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The Correlations between Bird Relative Abundance with the Stem Density in Two Years Old *Acacia mangium* Plantation at Sabah Forest Industries, Sipitang

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Abstract

Avian population is one of the components of biodiversity that is affected by the loss of the natural forest. *Acacia mangium* is one of the exotic species that is mainly planted in Sabah Forest Industries (SFI) in order to meet the demand of pulp and paper supply. Due to the fast growing ability of mangium species, the tree stand density in Mendulong Estate is relatively high. This research was conducted to investigate the influence of tree stem density toward the avian population in 2-years age *Acacia mangium* forest plantation, SFI. Bird survey was conducted using point count method and binocular with 10 (magnification) X 40 (objective size) was used for direct observation. A positive correlation between tree stem density and bird population was obtained via Pearson's correlation ($r=0.394$, $p=0.031$). This study shows that increasing of tree stem density can positively influence the avian population significantly.

Introduction

According to FAO (2005), natural forest decline dramatically due to the large-scale land conversion and extreme timber exploitation over the last 30 years. Most of the natural forests have been cleared up rapidly for exotic plantation (Sheldon & Styring, 2011). In 1980s, the first pulp and paper mill was established in Sipitang by the Sabah Forest Industries (SFI), and the expected reforestation and afforestation area is up to 130,000 ha with industrial forest plantations, mainly in planting of *Acacia mangium* (FAO, 2002).

The number of Forest plantation establishments has become increasing more due to the growing world population and the demand for wood materials. Deforestation and transformation of forest cover to other land-uses cause the loss of biodiversity (ICRAF, 2011). This compels birds species to move to other preferable habitats such as plantation or forest plantation (Gregory *et al.*, 2003; Hartley, 2002).

Bird abundance is influenced primarily by vegetation structure, age and species composition of the forest (Conner & Dickson, 1997). Apart from it, forest landscape and surrounding vegetation also

influence the bird species composition and abundance (Conner & Dickson, 1997). This paper presents the results on the relationship between bird abundance and their habitat in *Acacia mangium*.

Methods

Background Information

The study site was located in Mendulong Estate, Sabah Forest Industries (4º 54' 56.5'' N; 115º 42' 27.6" E) in the compartment L41 with elevation range 324m to 415m that is located in the Sipitang district of south-western part Sabah (Figure 1). SFI Concession Area covers 183,316 ha of forest plantation, including Mendulong Estate (SFI, 2015).

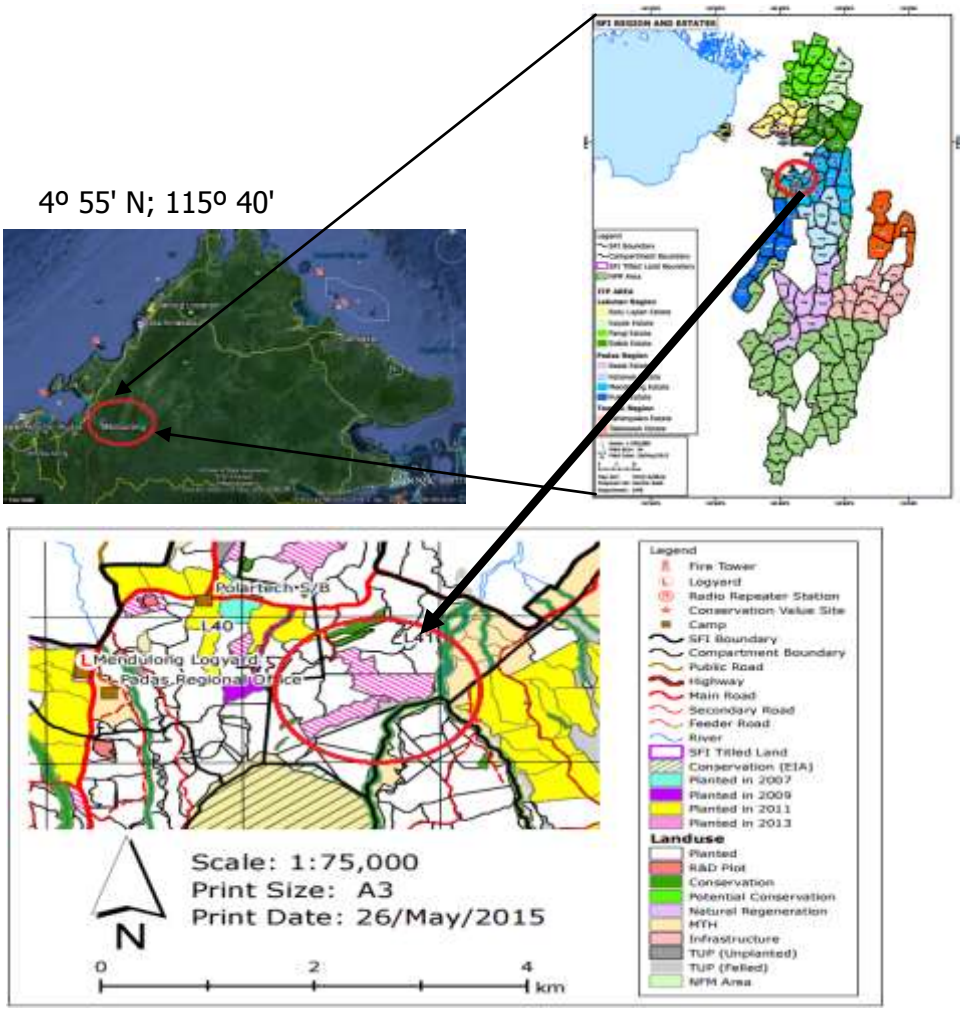

Figure 1. The location of the study site in compartment L41 (Source: SFI, 2015)

The Mendulong Estate of two years old *Acacia mangium* plantations covers 617.11 ha. Compartment L41 covers about 44.18 ha of *Acacia mangium* plantation (SFI, 2015). The annual rainfall was approximately 3,757 mm (SFI, 2015). The maximum and minimum temperatures in July to August 2014 are 30 ºC and 19 ºC respectively (SFI, 2015). Mendulong Estate was located about 177 km from Kota Kinabalu and 39.6 km from Sipitang town.

Data Collection

Twenty-one days were spent in the two year old *Acacia mangium* plantation, Mendulong Estate from 1st to 21st of August 2015 to obtain a reliable and high precision data (Rajpar & Zakaria, 2010; Styling *et al*., 2011). Standard point count method was carried out and species of birds were identified through direct observation from 0630 hr to 1130 hr by using a pair of binocular (10 magnification X 40 objective size) because the best time for the bird observation was in the morning (Zakaria *et al*., 2009). When it was raining, birds survey was not conducted, as cold weather could shut down bird activity (Ralph *et al*., 1993). During each point count survey, each individual of bird detected by sighting were recorded in point count data form and identified using the field guide "Birds of Borneo" (Wong, 2012) and "Field Guide to The Birds of Borneo" (Phillipps & Phillipps, 2014). Only birds that perched in a tree were recorded for standard survey while the birds on flight were recorded as opportunities survey (Zakaria & Rajpar, 2010).

A total of 25 point count stations were established for the bird survey in two years old *Acacia mangium* plantation, Mendulong Estate. Five point count stations were set in each transect and there were five transects. The length of the transect line was set as 250 m. A 20m distance was established before the first point count station to avoid forest edge affect (McCollin, 1998). Transect lines was parallel to each other, which were established using a mapping compass. The interval between points counts stations were 50 m (Sheldon *et al*., 2010, Styring, *et al*., 2011). The distance between the transect line was at least 50 m. Points were spaced closely together to provide a comprehensive inventory (Styring *et al*., 2011). At least four transect lines or 1000 m was done daily. The observation last exactly for 5 minutes at each point count station (Mojiol *et al*., 2008). Five minute observation in each point count enables to record sufficient number of individuals with minimal efforts and disturbance (Rajpar & Zakaria, 2010).

The vegetation survey of the two years old *Acacia mangium* plantation was also conducted on 1st and 2nd of August 2015. A vegetation plot of 10m x 100m was established randomly on each transect line. The total area of *Acacia mangium* survey carried out was 0.1 ha as follow Sompud *et al*. (2014), because 0.1 ha was the minimum requirement for vegetation survey (Newton, 2007). To standardize the measurements, tree diameter was typically measured at 4.5 feet from the ground, or approximate to the breast height which is 1.3 meter (Neldner *et al*., 2012). Only *Acacia mangium* trees with 10cm diameter or more at breast height (DBH) enumerated using diameter tape. The height of trees was measured by using rangefinder trupulse. Data were recorded in a standard vegetation form.

Data Analyses

The analysis based on stem density and basal area allowed a more informative examination (Neldner *et al*., 2012) of the stand structure of the vegetation. Diameter at breast height can be converted into basal area, a useful measure for describing the tree stand. It is used to describe average of an area occupied by tree stems (Neldner *et al*., 2012). Pearson's correlation was used to test the strength of

the relationship between stand density and relative abundance of bird. The coefficient range values from 0 to 1 while the positive and negative sign indicate the direction (Coakes & Ong, 2011).

Results

A total of 53 bird species from 21 families (343 individuals) were recorded in 2-year mangium plantation L41. There were 18 bird species (38 individuals) were recorded in Transect 1 (T1), 24 bird species (57 individuals) in Transect 2 (T2), 22 bird species (58 individuals) in Transect 3 (T3), 22 bird species (81 individuals) in Transect (T4), and 27 bird species (109 individuals) in Transect (T5) respectively, as shown in Table 1.

Table 1: Number of species and individuals by family in 2-year mangium plantation (L41) recorded for 21 days continuously.

Family	T1	T2	T3	T4	T5
Acciptridae	1 (1)		1 (2)		
Aegithinidae	1 (3)	2 (5)		1 (1)	1 (2)
Alcedinidae		1 (1)		1 (1)	1 (4)
Campephagidae					1 (2)
Ciconidae					1 (4)
Columbidae			1 (1)	1 (3)	2 (5)
Cuculidae				1 (1)	1 (1)
Culcicapa					1 (1)
Dicaeidae	2 (2)	1 (8)	1 (5)	1 (18)	3 (10)
Estrildidae	1 (3)	2 (7)		2 (6)	2 (8)
Cisticolidae	1 (1)	3 (3)	1 (3)	1 (1)	1 (4)
Monarchidae	1 (3)	1 (4)	1 (3)	1 (14)	1 (8)
Muscicapidae	1 (1)	1 (1)			
Nectarinidae	2 (3)	3 (3)	2 (3)	3 (3)	2 (2)
Oriolidae		1 (2)			1 (4)
Psittacidae		1 (3)	1 (7)	1 (1)	1 (2)
Pycnonotidae	3 (7)	6 (16)	6 (23)	6 (24)	6 (47)
Rallidae			1 (1)		
Strigidae			1 (3)		
Timaliidae	4 (10)	1 (3)	5 (6)	3 (8)	2 (5)
Turdidae	1 (4)	1 (1)	1 (1)		
TOTAL	**18 (38)**	**24 (57)**	**22 (58)**	**22 (81)**	**27 (109)**

Note: The first number refer to the number of species; the one number in bracket refer to the number of individual

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The density and basal area in 2-year mangium plantation L41 is shown in Table 2. T5 shows the highest stem density compared to the other transects. T1 and T2 show very few trees in one hectare compared to the others. However, the average height of trees among the five replicates was similar due to the same planting time.

Table 2: Stem density and basal area of 2-year mangium plantation L41 in SFI, Sabah.

	T1	**T2**	**T3**	**T4**	**T5**
Stem density (tree/ha)	250	400	700	700	1000
Basal area per hectare (m^2/ha)	77.21	99.45	146.63	195.24	246.36
Average of tree height (m)	8.42	8.85	9.48	9.11	7.41

Table 3 shows a significant correlation between complexities of vegetation and bird individual based on Pearson's correlation (r=0.394; p=0.031). The strength of the association in the two variables was categorized as weak (Cohen, 1998). The result of Pearson's correlation shown a positive direction. This mean that the number of bird individual increase with higher number of tree stand in *Acacia mangium* plantation.

Table 3: Pearson's correlation between stem density and bird individuals.

		Stem density	**Bird individual**
Stem density	Pearson Correlation	1	0.394*
	Sig. (2-tailed)		0.031
	N	30	30
Bird individual	Pearson Correlation	0.394*	1
	Sig. (2-tailed)	0.031	
	N	30	30

*Correlation is significant at the 0.05 level (2-tailed).

Discussion

According to the results of this study, the bird abundance increase with stems density. It is similar with the past findings of Sheldon and Styring (2011) and Sheldon *et al.* (2010). The factors that influence the bird abundance were canopy gaps, secondary canopy cover and shrub height (Styring *et al*., 2011; Sheldon *et al.*, 2010). The increasing of stem density creates smaller canopy gap and complexity of vegetation such as full of secondary canopy cover and bushes (Styring *et al.*, 2011; Sheldon *et al.*, 2010). Furthermore, high stem density increases the foliage density that can influence the bird abundance (MacArthur, 1961; Kricher 1972; Conner & Dickson, 1997).

Generally, high foliage density promotes bird abundance (James & Warner 1982; Conner & Dickson, 1997). As such, the complexities of mangium plantation promote a great insect species and mangium seeds that increase the food source availability for the bird species (Sheldon *et al.*, 2010; Lindenmayer & Hobbs, 2007). The complexities of vegetation also provide numerous microhabitats for birds due to the availability of diverse food sources for suitable breeding (Rajpar & Zakaria, 2015). Closed canopy gap in forest plantation increased the nesting site for some upperstory birds as well (Powell and Steidl, 2000). Some birds prefer nesting in closed canopy to be hidden from predators (Alderton, 2008). In addition to that, food source is more available at high stand density as compared to low stand density (Sheldon *et al.*, 2010).

Conclusion

Bird population abundance has positive correlation ship with the *Acacia mangium* tree stand density. We recommend an enrichment planting of fruit tree species along riverbank or surrounding area of the plantation in order to increase the biodiversity of the area. In addition to that, fruit tree species can act as windbreak to protect or minimize the damage from natural disaster directly toward young mangium plantation.

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