of rs=0.31, while the rest have a negligible relationship (rs<0.2) (Table 1). Figures 4 to 7 display the scatter plots of the number of *P. montanus* and the variables. As seen, there is no visible linear relationship as the points lie randomly on the graph.

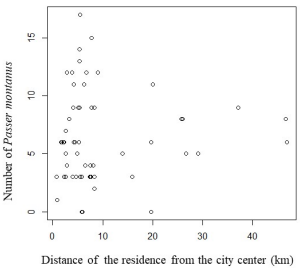

Figure 3. The relationship between the distance of the residence from the city center and the number of *P. montanus.*

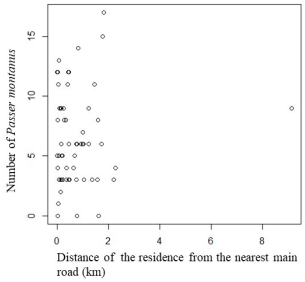

Figure 4. The relationship between the distance of the residence from the nearest main road and the number of *P. montanus.*

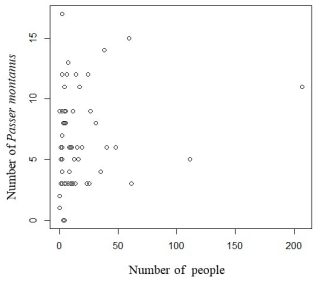

Figure 5. The relationship between the number of people and the number of *P. montanus.*

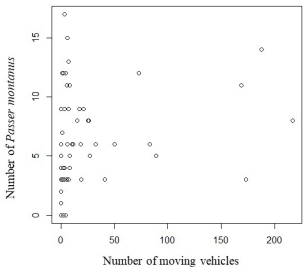

Figure 6. The relationship between the number of moving vehicles and the number of *P. montanus.*

In the sampling sites, it was observed that in urban environments, where there is habitat fragmentation and human disturbance, urban adapter species, particularly *P. montanus*, persist. Urban adapters are found in urban communities [11] and are predominant in these areas [10]. This is further supported by the gathered data, wherein the highest bird count of seventeen (17) was observed in the urban area with the coordinates: 10.672679, 122.995988 (Barangay Estefania, Bacolod City). Urban adapters take advantage of the resources provided by humans but do not depend on them [15].

Urbanization causes severe habitat fragmentation wherein the urban patches have discrete and high-contrast edges. According to Yuan & Lu [16], habitat fragmentation and disturbance caused by humans increase the number of urban adapters due to the diverse vegetation of the smaller areas, increasing the habitat's heterogeneity and attracting some bird species. In Iloilo and Bacolod, habitat fragmentation can be observed as wide areas of land, typically, vegetation areas, are transformed into smaller patches isolated from each other by deforestation or the construction of roads. Roads such as San Rufino Street (10.818954, 122.432563) in Alimodian, and Aleosan Road (10.780912, 122.465202) in San Miguel, Iloilo are mainly seen to divide the vegetation areas into smaller total areas. The bird count reported in these areas are six and five, respectively. Additionally, in some, small-scale deforestation occurred such as in Batuan Ilaya, Oton (10.742100, 122.429908), and M.V. Hechanova, Jaro, Iloilo (10.747357, 122.567027) to build the residences that can be seen now. The participants in both areas observed a bird count of three birds.

Our results show that *P. montanus* persists in urban and urban sprawl areas in the sampling sites with different built-up areas and vegetation coverage. In the study of Peh et al. [17], the term "persistent" was used to describe the species present in mixed-rural habitat observation areas. Even if only one bird was detected, the species was still classified as persistent since low abundance does not necessarily mean a negative species-habitat relationship [17].

The species has variable nesting habits, making them more resilient in adapting to environments [18]. Hollows of buildings may be important nesting spots in urban areas; areas with urban infrastructures and low-rise buildings including residences near Lacson Street (10.683290, 122.956049) and Araneta Avenue (10.638403, 122.931227) in Bacolod City, while gardens in residences may serve as foraging sites such as in the case of some participants living in subdivisions in Barangay Mansilingan (10.617908, 122.971113) and Barangay Estafania (10.669764, 122.987048) in Bacolod City.

Additionally, *P. montanus* is not a suitable biological indicator for urbanization in the sampling sites. Biological indicators are organisms associated with their environment. Their presence is indicative of the existence of certain conditions [19]. Based on the gathered data, *P. montanus* was observed in relatively high numbers in both urban and urban sprawl areas.

According to Yuan & Lu [16], vegetation within the area supports bird presence because they utilize it as habitat and food. In the study, however, despite the evidence that most of the participants reported having trees as the predominant type, it was found that there is no specific vegetation type that usually serves as the species' food and nest sites in the observation areas. As urban adapters, the *P. montanus* observed may have no specific preference for the vegetation they use for nesting and food. Their diet includes a variety of seeds and insects. In urban areas, they consume flowers, leaf buds, plant shoots, and even insects [20]. In the Philippines, *P. montanus* feeds on rice and seeds [21]. This supports the claim that it likely has a diverse diet that varies in different locations because of learned behavior and adaptation, and by relying on locally abundant food [22].

Some participants reported having a zero bird count. This is not due to human disturbance, as the participants observed only around 0-4 moving vehicles and people, which is lower compared to other reported data. Participants said that it may be due to their chosen time. Before the time started, birds can be seen perching. But, when the time started, no perched birds were observed. Because of the varying observation times, environmental factors such as the weather conditions not considered in the study may have affected the bird count.

The results of this study indicate that the *P. montanus* bird count has no relationship with the number of people. The birds may have adapted to the presence of humans. Studies show *P. montanus* could adapt to human environments and even increase in number; however, they are unable to adapt to the rapid expansion of urban development as it decreases vegetation coverage [16, 4].

An increase in main roads results in high vehicle flux. There was no association between the bird

count and the distance of the residences from the nearest main road. According to the study of Zhang & Zheng [4], city centers and main roads may not be suitable environments for *P. montanus* due to the high human population and vehicle flux, nevertheless, some participants were able to report a high bird count despite residing near or even by the main road such as those residing near Lacson Street and Negros South Road (9.295563, 123.300249) in Bacolod City. This may be due to the presence of alternative sites for nesting and foraging, such as hollows in buildings and decorative trees. According to the study of Yuan & Lu [16], as the density of roads increases, there is a decrease in vegetative composition, which may negatively affect the species, suggesting that mixed areas having artificial surfaces and city green and less disturbance are suitable environments for the birds. Most of the observation areas in this study are mixed areas including Estefania in Bacolod and Pavia (10.760336, 122.525959) in Iloilo.

Based on the results, the number of birds and number of moving vehicles have a moderate relationship. The surveyed species are tolerant of vehicles because in some areas with high vehicle flux, *P. montanus* can still be seen. The bird may also perch in taller buildings farther from the ground where there are moving vehicles, where disturbance and noise pollution brought by the vehicles is reduced. This can be observed in residences near Iloilo City Proper (10.695209, 122.564690). However, in urban sprawl areas farther from the city center, the cars may enter the observation area in intervals and do not produce loud sounds, as observed by a participant in Pavia, Iloilo.

Limitations. The study did not account for meteorological conditions during the bird survey. Furthermore, due to restrictions at the time of the study, the survey is restricted to the participants' residences. The data is also not widely distributed geographically and is mostly concentrated within urban areas since prospective participants from rural areas are difficult to contact. Thus, no data was gathered from rural areas which were initially included in the scope to be studied. Communication barriers and data quality were the major limitations since the participants conducted the bird survey without the researchers' supervision. Nonetheless, supplemental guides were provided to aid the participants. Lastly, research conducted on the relationship of *P. montanus* and urbanization dealt with the abundance of species, while this study focused on the *P. montanus* bird count.

Conclusion. In urban environments in Iloilo Province and Bacolod City where there is habitat fragmentation and human disturbance, urban adapter species, particularly *P. montanus*, persist. In urban areas, as many as seventeen were counted, while in urban sprawl areas, eleven birds were the highest bird count observed. There is no specific vegetation type that usually serves as the species' food and nest sites in the observation areas. The species is also tolerant of the presence of humans and to moving vehicles. Mixed areas with artificial surfaces and city green are important sites for the species. Thus, the conservation of diverse patches with vegetation, serving as foraging sites, and buildings, for nest sites, are essential for *P. montanus* to establish populations in urban areas.

Recommendations. - Further research should be conducted on the relationship between specific plant groups and *P. montanus*. In the study, only vegetation type categories based on the physical characteristics of the plants were considered. The researchers also recommend studying a broader scope of the geographical area to better understand the relationship between *P. montanus* or other species to varying land characteristics, namely in urban, urban sprawl, and rural areas. Lastly, the researchers may consider the weather conditions during the survey. The research may be used to conduct studies in other birds, especially those endemic in the country. A longer duration should also be considered, especially when citizen science is involved and if there will be more than one observation.

Acknowledgment. - The researchers would like to express their gratitude to the Department of Education Iloilo and Bacolod Division for endorsing the bird survey in their respective schools and for their assistance in the recruitment aspect. The researchers would also like to thank the Provincial Planning and Development Office, Iloilo, for providing the framework map of Iloilo Province.

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