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Research Article

Diurnal Avifaunal Species in the Designated Mangrove Eco-park in Cabadbaran City, Philippines

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ABSTRACT

The Cabadbaran Mangrove Eco-Park (CaME) intends to rehabilitate and establish eco-tourism through nature immersion and birdlife watching. However, baseline assessment of avifauna is lacking. Thus, this study aimed to identify the composition of diurnal bird species present in the designated mangrove eco-park, determine the diversity, dominance and evenness of the mangrove avifauna, and compare the bird species richness in the three sites. A total of 36 avian species representing 24 families and 9 orders were recorded during the study. Among the 373 individuals documented, 181 were found in abandoned fishponds which is 49% of all bird individuals; while *C. hybrida, T. stagnatilis,* and *E. garzetta* were the most abundant species. Shannon-Wiener diversity index revealed that mangrove site (H'=2.78) was the most diverse among the three sites which can be attributed to the presence of lush vegetations. Conversely, dominant species were recorded in the abandoned fishponds which were composed of migratory species mostly. There was a significant difference of species richness in mangrove site compared to other sites since species richness was highly influenced by vegetations. Moreover, this study also documented the first scientific record of migratory species in the area, which could be one of the stopovers of migratory species. Henceforth, the estuary of Cabadbaran City offers a suitable habitat for migratory and non-migratory birds.

Key words: Eco-park, abundance, diversity, Cabadbaran City, avifauna

INTRODUCTION

For the past century, the decline of global mangrove forest has been recorded (Friess *et al.,* 2019). From 2000 to 2016 alone, 62% of the global mangrove loss was caused by human activities and 92% mangrove loss in Southeast Asia was due to the extraction of resources by humans for commodities (Goldberg *et al.,* 2020). In the Philippines, the remaining mangrove forest cover was 356,000 hectares in the year 2015 (FAO, 2015). The recent report on the mangrove cover was still less than the original cover in the year 1920 with 400,000-500,000 hectares (Primavera 2000). On the other hand, FAO (2007) reported that starting in 1980, the Indo-Malay Philippines Archipelago registered as one of the regions that rapidly lost its mangroves at a rate of 30%. Furthermore, the Philippines is ranked tenth when it comes to the areal loss of mangrove in the entire world (Bryan-Brown *et al.,* 2020). Conversion to aquaculture and unsustainable utilization of the forest is seen to be the major culprits in the decline of trees in the past years (Bryan-Brown *et al.,* 2020; Primavera, 2000). This recurring event prompted several agencies in the country like the Local Government Units (LGU), Non-government Organizations (NGO) and People's Organization (PO) with external funding from Overseas Economic Cooperation Fund of Japan and World Bank, to name a few, to rehabilitate and conserve the remaining forest cover (Primavera and Esteban, 2008).

Goldberg *et al.,* (2020) noted that there is a decline in mangrove destruction due to the enthusiasm in mangrove rehabilitation worldwide. However, the implementation stage is the most difficult part noting the poverty level in the country is high. People tend to utilize and exploit resources from the mangroves for their livelihood. One way of conserving the mangroves while involving people in the coastal areas is by setting up ecological parks. The involvement of locals in the rehabilitation, also known as community-based-approach, is vital in the success of the conservation efforts (Valenzuela *et al.,* 2020). This result in the reduction of mangrove exploiters and allow the forest to regenerate and attract diverse faunal species such as molluscs, fish, crustaceans, reptiles, and birds. Besides, Salam (2000) emphasized the increment of global eco-tourism, especially in national parks, and other restricted areas and this includes mangrove parks.

In mangrove setting, birds are seen to be one of the major factors for tourist to visit the area (Rahmila and Halim 2018). Spalding and Parrett (2019) reported that birds, as key mangrove attraction, is noted by tourists in 566 sites around the world in the popular travel website, TripAdvisor. The number is 28%, highest among other wildlife categories such as firefly, bioluminescence, monkey, manatee, dugong, crocodile, and alligator. Aside from being the major attraction for tourists, migratory birds also use mangrove as stopover to feed on cructaceans and molluscs that are abundant in some mangrove forests (Nagelkerken *et. al*., 2008; Azimah and Tarmiji, 2018). And because of this prey-predator relationship, avifaunal community in the mangrove forest is considered to be an important

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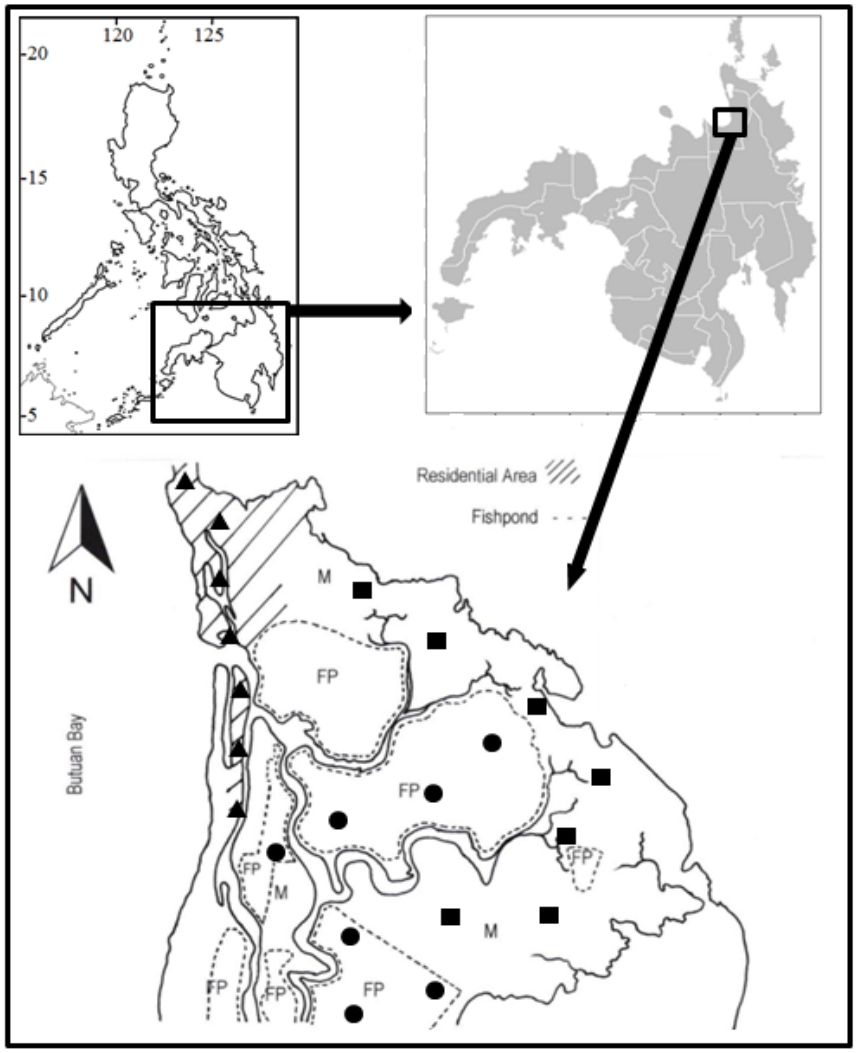

Figure 1. The location of the mangroves in the coast of Cabadbaran City, Philippines. Triangle=observation points in the residential area; Circle=observation points in abandoned fishponds; Square=observation points in the mangrove forest; FP=Fishponds; M=Mangroves.

bioindicator in determining the status of the area (Canales-Delgadillo *et al.,* 2019).

The city of Cabadbaran in the southern Philippines, in cooperation with several local and national agencies, signed an agreement to create the city's first mangrove park; the Cabadbaran Mangrove Eco-Park (CaME). It aims not only to rehabilitate the exploited mangrove forest but also to establish eco-tourism through nature immersion and birdlife watching. However, baseline assessment of faunal species, one of which is avifauna, is lacking. Thus, this study aimed to: 1) identify the composition of diurnal bird species present in the designated mangrove eco-park in Cabadbaran City, 2) determine the evenness, dominance, and diversity of the mangrove avifauna, and 3) compare the birds species richness the in three observation sites. The preliminary survey of birds in the mangrove area of Cabadbaran provides data on the current status of the place. In addition, the study furnishes information on the planned strategies in the eco-tourism of the mangrove park.

MATERIALS AND METHODS

Description of the study site

The study was conducted in the estuarine area of Barangay La Union, Cabadbaran City, the designated area for the proposed Cabadbaran Mangrove Eco-Park (CaME) with the coordinates of 9°07'29" N 125°32'12" E. The establishment of the park is a joint effort of Cabadbaran City Local Government Unit, Caraga State University Cabadbaran Campus, Department of Environment and Natural Resources, Bureau of Fisheries and Aquatic Resources and the local community. Memorandum of Agreement was already signed among mentioned agencies. The mangrove cover in the area as of 2020 is 116.9 hectares. Couple of decades ago, many parts of the mangrove forest were cleared to give way to the construction of aquaculture facilities. But many fishponds were abandoned leaving few to no trees and just empty spaces.

The study area, which is a portion of Barangay La Union, were divided into three sites (Figure 1). The sites were partitioned based on their different characteristics. Site 1 is the residential site adjacent to the mangroves which was originally a mangrove forest. On the other hand, Site 2 is the abandoned fishponds found inside the mangrove forest. This mangrove area was converted to aquaculture, but many fishponds are not operating anymore leaving the place unproductive. Lastly, Site 3 is the remaining mangrove forest cover which contains all the species of mangrove and

Table 1. The coordinates of bird observation points in the three sites in La Union, Cabadbaran City.

Sampling Stations	Coordinates
Site 1 – Residential Site	9˚05'16" N 125˚32'01" E
	9˚05'03" N 125˚32'06" E
	9˚04'56" N 125˚32'09" E
	9˚04'45" N 125˚32'11" E
	9˚04'38" N 125˚32'09" E
	9˚04'30" N 125˚32'09" E
	9˚04'19" N 125˚32'09" E
Site 2 – Abandoned Fishponds Site	9˚04'15" N 125˚32'24" E
	9˚04'20" N 125˚32'32" E
	9˚04'26" N 125˚32'40" E
	9˚04'00" N 125˚32'28" E
	9˚04'12" N 125˚32'15" E
	9˚03'55" N 125˚32'38" E
	9˚03'51" N 125˚32'24" E
Site 3 – Mangrove Site	9˚04'48" N 125˚32'32" E
	9˚04'43" N 125˚32'38" E
	9˚04'32" N 125˚32'53" E
	9˚04'23" N 125˚32'57" E
	9˚04'18" N 125˚33'00" E
	9˚04'04" N 125˚32'54" E
	9˚04'04" N 125˚32'42" E

mangrove associates. These species are the *Avicennia marina, Avicennia alba, Avicennia rumphiana, Rhizophora mucronata, Rhizophora apiculata, Sonneratia alba, Sonneratia caseolaris, Bruguiera sexangula, Aegiceras corniculatum, Nypa fruticans, Acanthus volubilis, Acanthus ilicifolius* and *Acanthus ebracteatus*. In each site, seven observation points were assigned where the birds were observed (Table 1).

Avifaunal sampling technique

In recording the presence of bird species in La Union, point count method was performed (Bibby *et al.,* 2000). Seven observation points in each site were randomly identified and were located by the observers throughout the study period. Between each point, a distance of approximately 300 meters were determined. By doing so, we limit the occurrence of duplication of counting. Birds present within the estimated radius of 100-meter from the observation point were counted. Moreover, a 10-minute visual observation time was done before moving to the next point. The observation was also done once a month for four consecutive months from August to November 2019. The time of bird observation started from 0600 to 1800 hours. Overall, the total observation hours spent was 14 hours with 4.67 observation hours per habitat. A Guide to the Birds of the Philippines by Kennedy *et al.,* (2000) was used to identify all the bird species recorded through visual observations. The International Union for Conservation of Nature (IUCN) Red List (2021) was used to determine the conservation status and population trend of each species.

Statistical analyses

The free software Paleontological Statistics version 2.17c was used to analyze the biodiversity indices specifically the Shannon-Wiener diversity, evenness and dominance (Hammer, 2012). Moreover, in determining the normality of the data, Shapiro-Wilk Normality Test was performed. Afterwards, the difference, in terms of species richness, across sites were determined using Kruskal-Wallis and Dunn's Tests.

RESULTS AND DISCUSSION

A total of 36 avian species representing 24 families and 9 orders were recorded during the study conducted from August to November 2019. Among the 373 individuals documented across three sites, 181 were found in site 2 (abandoned fishponds) covering 49% of the observed individuals. In terms of the number of species, mangrove forest had the highest richness with 26 species compared with sites 1 and 2 with only 11 and 13 recorded species, respectively. The presence of Order Charadriiformes during the northeast monsoon season is also a significant finding because all species under this Order were migratory birds according to the works of Bamford *et al.* (2008) and Jensen (2018). This finding further implies that La Union may be one of the stopovers of birds from Siberian Region that travels south *via* East Asian-Australasian Flyway. Seven annual migratory species coming from Order Charadriiformes were recorded namely *Pluvialis fulva*, *Charadrius leschenaultii, Tringa totanus, Numenius phaeopus, Tringa nebularia, Tringa stagnatilis,* and *Chlidonias hybrida.* These seven species were the first scientifically documented migratory species in Cabadbaran City during the northeast monsoon season. Migration of birds from the Siberian Region going south, traversing the East Asian-Australasian Flyway, towards the warmer regions including the Philippines is an annual sighting.

Table 2. The list of avian species with their respective families, order and IUCN conservation status and population trend. S1=residential area; S2=abandoned fishponds; S3=mangrove forest; LC=Least Concern; VU=Vulnerable; SW=Southwest monsoon; NE=Northeast monsoon; IN=Increasing; DC=Decreasing; ST=Stable; UK=Unknown; + =present; - =absent

Order and Family	Scientific Name	S1	S2	S3	Total	IUCN Red List Status 2021	Population Trend IUCN 2021	SW	NE
Accipitriformes									
Accipitridae	*Haliastur indus*	0	0	2	2	LC	DC	+	-
	Spilornis cheela	0	0	2	2	LC	ST	+	-
Anseriformes									
Anatidae	*Anas luzonica*	0	2	0	2	VU	DC	+	-
Charadrii-formes									
Charadriidae	*Charadrius leschenaultii*	0	13	0	13	LC	DC	-	+
	Pluvialis fulva	0	8	0	8	LC	DC	-	+
Laridae	*Chlidonias hybrida*	0	45	2	47	LC	ST	-	+
Scolopacidae	*Numenius phaeopus*	0	2	0	2	LC	DC	-	+
	Tringa nebularia	0	5	0	5	LC	ST	-	+
	Tringa stagnatilis	0	43	0	43	LC	DC	-	+
	Tringa totanus	0	15	0	15	LC	UK	-	+
Columbiformes									
Columbidae	*Geopelia striata*	3	0	3	6	LC	ST	+	+
	Treron vernans	0	0	1	1	LC	ST	+	-
Coraciiformes									
Alcedinidae	*Todiramphus chloris*	3	0	7	10	LC	DC	+	+
Meropidae	*Merops philippinus*	4	0	0	4	LC	ST	+	+
Cuculiformes									
Cuculidae	*Centropus sinensis*	0	0	2	2	LC	ST	+	+
Gruiformes									
Rallidae	*Gallinula chloropus*	0	0	2	2	LC	ST	+	+
Passeriformes									
Artamidae	*Artamus leucorynchus*	6	0	2	8	LC	ST	+	+
Campephagidae	*Lalage nigra*	0	0	5	5	LC	DC	+	+
Corvidae	*Corvus macrorhyncus*	0	0	4	4	LC	UK	+	-
Dicaeidae	*Dicaeum australe*	1	0	2	3	LC	ST	+	+
Hirundinidae	*Hirundo tahitica*	5	2	4	11	LC	UK	+	+
Laniidae	*Lanius cristatus*	0	0	3	3	LC	DC	-	+
Muscicapidae	*Cyornis rufigastra*	0	0	1	1	LC	DC	-	+
Nectarinidae	*Cinnyris jugularis*	6	0	0	6	LC	ST	+	+
Pachicepha-lidae	*Pachycephala cinerea*	0	0	10	10	LC	ST	+	+
Passeridae	*Passer montanus*	19	0	21	40	LC	DC	+	+
Pycnonotidae	*Pycnonotus goiavier*	6	0	26	32	LC	IN	+	+
Rhipiduridae	*Rhipidura nigritorquis*	5	0	1	6	LC	ST	+	+
Sturnidae	*Aplonis panayensis*	10	0	4	14	LC	UK	+	+
Pelicaniformes									
Ardeidae	*Ardea purpurea*	0	0	5	5	LC	DC	+	+
	Ardeola speciosa	0	3	1	4	LC	UK	+	+
	Butorides striata	0	2	5	7	LC	DC	+	+
	Egretta alba	0	3	0	3	LC	UK	+	+
	Egretta garzetta	0	38	3	41	LC	IN	+	+
	Ixobrychus cin-namomeus	0	0	2	2	LC	ST	+	+
	Ixobrychus sinensis	0	0	4	4	LC	UK	+	+
	Total No. of Individuals	68	181	124	373				
	Number of Species	11	13	26					

Recording the presence of migratory birds that travels along this flyway in La Union, Cabadbaran City entails the importance of the area as the possible resting and feeding grounds for these birds. According to Bamford *et al.* (2008), a flyway are regions that support migratory birds throughout their annual cycle. The designated mangrove eco-park in La Union supports migrating bird populations during the northeast monsoon only since there was no sightings of migratory birds during the southwest monsoon. On the other hand, all species belongs to the Least Concern Category of the IUCN Red List 2021 except for *Anas luzonica* which was categorized as a vulnerable species. Table 2 shows the list of avian species documented in three zones together with their IUCN conservation status and population trend.

In terms of the species relative abundance, the result revealed that the *C. hybrida* had the highest percentage with 12.6% followed by *T. stagnatilis* (11.5%), and *E. garzetta* (11.0%). The top three abundant species were found in abandoned fishponds. Several factors were considered aside from the presence of abundant food. According to Jensen (2018), terns, egrets and medium or small shorebirds prefer fishponds as their habitat. In addition, fishponds attract large populations of shorebirds as reported by Jensen (2018). With this suitable environment for these species, their abundance can be attributed to the factors mentioned above. Figure 2 shows the relative abundance of bird species in the entire designated mangrove eco-park in Cabadbaran City.

The overall relative abundance of birds in different sites showed that Site 2 had recorded a total of 49%, the highest among others, followed by Site 3 with 33% and Site 1 with only 18%. The number of individuals was concentrated in site 2 which was composed of 13 species. Majority of the species on this site are from Orders Charadriiformes and Pelicaniformes. Flocks of migratory birds under Order Charadriiformes aggregated the open spaces of abandoned fishponds to forage on abundant molluscs and crustaceans. According to Beauchamp (2011), long-distance migrating birds tend to travel in larger groups for several reasons such as increase in navigational accuracy during migration. These groups endure harsh places such as oceans that tests the limits of their physiological abilities (Klaassen *et al*., 2012). As a result, migratory birds, upon arriving at their stopover, are refueling their bodies with energy by foraging food in the most convenient way possible. This is supported by the work of Hambali *et al.* (2020) which stated that stopovers are vital in determining the success of bird migration. Upon observing the birds during the study, it was found out that open spaces such as abandoned fishponds provided a convenient feeding area for birds. In contrast, low abundance of birds was documented in the residential zone of the coastal La Union. Among the three sites observed, residential site had the lowest abundance because of human disturbances and this is the major factor observed in this study. In La Union, the residential site is composed of closely-

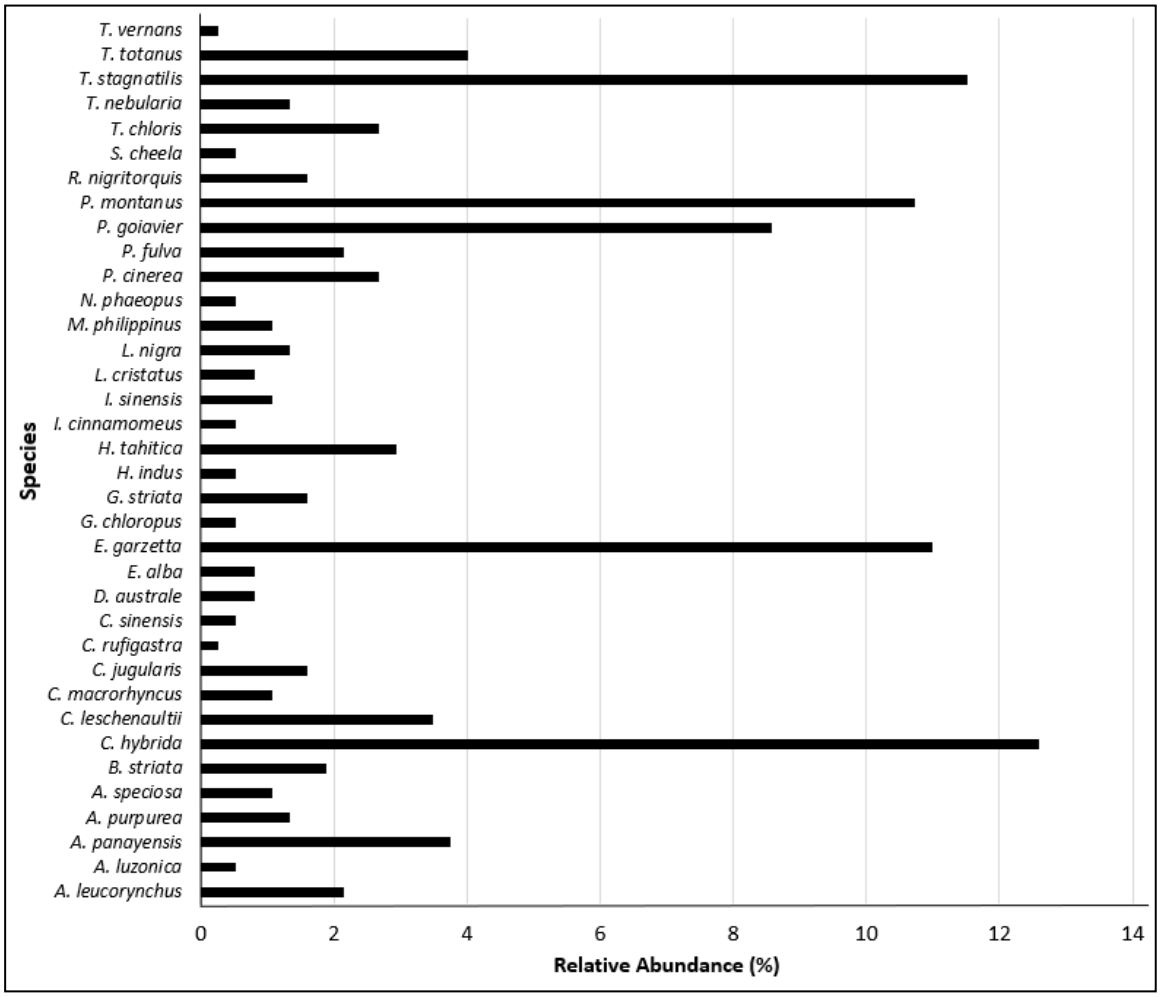

Figure 2. The relative abundance (%) of bird species in the estuary of Barangay La Union, Cabadbaran City

Table 3. The diversity indices of avifaunal species in three sites in the designated mangrove eco-park in Cabadbaran City, Philippines.

Indices	Sampling Sites		
	1	2	3
No. of Species	11	13	26
No. of Individuals	68	181	124
Shannon-Wiener (H')	2.169	1.983	**2.783**
Dominance	0.141	**0.178**	0.096
Evenness	**0.795**	0.559	0.622

packed housing structures, beach resorts and a mini-market. In addition, the construction of a kilometer long breakwater was evident.

The mangrove site (Site 3) recorded the highest Shannon-Wiener diversity index value with H'= 2.783 while the residential and abandoned fishponds registered values of H'=2.169 and H'=1.983, respectively. Based on these values, the mangrove and abandoned fishponds were classified to be moderately diverse while the residential site was classified as low in diversity. On the other hand, abandoned fishponds registered the highest value in terms of the species dominance with 0.178. Species evenness is highest in the residential area having a value of 0.79. Table 3 shows the values of various diversity indices among three sampling sites in the designated mangrove eco-park in Cabadbaran City.

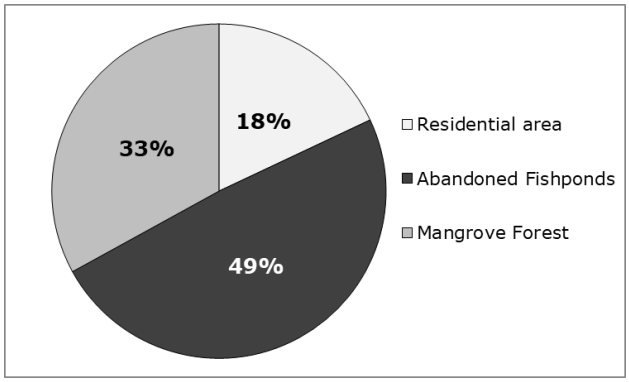

Figure 3. Relative abundance (%) of birds in different sampling sites in the mangrove estuary of Cabadbaran City, Philippines

In terms of diversity, Shannon-Wiener diversity index showed that the mangrove site (Site 3) had the highest value with 2.783. This finding can be attributed to the presence of lush vegetations in the site in comparison with other sites namely the residential and abandoned fishponds. The vegetations give protection and roosting place for numerous species. Asri *et al*., (2020) reported that bird diversity in Kelantan Delta in Malaysia was affected by habitat vegetation such as trees, shrubs and emergent vegetations to name a few. Trees act as their habitat and also a source of protection against predators. This finding was supported by the work of Jakobsson and Lindborg (2017) when they reported that bird diversity increased with tree density. Furthermore, it is also a place where food source such as insects, small reptiles and arboreal molluscs are found. These food sources can sustain bird population found in mangrove habitat. Food sources in the mangrove site are different to the food sources in the abandoned fishponds. It showed that different food sources attract different bird species that forage on their preferred food. The result showed the importance of mangroves to the diversity of birds in La Union, Cabadbaran City. On the other hand, anthropogenic activity was considered to be the major factor for the low diversity of birds in the residential site. Sheta *et al*. (2011) pointed out that habitat destruction by human activities caused the decline of bird diversity in the coast of Egypt. This factor is further supported by the work of Rodrigues *et al*. (2018) in their study on bird diversity in Canoas, Brazil.

Shochat *et al.* (2010) defined evenness as the similarity of all species relative abundance within the community. The bird populations in the residential site were more uniformed compare to other habitats (Table 3). Majority of these birds, such as the Eurasian Tree Sparrow (*P. montanus*), Asian Glossy Starling (*A. panayensis*), Olived-backed Sunbird (*C. jugularis*), and White-breasted Woodswallow (*A. leucorynchus*), were synanthropic species which adapted to co-habit with humans without altering their physiology and behavior (Shochat *et al*., 2010). This ability allows them to reproduce efficiently and forage confidently even in close proximity with humans. In addition, Symonds and Johnson (2008) reported that a habitat may be dominated with few species of birds but are more uniformed in terms of relative abundance. As a result, the populations of different bird species in the residential site were similar.

Abandoned fishponds (Site 2) had the highest dominance index value. This means that dominant bird species is found in this particular habitat (Cagod and Nuñeza, 2012). Among the birds found in the abandoned fishpond site, *C. hybrida* (12.6%), *T. stagnatilis* (11.5%), and *E. garzetta* (11.0%) appeared to be the most dominant species. The dominance of species in Site 2 was attributed to the abundant food source for these birds. Probing and gleaning along the muddy plains of abandoned fishponds, these species would physically interact but caused no threat to each other. The dominant birds observed in this study simultaneously feeding and resting without competing for the abundant food and wide space. These species tend to travel in groups thus dominating the feeding area of the mangrove estuary. Thus, two factors were considered to be the reason for the high dominance index of birds in

Table 4. Kruskal-Wallis and Dunn's test results on species richness of birds in three sites of La Union, Cabadbaran City. Site 1- residential, Site 2- abandoned fishponds, Site 3- mangrove site

Site	Test	α value	*P* value	Analysis
All sites	Kruskal-Wallis	0.05	**0.02**	significant
Site 1 & Site 2	Dunn	0.05	0.63	not significant
Site 1 & Site 3	Dunn	0.05	**0.01**	significant
Site 2 & Site 3	Dunn	0.05	**0.03**	significant

Site 2. The first is the availability of source that would attract number of individuals. The abundant food in Site 2 were epifaunal and infaunal molluscs and crustaceans such as fiddler crabs and shrimps. The second factor is the type of bird species that dominated the site. In this study, the type of birds that were dominant are species that forage on molluscs and crustaceans.

In comparing the species richness, it was found out that there was a significant difference among the three sites ($H(2)=7.78$, $P=0.02$). Upon further analysis, species richness in the residential site and abandoned fishpond site had no difference ($P=0.63$). On the other hand, residential site and mangrove site showed a significant difference ($P=0.01$), same with the abandoned fishpond site and mangrove site, ($P=0.04$). The Kruskal-Wallis and Dunn's test results are shown in Table 4. The findings shows that the vegetations in the mangrove site highly influenced the bird species richness. This is further supported by the work of Tassicker *et al.* (2006) where they reported the highest species richness in areas with intact vegetation.

Roos *et al.* (2020) also reported that bird species richness in the mangroves of southern Brazil increased as the patches of mangroves also increased. In support, the same result was reported by Mohd-Azlan *et al.* (2015) where the bird species richness in the mangroves of Darwin Region in Australia were highly correlated to the quality of the vegetation. Therefore, the vegetated site in La Union, Cabadbaran city is vital in maintaining the higher species richness in the area. Further destruction of mangroves may result in the decrease of bird population.

CONCLUSION

This study had successfully documented the preliminary survey of avifaunal species in the designated mangrove eco-park in Cabadbaran City, Philippines. The abandoned fishponds were the most abundant site due to the presence of food *i.e.* epifaunal and infaunal molluscs and crustaceans for gleaner birds and populations of migratory species. The *C. hybrida, T. stagnatilis, G. garzetta, P. montanus,* and *P. goiavier* were the most abundant species in the designated mangrove eco-park. On the other hand, it was recorded that species found in the abandoned fishponds were dominant compared to species found in other habitats. In terms of species evenness, populations of synanthropic birds in the residential site were documented to be evenly distributed in comparison to the bird populations in the mangroves and abandoned fishponds. Shannon-Wiener diversity index revealed that the mangrove site was the most diverse habitat and was attributed to the presence of lush vegetations that host food sources. It showed the importance of mangroves to the diversity of birds. Finding also revealed that there was a significant difference of species richness in mangrove site compared to other sites since species richness was highly influenced by vegetations. Moreover, this study also documented the first scientific record of migratory species in the area which may be one of the stopovers of migrating species. Henceforth, the estuary of Cabadbaran City offers a suitable habitat for migratory and non-migratory birds. Based on the present results, it is recommended to conduct further studies of birds such as monthly monitoring and assessment of nocturnal species to thoroughly document the avian community in the area. This initial result is significant in the planning and policy crafting of mangrove conservation and eco-tourism.

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