

Searching for Nature Stories 2017

The impacts of noise on birds' acoustic behavior



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1. Abstract

Study has shown that calls from birds can proclaim and defend their territories, attract and impress potential mates, and signal the overall health of the singer. Calls can also be used to communicate a nearby threat or an individual's location. However noise pollution has escalated over the past century, disturbing the integrity of natural ecosystems.^[1] It may hinder birds' efficiency in signal transmission in urban areas.

In this research the objectives are to study the effect of background noise level across urban and peri-urban areas in Hong Kong on the type and the frequency of vocal signals made by two birds (Red-whiskered Bulbul/*Pycnonotus jocosus* and Black-collared Starling/*Sturnus nigricollis*)

From the data collected in the field studies and the results from experiments, it was believed that the noise level does not affect the type of call made by Red-whiskered Bulbul and Black-collared Starling. However, the peak frequency of type I call made by Black-collared Starling and high frequency of type II call made by Red-whiskered Bulbul increased with the increase in ambient noise level.

2. Introduction

2.1 Introduction to research topic

Red-whiskered Bulbul (*Pycnonotus jocosus* 紅耳鶯) can make a loud call. Type I is the short and sweet whistle containing 1 to 3 syllables (~800 to 17,000Hz) while type II is the long song containing about 5 syllables(~900 to 16,000 Hz). Black-collared Starlings(*Sturnus nigricollis* 黑領椋鳥) has a call which sounds like the music played by the flute. Type I is the long song (~700 to 19,000Hz) while type II is the short harsh call (~1300 to 17000Hz). Since man-made noise, often in low frequency, is increasing in the wild, the communications between birds may be interfered, as birds mainly communicate by sounds. It may affect the mating patterns and other behavior, hence threatening their survival.^[6] Our group suspected that birds may use different type of call in different noise level and the frequency of the call may be higher in order to avoid calls being masked by the low frequency noise.^[6] Therefore our group decided to investigate the effects of noise level on the type of call and the frequency of the calls made by the two birds. The two birds are chosen to be investigated as they can make different types of call and are very common in Hong Kong.

2.2 Objectives

1. To investigate the effect of noise level on type of call made by Red-whiskered Bulbul and Black-collared Starlings
2. To investigate the effect of noise level on frequency of the two types of calls made by Red-whiskered Bulbul and Black-collared Starlings

2.3 Research questions

1. Would noise level affect the type of call made by Red-whiskered Bulbul and Black collared Starling?
2. Would noise level affect the frequency of the two types of calls made by Red-whiskered Bulbul and Black-collared Starlings?

2.4 Background information of Red-whiskered Bulbul

2.4.1 Classification^[5]

Kingdom	Animalia
Phylum	Chordata
Class	Aves
Order	Passeriformes
Family	Pycnonotidae
Genus	Pycnonotus
Species	Pycnonotus jocosus



2.4.2 Description

The red-whiskered bulbul is about 20 cm in length. It has black crest, red cheek patch (except juveniles) and orange-red vent. They are often found in woodland in the countryside, urban parks and wooded areas.^[5] It can make a loud call. Type I is the short and sweet whistle containing 1 to 3 syllables (~800 to 17,000Hz) while type 2 is the long song containing about 5 syllables(~900 to 16,000 Hz).

2.5 Background information of Black-collared Starlings

2.5.1 Classification^[2]

Kingdom	Animalia
Phylum	Chordata
Class	Aves
Order	Passeriformes
Family	Sturnidae
Genus	Sturnus
Species	Sturnus nigricollis



2.5.2 Description

The Black-collared Starlings is about 28 cm long. Head is white, skin around eyes yellow, bill black, underparts and rump white, legs yellow. Juvenile lacks black collar. It gives a loud pipping cry. ^[3]They are often found in open lowland areas in the countryside and major urban parks. Black-collared Starlings/ *Sturnus nigricollis* (黑領椋鳥) has a call which sounds like the music played by the flute. ^[4] Type I is the long song while type II is the short harsh call.

3. Methodology

3.1 Working Schedule

	Date	Time	Venue	Event
1 st field study	27/11/2016	10:00 – 11:00	Ma On Shan Park	Recording calls from the two birds in different noise level.
2 nd field study	02/12/2016	17:00 – 17:30	Hoi Sham Park	
3 rd field study	04/12/2016	10:35 – 11:05	Hoi Sham Park	
4 th field study	09/12/2016	17:00 – 17:30	Hutchison Park	

5 th field study	19/12/2016	17:15 – 18:00	Kowloon Park
6 th field study	22/12/2016	10:00-10:30	Li Cheng Uk Park
7 th field study	22/12/2016	10:45-11:00	Li Cheng Uk Han Garden
8 th field study	22/12/2016	11:00 – 11:30	Li Cheng Uk Estate Platform
9 th field study	22/12/2016	13:15 – 13:30	Central Pier
10 th field study	22/12/2016	15:45 – 16:30	Lamma Island Hung Shing Yeh Beach

3.2 Field Study

Ten field studies were carried out at the Ma On Shan Park, Hoi Sham Park, Hutchison Park, Kowloon Park, Li Cheng Uk Park, Li Cheng Uk Han Garden, Li Cheng Uk Estate platform, Central Pier and Lamma Island Hung Shing Yeh Beach. (Fig 1 refer to the maps as shown below). The two types of call of Red-whiskered Bulbul and Black-collared Starlings were recorded in different noise level.

Data collected in the field studies	
Calls from red-whiskered Bulbul	Calls from Black-collared Starlings
Noise level of the environment	

3.3 Objective 1: To investigate the effect of noise level on type of call made by Red-whiskered Bulbul and Black-collared Starlings

An experiment was designed to investigate the effect of noise level on type of call made by Red-whiskered Bulbul and Black-collared Starlings. It was carried out by conducting ten field studies to measure the type I and type II calls from Black-collared Starlings and Red-whiskered Bulbul by using Furry wing cover VideoMic connected to NTG-2 dual powered directional handy recorder. (Fig 1 refer to the photo as shown below). The noise from the environment was also recorded simultaneously by using sound level meter (Fig 2 refer to the photo as shown below)



Objective of the experiment :

To investigate the effect of noise level on type of call chosen by Red-whiskered Bulbul and Black-collared Starlings

Hypothesis of the experiment:

Red-whiskered Bulbul and Black-collared Starlings choose different type of call in different noise level

Principal of the experiment:

Red-whiskered Bulbul and Black-collared Starlings can make two types of call. The type of call chosen by the birds in different noise levels is recorded during the field study. To find out the effect of noise level on the type of call chosen by the birds, the proportion of each type of call under certain noise level is calculated. The r^2 and p value between noise level and proportion of the type of call chosen are then used to find out if they have significant correlation. Significant correlation would support the hypothesis of the experiment.

Procedures:

1. Red-whiskered Bulbul and Black-collared Starlings were located by hearing the chirp of the birds.
2. The bird was identified by using binoculars.
3. The calls of the birds were recorded by using furry wind cover VideoMic connected to NTG-2 dual powered directional handy recorder.
4. The sound level of the noise was also recorded by using a sound level meter. (p.s. the recording was carried out during the 10 field studies)

3.4 Objective 2: To investigate the effect of noise level on frequency of the two types of calls made by Red-whiskered Bulbul and Black-collared Starlings

The experiment mentioned above can also be used to find out the effect of noise level on frequency of the two types of calls made by Red-whiskered Bulbul and Black-collared Starlings.

Objective of the experiment :

To investigate the effect of noise level on frequency of the two types of calls made by Red-whiskered Bulbul and Black-collared Starlings.

Hypothesis of the experiment:

The frequency of the call made by Red-whiskered Bulbul and Black-collared increases with noise level.

Principal of the experiment:

The calls by the birds in different noise levels are recorded during the field study. Interactive sound analysis software Raven Pro 1.5 Beta Version was used to find out the low frequency, high frequency and peak frequency of each type of call in different noise level. Low frequency is the lowest frequency of the call; High frequency is the highest frequency of the call; Peak frequency is the frequency of the call with the strongest magnitude The spectrum of each record can be shown by using the programme. For example, one of the records of Red-whiskered Bulbul is shown in figure 3 below.

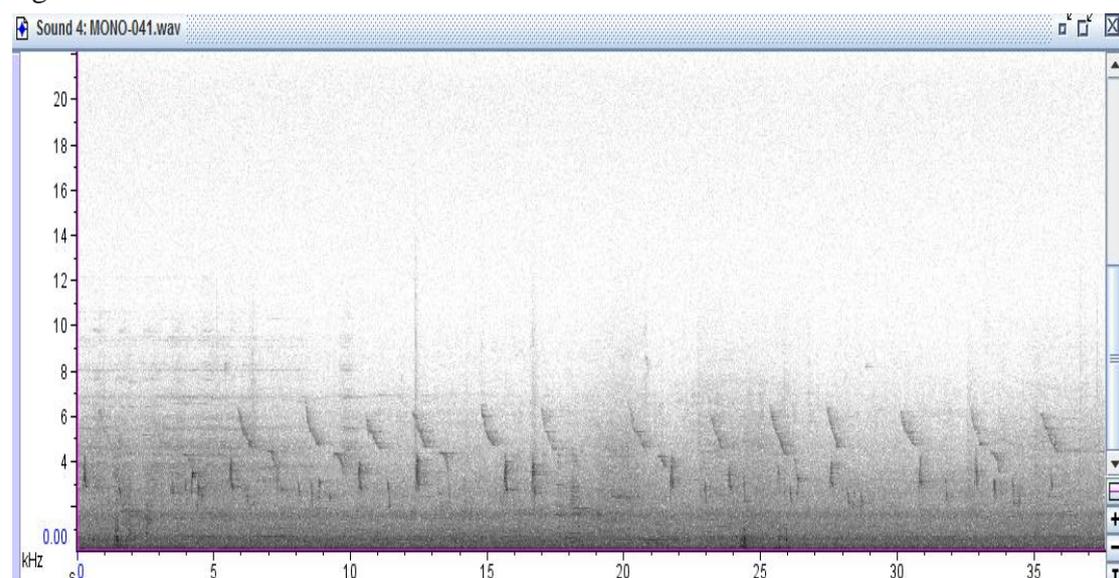


Fig 3: Spectrum of one of the records of Red-whiskered Bulbul.

By listening to the record, the type I call from Red-whiskered bulbuls is identified and selected as below. In figure 4. The low, peak and high frequency is then found by using software Raven..

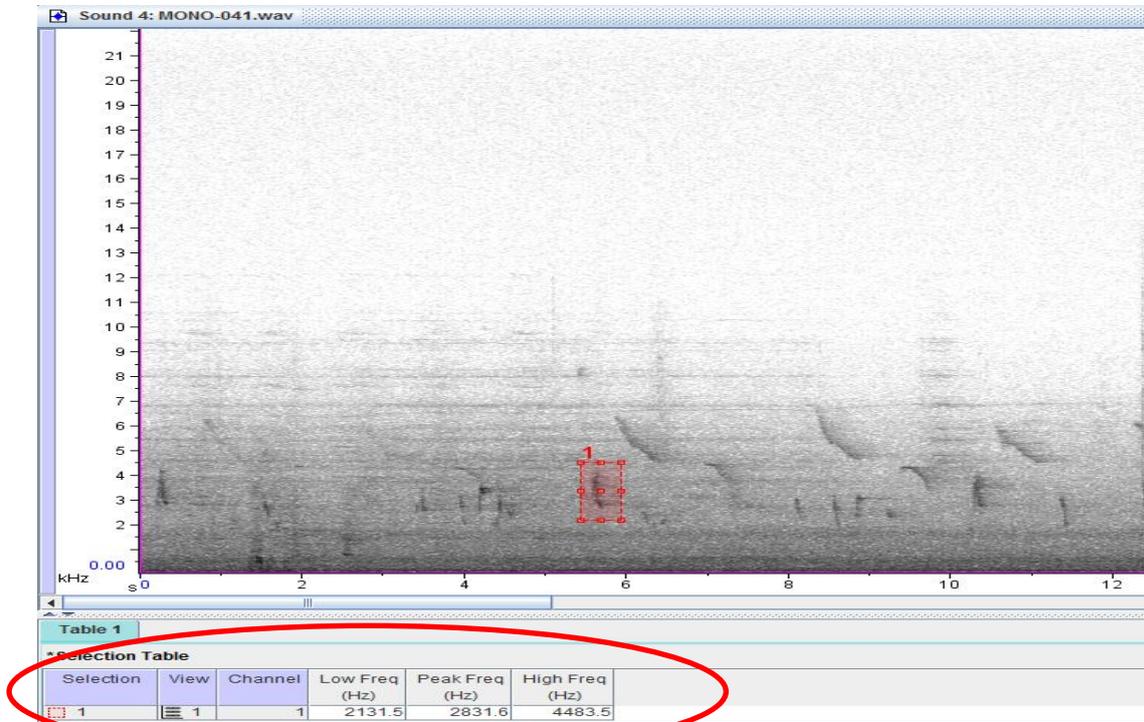


Figure 4: Type I call from Red-whiskered Bulbul is chosen in the red box. Low, peak and high frequency of the call is then automatically calculated.

The r^2 and p value between noise level and low/high/peak frequency of call are calculated for each type of call to see if they have significant correlation. Significant correlation would support the hypothesis of the experiment.

4. Results

4.1 Result on Objective I: To investigate the effect of noise level on type of call made by Red-whiskered Bulbul and Black-collared Starlings

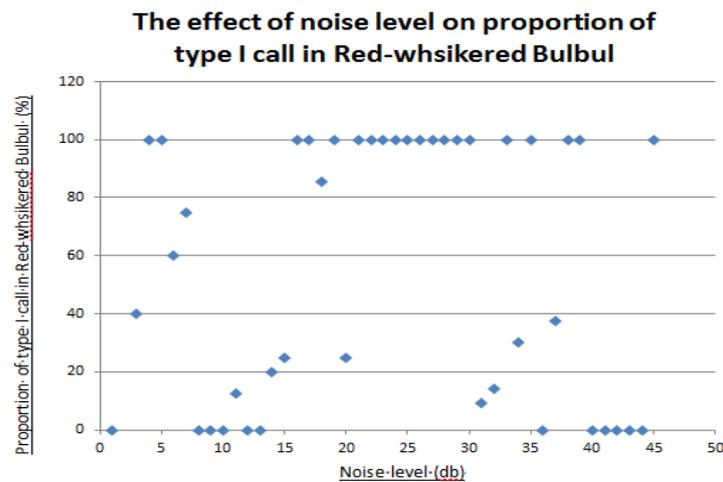
-The type of call use by Red-whiskered Bulbul and Black-collared Starlings is insignificantly correlated to the noise level.

4.1.1 Data collected from Red-whiskered Bulbul

-For the raw data of call from Red-whiskered Bulbul, refer to attachment 1.

-For the proportion of type I and II in each record, refer to attachment 2.

Below is the graph showing the effect of noise level on proportion of type I call in Red-whiskered Bulbul.

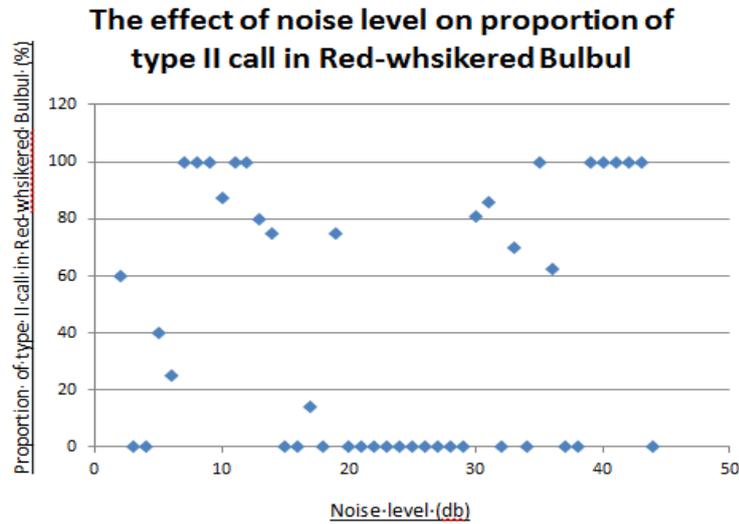


From the summary report generated from Excel.

	A	B	C	D	E	F	G	H	I
1	SUMMARY OUTPUT								
2									
3	Regression Statistics								
4	Multiple R	0.158597088							
5	R Square	0.02515303							
6	Adjusted R Square	-0.001576275							
7	Standard Error	44.89818223							
8	Observations	43							
9									
10	ANOVA								
11		df	SS	MS	F	Significance F			
12	Regression	1	2132.530436	2132.53	1.057883203	0.309728305			
13	Residual	41	82649.71747	2015.847					
14	Total	42	84782.24791						
15									
		Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%
17	Intercept	111.0143013	53.33918817	2.08129	0.043698992	3.293625511	218.735	3.293625511	218.7349772
18	X Variable 1	-0.834230123	0.81108619	-1.02856	0.309728305	-2.472251915	0.803792	-2.472251915	0.803791668
19									

It was found that the r^2 value is 0.025 while p value is 0.309. As $p > 0.05$, it indicates the type I proportion has insignificant correlation to the noise level.

Below is the graph showing the effect of noise level on proportion of type II call in Red-whiskered Bulbul.



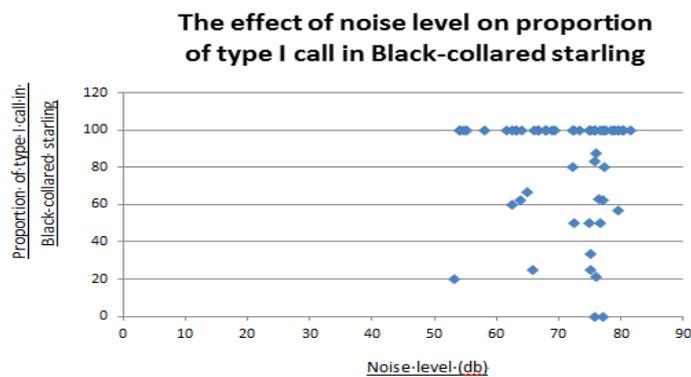
It was found that the r^2 value is 0.024 while p value is 0.319. As $p > 0.05$, it indicates the type II proportion has insignificant correlation to the noise level.

4.1.2 Data collected from Black-collared Starling

-For the raw data of call from Black-collared Starling, refer to attachment 3.

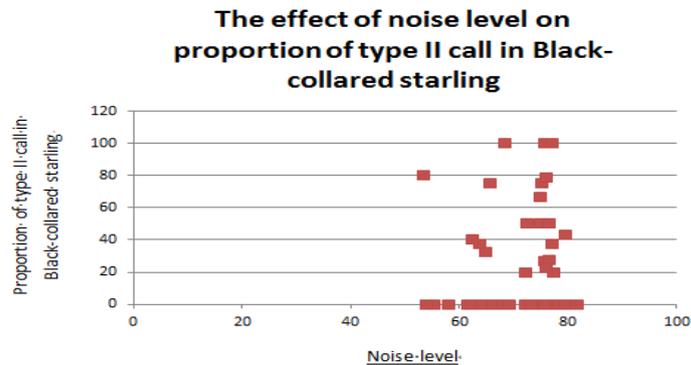
-For the proportion of type I and II in each record, refer to attachment 4.

Below is the graph showing the effect of noise level on proportion of type I call in Black-collared starling.



It was found that the r^2 value is 0.03 while p value is 0.677. As $p > 0.05$, it indicates the type I proportion has insignificant correlation to the noise level.

Below is the graph showing the effect of noise level on proportion of type II call in Black-collared starling.



It was found that the r^2 value is 0.0036 while p value is 0.657. As $p > 0.05$, it indicates the type II proportion is insignificant correlation to the noise level.

Therefore, it shows the noise level does not have any significant correlation to the type of call made by the two birds.

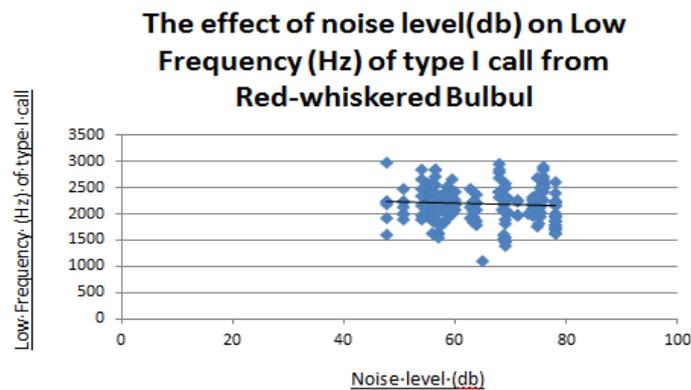
4.2 Result on Objective II: To investigate the effect of noise level on frequency of the two types of calls made by Red-whiskered Bulbul and Black-collared Starlings

- For type I call of Black-collared Starling, peak frequency is significantly correlated to noise level.
- For type II call of Red-whiskered Bulbul, high frequency is significantly correlated to noise level.
- For other types of call in Black-collared Starling and Red-whiskered Bulbul, the frequencies are not correlated to noise level.

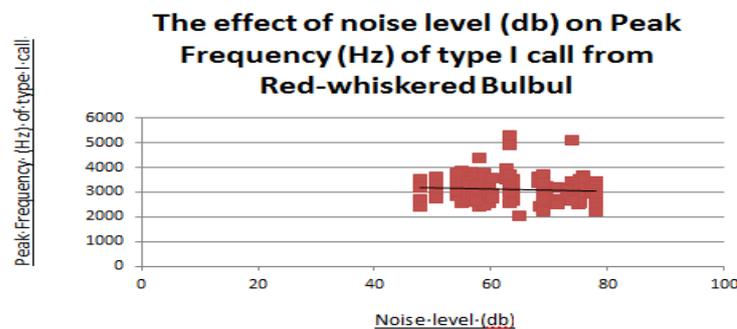
4.2.1 Data collected from Red-whiskered Bulbul

-For the raw data of low frequency, peak frequency and high frequency for each type of call from Red-whiskered Bulbul, refer to attachment 5

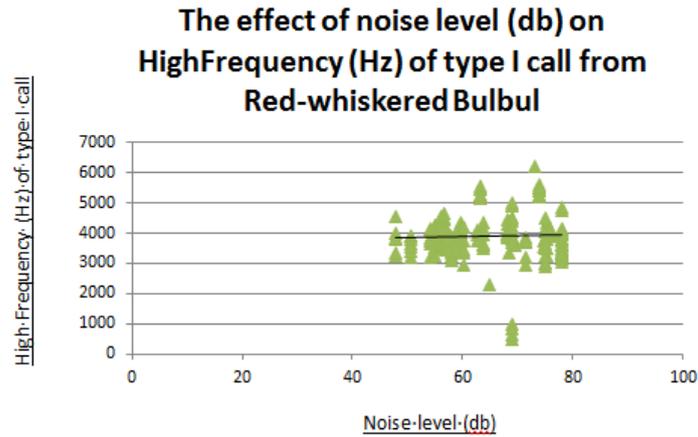
Below are the graphs showing the effect of noise level on low/high and peak frequency in type I and II for Red-whiskered Bulbul.



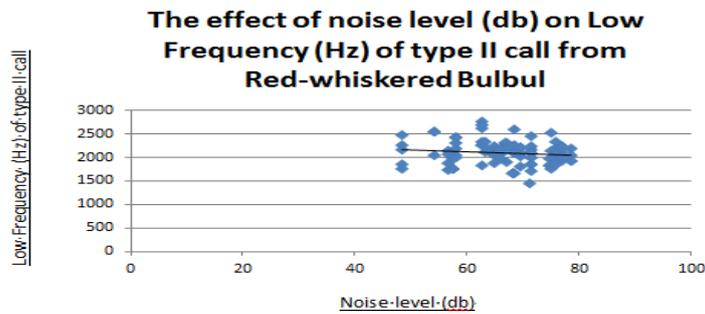
It was found that the r^2 value is 0.0067 while p value is 0.227. As $p > 0.05$, it indicates the low frequency of type I call in Red-whiskered Bulbul has insignificant correlation to the noise level.



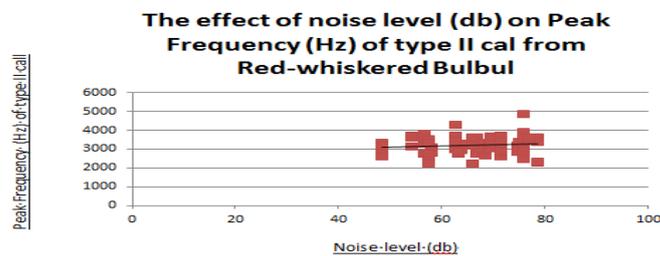
It was found that the r^2 value is 0.0052 while p value is 0.285. As $p > 0.05$, it indicates the peak frequency of type I call in Red-whiskered Bulbul has insignificant correlation to the noise level.



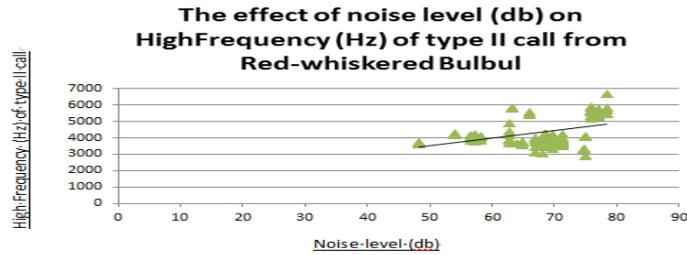
It was found that the r^2 value is 0.0016 while p value is 0.553. As $p > 0.05$, it indicates the high frequency of type I call in Red-whiskered Bulbul has insignificant correlation to the noise level.



It was found that the r^2 value is 0.0175 while p value is 0.189. As $p > 0.05$, it indicates the low frequency of type II call in Red-whiskered Bulbul has insignificant correlation to the noise level.



It was found that the r^2 value is 0.0147 while p value is 0.230. As $p > 0.05$, it indicates the peak frequency of type II call in Red-whiskered Bulbul has insignificant correlation to the noise level.

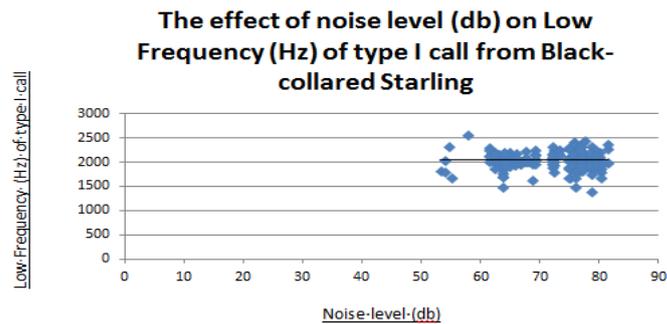


It was found that the r^2 value is 0.198 while p value is 3.4×10^{-6} . As $p < 0.05$, it indicates the high frequency of type II call in Red-whiskered Bulbul has significant correlation to the noise level.

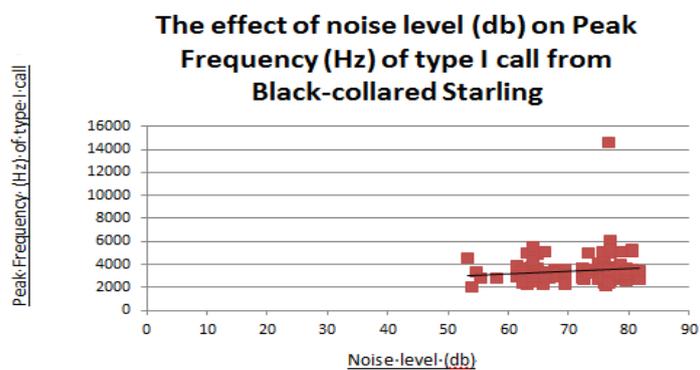
4.2.2 Data collected from Black-collared Starling

-For the raw data of low frequency, peak frequency and high frequency for each type of call from Black-collared Starling, refer to attachment 6

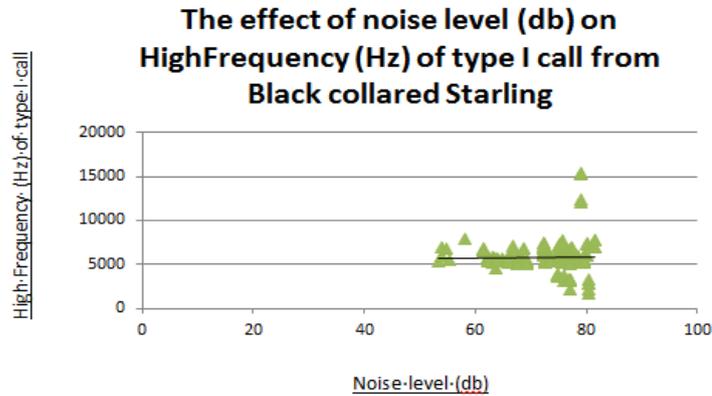
Below are the graphs showing the effect of noise level on low/high and peak frequency in type I and II for Black-collared Starling:



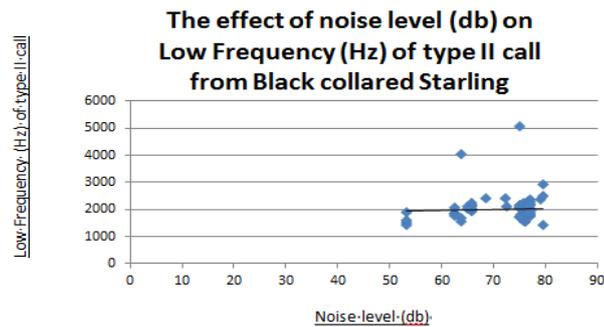
It was found that the r^2 value is 6.18×10^{-6} while p value is 0.970. As $p > 0.05$, it indicates the low frequency of type I call in Black-collared Starling has insignificant correlation to the noise level.



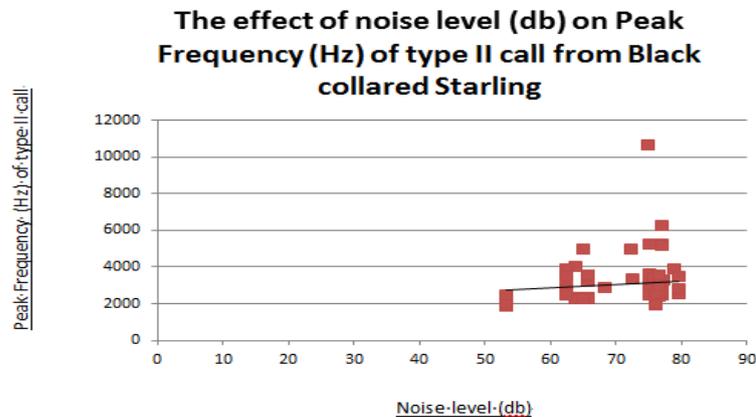
It was found that the r^2 value is 0.021 while p value is 0.026. As $p < 0.05$, it indicates the peak frequency of type I call in Black-collared Starling has significant correlation to the noise level.



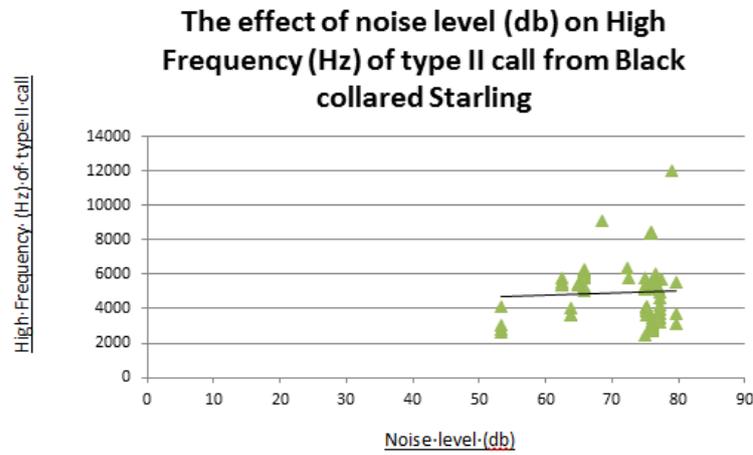
It was found that the r^2 value is 6.44×10^{-6} while p value is 0.903. As $p > 0.05$, it indicates the high frequency of type I call in Black-collared Starling has insignificant correlation to the noise level.



It was found that the r^2 value is 0.00349 while p value is 0.607. As $p > 0.05$, it indicates the low frequency of type II call in Black-collared Starling has insignificant correlation to the noise level.



It was found that the r^2 value is 0.00117 while p value is 0.347. As $p > 0.05$, it indicates the peak frequency of type II call in Black-collared Starling has insignificant correlation to the noise level.



It was found that the r^2 value is 0.0035 while p value is 0.607. As $p > 0.05$, it indicates the high frequency of type II call in Black-collared Starling has insignificant correlation to the noise level.

5. Discussion

5.1 Discussion on Objective 1: To investigate the effect of noise level on type of call made by Red-whiskered Bulbul and Black-collared Starlings

After analyzing all the results, it was found that the proportion of type of call made by the two birds has insignificant correlation to noise level. It seems that noise level would not affect the type of call chosen by the two birds. It was deduced that the effectiveness of communicating between the birds would not be affected by the type of call. The birds may use different type of call in order to convey different messages among them, but not affected by the noise level.

5.2 Discussion on Objective 2: To investigate the effect of noise level on frequency of the two types of calls made by Red-whiskered Bulbul and Black-collared Starlings

After analyzing all the results, it was found that the high frequency of type II call in Red-whiskered Bulbul and the peak frequency of type I call in Black-collared Starling have significant correlation to the noise level. It shows that the two birds altered their vocalizations in response to variable urban acoustic environment.

The response to noise differed by bird type: Red-whiskered Bulbul would like to increase the high frequency of type II call when noise level increases, while Black-collared Starling would like to increase the peak frequency of type I call. It was deduced that the increase of the frequency may help them communicate better among the birds with increasing noise level which is mostly at low frequency.

5.3 Further Investigation

1. What are the functions of different types of calls?
 - From our findings, the noise level has no significant correlation with the use of different type of call. Therefore, a particular kind of call would not have better signal transmission power than the other. Then the function of different type of call is unknown.
2. Do signal shifts from birds are adaptive?
 - From our findings, it shows that Red-whiskered Bulbul would like to increase the high frequency of type II call when noise level increases, while Black-collared Starling would like to increase the peak frequency of type I call. To determine whether these signal shifts are adaptive, future studies will require direct investigation of the sound transmission efficiency as well as reproductive success of the birds with different features in the same habitats^[6]. In combination with the current study, this could give new insights into the evolution of animals in the novel habitats.^[6]
3. Why do only a certain type of frequency in a certain type of call from a bird would increase with the noise level, but not other frequencies? The increase of other frequencies may have other functions, not for transmitting signals in noisy environment.

6. Conclusion

- The type of call use by Red-whiskered Bulbul and Black-collared Starlings is insignificantly correlated to the noise level.
- For type I call of Black-collared Starling, peak frequency is significantly correlated to noise level.
- For type II call of Red-whiskered Bulbul, high frequency is significantly correlated to noise level.
- For other types of call in Black-collared Starling and Red-whiskered Bulbul, the frequencies are insignificantly correlated to noise level.

7. Bibliography

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