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A Preliminary Survey on the Effect of Anthropogenic Noise to Bird Community in Gaya Island

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ABSTRACT To date, there is still scarce study that has been done looking on the impact of the anthropogenic noise in influencing the bird community in Gaya Island as it acts as an important indicator for the health of the island's ecosystem. Hence, this preliminary study aims to determine the effect of the anthropogenic noise on the bird community in Gaya Island. The data collection was conducted for three months in three of the selected sites within the island. The methods that were being used were the point count sampling and noise mapping respectively. The anthropogenic noise level that was being measured at the selected sites ranges from 29dB to 80dB. Meanwhile, descriptive analysis, diversity indexes and correlation analysis were used to analyze the obtained data. A total of 422 individuals from 24 species and 16 families were recorded during the survey in Gaya Island. The result of the Shannon_Wiener index showed that the diversity of the birds in low anthropogenic noise zone is slightly higher (H'=2.559) as compared to the bird in high anthropogenic noise zone (H'= 2.558) even though there is no significant different in terms of diversity of birds between these two zones. However, the Spearman's correlation analysis showed a very significant and negative correlation of the anthropogenic noise with the abundance and species richness of bird (r= -0.076, p=0.000). Therefore, this study shows that the bird community is negatively affected with the increasing of anthropogenic noise in Gaya Island.

KEYWORDS: Anthropogenic Noise, Gaya Island, Bird Community, Primary Forest, Borneo

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INTRODUCTION

Anthropogenic noise is a phenomenon that can affect wildlife communication across all types of habitats (Luther & Baptista, 2010; Diaz *et al*., 2011; Gilbert *et al*., 2017) including birds. The island of Borneo harbors more than 600 species of birds (Pang *et al*., 2017). Bird has become important to the environment as it involves in balancing the ecosystem through its roles such as pollinator, predators and seed disperser (Peh *et al*., 2005) in the food chains (Basnet *et al*., 2016). Apart from that, the ability of the bird in detecting changes in its' surrounding environment (Yap *et al*., 2007; Kumar & Shahabuddin, 2006) and forest health (Miller *et al*., 2004) shows the potential of bird as an effective biodiversity indicator (Sodhi *et al*., 2005).

Dooling & Popper, 2007 stated that the anthropogenic noise can interfere the signal of a sound from being detected by the receiver of which then causing a great impact toward the birds that depend on acoustic signal as their tool for communication. The decreasing number on the individuals birds resulted from the increasing of anthropogenic noise level (Brumm, 2004) has drawn the concern towards the effect of this noise on wildlife such as on their social behaviour. This is because their acoustic communication has already specifically adopted with their environment (Dowling *et al*., 2012). Furthermore, the transmission of the acoustic signal is crucial as it contains encrypted message about their species identity and capability that is useful especially in attracting their mating partner (Slabbekoorn & Ripmeester, 2008).

Species composition, habitat quality (Bayne *et al*., 2008) and behaviour (Brumm, 2004) are among the impact of anthropogenic noise towards the bird population based on the result of past studies. Apart from that, the continuous anthropogenic noise exhibited in a particular habitat hinders the birds' ability in selecting their mating partner, detecting predators through sound (Dooling & Popper, 2007), navigating and also nurturing (Herrera-Montes & Aide, 2011). This will then results on the serious impact on the birds' reproduction output (Halfwerk *et al*., 2011) that can cause a direct consequences towards the bird population sustainability (Riebel, 2003). In addition, the impact of anthropogenic noise can also lead to mortality of birds by causing the loss of hearing ability and makes them become vulnerable to predators (Rabin *et al*., 2003; Chan *et al*., 2010). The responses of the birds towards the anthropogenic noise have also been identified through several studies such as (Hana *et al*., 2011; Nordt & Klenke, 2013; Polak, 2014). However, most of these studies focus on the responses at the species level only. A good understanding related with anthropogenic noise is still needed in order to mitigate this environmental changes (Barber *et al*., 2010) especially at a wider scope including at population level. Therefore, this study aims to identify the impact of the anthropogenic noise in order to provide beneficial information on the fundamental understanding of the relationship of anthropogenic noise with the bird community in Gaya Island.

METHODOLOGY

Study Site

Gaya Island is one of the five islands that have been gazetted as the Tunku Abdul Rahman (TAR) Marine Park. Located in N6000'36" E116001'48" at the west coast part of Sabah. This island has 1,465 acres of land consisting of primary forest and a small patch of mangrove area (Said, 2008).

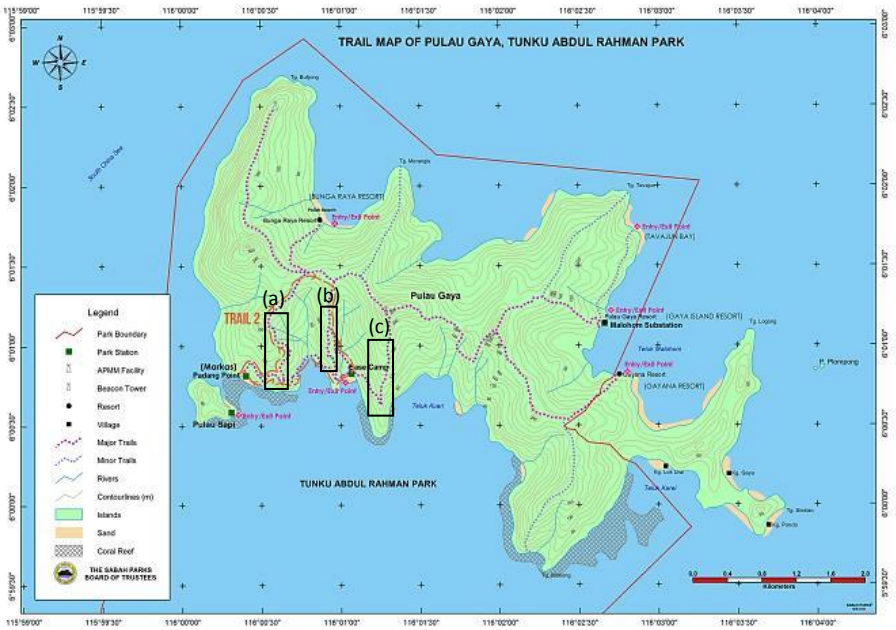

Figure 1. The map of Gaya Island: (a) is the Padang Point Trail, (b) is the Base Camp Trail and (c) is the Highest Point Trail (Sabah Park, 2013).

The study was conducted for three months between December 2016 until May 2017 in three locations within the Gaya Island namely Padang Point Trail, Base Camp Trail and Highest Point Trail. Each of these selected sites has their own trails whereby 1.5km of the trail's length were

selected from these sites for noise mapping and bird survey to be conducted. The locations of the three sampling sites were shown in Figure 1.

Noise Mapping

The noise mapping sampling is a method that was used to document the anthropogenic noise of an area and it is also a standard method adopted from (Herrera-Montes & Aide, 2011). A sound level meter was used to record the anthropogenic noise at the trails of the three selected sites. 60dB was set as a noise threshold based on the study that has been done by (Dooling & Popper, 2007) with a setup to an A-weighting according to Herrera-Montes & Aide, 2011. Therefore, each study sites had two types of zones namely high anthropogenic zone (≥60dB) and low anthropogenic zone (<60dB). Apart from that, the anthropogenic noise that was being recorded were the sound from the aeroplane as well as the boats that were moving around the island. The measurement was taken at each of the established point station with 50m interval within the 1.5km trail at each of the sites. The sound mapping measurement was conducted simultaneously with the avian survey. This is to record the reading of the anthropogenic noise that was experienced at each point stations during the survey.

Avian Survey

Point count of distance sampling is a standard method adopted from (Buckland *et al*., 2008) that was used to record the bird population in primary forest of Gaya Island. It is also an effective method in measuring the population density of bird (Farnsworth *et al*., 2002). A total of 30 point stations were established within the 1.5km of trails at each sampling sites. The distance between the points was 50m intervals (Sheldon *et al*., 2010; Sompud *et al*, 2016). The observation was carried out in the morning at 6.00am until 11.00am and continued again in the afternoon from 1.00pm until 4.30pm by a using a binocular with 10x40 magnification. The "Birds of Borneo" field guide book (Phillips & Phillips, 2011) was used in order to identify the observed birds. The time that was spent for one station was only 5 minutes before moving to another station in order to avoid recording the same bird from the other station (Buckland, 2006). Apart from that, the survey was immediately stopped during rainy day or when there was a strong wind (Peh *et al*., 2006) as to avoid the survey being affected. This survey was conducted for 3 months selected sites in order to obtain a preliminary data for the bird community in Gaya Island.

Data Analysis

There were several types of data analysis that were used to analyze the data obtained from this study. The descriptive analysis was used to analyze the bird community and anthropogenic noise in the selected trails. Apart from that, a few indices were also used to analyze the diversity of the bird population namely the Shannon-Wiener Index and Shannon Diversity t-test (Magurran, 2004). A Spearman's Correlation analysis was conducted to identify the relationship between the anthropogenic noise and the birds as the data are not normally distributed. The PAST (Hammer & Harper, 2006) and SPSS software were used to analyze the data obtained from this research.

RESULT

A total of 422 individuals from 16 families and 24 species, of which includes the unidentified birds, were recorded during the preliminary bird survey in three of the selected sites in Gaya Island. The Table 1 showed a comparison of the number of species and individual of birds between the low anthropogenic noise zone and high anthropogenic noise zone by including the unidentified birds.

The low anthropogenic noise zone was dominated by the Monarchidae family with 48 individuals recorded followed by the Nectariniidae and Timaliidae families with 35 and 34 individuals recorded in each family. Apart from that, there were also two families of bird namely Picidae and Picuminae that were only found in the low anthropogenic noise zone during the survey. Meanwhile, the Pycnonotidae family was found to be abundance in high anthropogenic noise zone with 33 individuals recorded. This was then followed by Pachephalidae and Monarchidae family with 26 and 23 individuals recorded in each family. Furthermore, the Columbidae family and Coracidae family were only recorded at this zone. Among the species that were found in both zones were the Black-naped Monarch (*Hypothymis azurea*), Artic Warbler (*Phylloscopus borealis*), Philippine Megapode (*Megapodius cumingii*), White-crowned Shama (*Copsychus strickladii*), Brown-throated Sunbird (*Anthreptes malacensis*), Mangrove Whistler (*Pachycephala grisola*), Pied Fantail (*Rhipidura javanica*), Oriental-pied Hornbill (*Anthracoceros albirostris*) and White-chested Babbler (*Trichastoma rostratum*).

Table 1. Comparison on the number of species and individual in low anthropogenic noise zone and high anthropogenic noise zone based on family.

Families	Zones	
	Low anthropogenic noise	High anthropogenic noise
Pycnonotidae	2(33)	3(33)
Pachcephalidae	1 (26)	1(26)
Monarchidae	1(48)	1(23)
Cisticolidae	1(27)	1(17)
Timaliidae	1(34)	1(13)
Aegithinidae	1 (16)	1(10)
Megapodiidae	1 (3)	1(9)
Muscicapidae	3 (16)	1(8)
Nectariniidae	1(34)	2(8)
Unidentified	1(7)	1(5)
Bucerotidae	1(3)	1(3)
Coracidae	0	1(2)
Columbidae	0	1(1)
Dicaeidae	1(1)	1(3)
Phylloscopidae	1 (2)	1(1)
Rhipiduridae	1 (1)	1(1)
Picidae	2(8)	0
Total	**21(259)**	**20(163)**

The Shannon Diversity index showed that the diversity of the bird community in low anthropogenic noise zone was slightly higher with H'=2.559 as compared with the high anthropogenic noise zone with H'=2.558 even though there was no significant different between these two zones. The result of the diversity index also indicates that both zones have diverse bird population as their diversity index values fall between the ranges of 1.5 to 3.5 according to Magurran, 2004.

Interestingly, the result of the Spearman's Correlation analysis in Table 2 showed there is a negative correlation between the anthropogenic noise and the number of species of birds and it was very significant (r=-0.076, p=0.000). The strength of the relationship between these two variables was low. Meanwhile, the result of the Spearman's Correlation analysis as shown in Table 3 also showed a

very significant and negative correlation between the anthropogenic noise and the number of individual of birds in Gaya Island (r=-0.076, p=0.000). This suggests that the anthropogenic noise does cause a negative impact towards the species richness and abundance on the bird community in Gaya Island.

Table 2. Spearman's Correlation analysis between the anthropogenic noise based on decibel and number of species of birds.

			Noise (dB)	No. of Species
Spearman's rho	Noise	Correlation Coefficient	1	-.076**
		Sig. (1-tailed)		.000
		N	3632	3632
	No. of Species	Correlation Coefficient	-.076**	1
		Sig. (1-tailed)	.000	
		N	3632	3632

**Correlation is significant at the 0.01 level (1-tailed)

Table 3. Spearman's Correlation analysis between the anthropogenic noise based on decibel and number of individual of birds.

			Noise (dB)	No. of Individual
Spearman's rho	Noise	Correlation Coefficient	1	-.076**
		Sig. (1-tailed)		.000
		N	3632	3632
	No. of Individual	Correlation Coefficient	-.076**	1
		Sig. (1-tailed)	.000	
		N	3632	3632

**Correlation is significant at the 0.01 level (1-tailed)

DISCUSSION

The result from this preliminary study showed that the number of species and individual were lower in high anthropogenic noise zone as compared to the low anthropogenic noise zone. This implies that the bird community does receive an impact from the anthropogenic noise. Reduction in terms of abundance and species richness due to noise were also similarly found in several studies namely by (Fontana *et al*., 2011; Proppe *et al*., 2013). Moreover, it also reveals the response of the birds towards the noise as they tend to avoid the noise affected zones (Radle, 2007; Forman & Alexander, 1998) that can mask their acoustic signals. The transmission of the acoustic signals is very crucial as it serve the purpose especially for the male birds to use for territory defense and attracting the female birds during their mating season (Verzijden *et* al., 2010; Appletants *et al*., 2005). In addition, the masking effect of the anthropogenic noise can also inhibit the foraging activity of the birds (Curtin & Wilkes, 2005).

The difference of species composition between the bird populations was not able to be proven statistically as the diversity t-test analysis shows that there was no significant difference between the species diversity of two zones. However, the value of the diversity index in low anthropogenic noise zone was still higher as opposed to the high anthropogenic noise zone. Hence, it implies that

anthropogenic noise still influences the species diversity of the bird community to decrease especially in areas that are highly affected by this factor (Yuan & Lu, 2016).

The findings from this preliminary study showed that the species richness and abundance of the birds was significantly correlated with the anthropogenic noise. According to the result from the Spearman's Correlation analysis, the species richness and abundance of the bird decline due to the high level of anthropogenic noise. Hence, this indicates that anthropogenic noise does play an important factor in affecting negatively towards the species richness and abundance of birds (Arevalo & Newhard, 2011; Ambrose *et al*., 2017).

Interestingly, White-chested Babbler (*Trichastoma rostratum*) that was recorded in both type of zones was listed as Near Threaten species in the International Union for the Conservation of Nature and Natural Resources (IUCN, 2016) red list. Apart from that, the White-crowned Shama (*Copsycus stricklandii*) that was listed as an endemic species based on (Phillips & Phillips, 2011) was able to be recorded during the avian survey in this study. Furthermore, the finding of this study also recorded the Artic Warbler (*Phylloscopus borealis*) of which is a common winter visitor (Phillips & Phillips, 2011). According to (Sompud *et al*., 2016), the primary forest of Gaya Island is a transit location for the migratory birds. The presence of the endemic and Near Threatened species as well as the migratory bird indicates that the primary forest in Gaya Island acts as a crucial habitat for these species of birds. Therefore, there is a need to investigate in depth such as identifying the spectrum of impact of the anthropogenic noise towards the bird community including the endemic and migratory birds in Gaya Island.

CONCLUSION

The findings from this preliminary study showed that anthropogenic noise causes negative impact by reducing the relative abundance and species richness of the bird community in Gaya Island. Hence, it shows that there is an urgent need to conduct further and in depth research on the impact of anthropogenic noise towards the bird community in Gaya Island. Apart from that, we also recommend to conduct a comparison study on the nesting phenology of birds between the high and low anthropogenic noise zones. These will then be beneficial for the park management in establishing effective policy that complies with the sustainable management of the island.

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