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DIVERSITY AND DENSITY OF BIRDS AT MANGROVES AND OIL PALM PLANTATIONS IN TWO DIFFERENT REGIONS IN SELANGOR, MALAYSIA

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ABSTRACT

This study is to determine the comparison of bird diversity and density between mangroves and oil palm plantation and its vicinity in the state of Selangor, Malaysia. The data was collected from two regions; Teluk Panglima Garang-Pulau Carey and Banting-Jenjarom. To determine the composition, diversity and density of resident bird communities, bird surveys were conducted using the Point Count technique at each study sites from October 2012 to May 2013. 4702 individuals were detected representing 108 species and 42 families from the surveys. The results show that species varied considerably in their use of habitat, and also responded differently in the same habitat in different regions. The oil palm plantation has also demonstrated the lowest species richness and absolute abundance of bird species in both sites. This study clearly shows that the undisturbed area; for this case mangrove is of critical importance for long-term survival of a great number of species.

Keywords: birds, mangroves, oil palm plantation, diversity, density, community.

INTRODUCTION

The word "mangroves" has been used to refer either to the plants that make up the tropical intertidal forest communities or the community itself (Ellison, 2008). Mangroves, which are one of the most disturbed habitats mainly due to intense human activities (Walton *et al*., 2007) are characterized by important concentrations of birds at both colonies of nesting and roosting sites (Alves *et al*., 1997), and tend to show more abundance of birds and species richness due to their high level of nutrients. Mangroves, where birds feed and rest, are also frequent by tourists for recreation; developed for shrimp farming and aquaculture, and unscrupulous acts of disposal of industrial and domestic waste. Human activities generate considerable disturbance to birds, especially when they are perched above the high tide, forcing them to fly from one place to another and increase their energy expenditure (Burger, 1986). Increase in marine traffic volume and recreation activities along the coast had also proven to be highly detrimental to the water bird assemblage. Together, these developments and natural threats such as coastal erosion and drought alter the coast in a way that degrades extensive bird habitat areas. Apart from mangroves, oil palm plantation is a major driver of the current biodiversity crisis in tropical Southeast Asia. Oil palm cultivation is becoming more widespread worldwide despite being considered by environmental NGOs as a serious threat to forest biodiversity (Danielsen *et al.*, 2009). Protecting biodiversity beyond that present in nature reserve is still a new conservation strategy, especially in developing countries (Sachs *et al*. 2010). It has been advocated that there is a need for better agricultural practices on farmlands that takes into consideration the elements of biodiversity conservation. The retention of forest patches in oil palm plantations, especially those with High Conservation Value (HCV) has been promoted by the Roundtable on Sustainable Palm Oil (RSPO) certification program as a means to reduce the loss of biological diversity in and around oil palm plantations (Yaap *et al*. 2010). Despite, its overall effectiveness has not been widely demonstrated; such strategy is usually considered as a useful practice to improve biodiversity and is part of the "wildlife-friendly" management system in the oil palm plantations (RSPO 2013).

JUSTIFICATION

Birds are used as the study taxon because they play important roles as predators, prey, seed dispersers and pollinators in the maintenance of ecological processes (Pimm, 1986). Birds are also easy to sample and sensitive to habitat changes making them useful environmental indicators (Johns, 1992). The study of the avian group is important for the understanding of the complexity of ecosystem structure and for providing updated information on each type of habitat in the ecosystem. In Malaysia, demand for food, raw materials and residential areas have opened the way to substantial loss of natural vegetation. Buildings and monocultures crop system, such as oil palm plantations have largely replaced large swath of natural vegetation areas (Munira *et al*., 2011). As reported in Uganda, species richness of the forest birds present in the native forest was higher than in the exotic coniferous plantation (Sekercioglu, 2002). Moreover, Barlow *et al.* (2007) have also reported that bird species richness is higher in indigenous primary forest and least species richness assemblage in Eucalyptus plantations. Secondary forest was recorded moderate bird species richness (Barlow *et al*., 2007).Good management practices should be implemented to strike balance between both ecosystem sustainability and human demand. However, the management efforts embedded in the surrounding landscape can also affect the composition and diversity of birds in that area. For example, birds were particularly high in the structurally rich landscape that contains large area of natural forest (Peh *et al.*, 2006). Therefore, the distance to the nearest natural forest habitat is too important for maintaining bird populations in managed landscape plantations (Peh *et al.*, 2006). Managed plantations in the vicinity of natural forest composed more forest birds than those located further away from natural habitats (Estrada *et al.*, 1997). High biodiversity has not only been associated with the complexity of landscapes, but also the structure of the vegetation within forest types. Several studies highlight the importance of tree cover in the tropical forest for the conservation of forest bird communities (Waltert *et al.*, 2005). Although homogeneous plantation trees with a dense canopy can still support some forest species (Peh *et al.,* 2006), vegetation heterogeneity has been shown to increase the number of niches and consequently the richness of species of birds (Peh *et al.*, 2006). This study was conducted at two different habitats; mangroves and oil palm plantations, in order to assess how much disturbance these two habitats are facing in the face of developments. These two sets of habitats chosen for this study are adjacent or almost contiguous to one another. The purpose of this study is to examine whether there are shared species of birds between the two habitats. Most notably, there are many fruit crops in oil palm plantation especially smallholders' plantation. This allows the birds to fly into nearby oil palm plantations for food. However, the birds are expected to use mangrove forests for the purpose of nesting and breeding. If this hypothesis is true, this research will assist in the management plan to ensure the oil palm plantations are biodiversity-friendly as well as maintaining similar levels of production and profitability. Mangroves also need to be conserved to maintain its biodiversity.

METHODOLOGY

The study regions were located in the state of Selangor. The data was collected from two regions; Teluk Panglima Garang-Pulau Carey (2^{o}56.477'N, 101^{o}25.261'E) and Banting-Jenjarom (2^{o}50.767'N, 101^{o}25.298'E). Each study region is composed of continuous mangrove area that is adjacent to oil palm plantation (Figure-1). Bird species survey was conducted in a total of four study sites within the two study regions (two mangroves and two oil palm plantations).

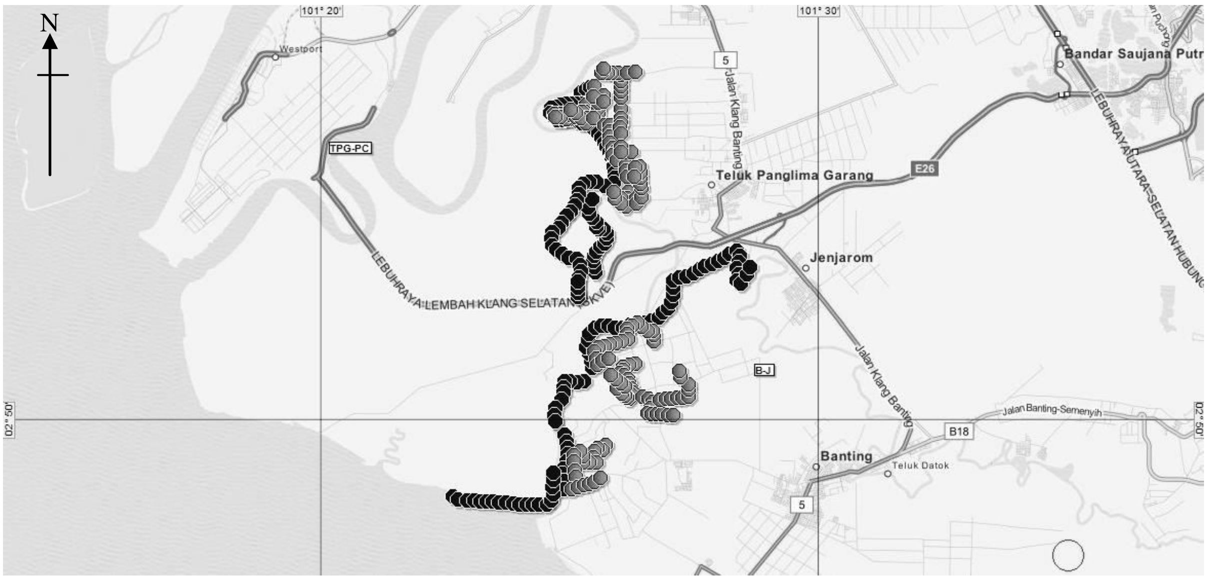

Figure-1. Geographical location and map of the study area. Dots represent the survey plots.

To determine the composition, diversity and density of resident bird communities, bird surveys were conducted using the Point Count technique at each study sites from October 2012 to May 2013. Each sampling conducted at a particular site consisted of 80 point counts. All bird surveys were carried out by the same observer (Peh *et al*., 2005).

The sampling points were chosen randomly with the constraint that they were at least 200m aparts (Rajpar and Zakaria, 2010). During each survey, birds that were seen or heard during a 10 minutes period within 40m radius were recorded from each sampling point (Kwok and Corlett, 2000). All bird surveys were conducted between 0700 and 1030h on days with no precipitation or strong wind (Peh *et al*., 2005).

If a bird was heard and could not be identified, the calls were documented using a voice recorder, and compared with local bird vocalization from a CD-ROM of Birds of Tropical Asia 3 (Scharringa, 2005).

Species accumulation curves for all study sites were graphed to assess inventory completeness. To estimate the bird species richness, Estimate S Win 752 (Colwell, 2005) were used to calculate the abundance-coverage based estimator ACE, incidence-based coverage estimator (ICE) and incidence based estimator (Chao2) (Lee and Chao, 1994). These three estimators were found to have the best performance predicting tropical bird species richness (Herzog *et al*., 2002).Estimate S was also used to Graph smoothed rarefaction curves for comparison of species richness among the study sites. The index of similarity was calculated to measure the degree of resemblance when comparing the species assemblages of two study sites. *Jaccard* (IsJ) was used to determine the qualitative index of similarity (McCune and Grace, 2002). Bird diversity indices, Shannon-Wiener (*H')* and Simpsons ($1/\sum p_i^2$)were calculated using Estimate S and were used to derive the Evenness Index that determine the degree of equitability of species abundances, and the inverse of Simpsons Index that measured the relative importance of dominant species. The Chi-squared test of independence was applied to determine if the bird species richness among study sites were significantly different.

Density of bird species was determined using Distance Software 6.0 (Thomas *et al.,* 2009). According to Marsden (1999), the bird density of those species whose numbers of detections were below five were not analysed due to low number of sample size. Determining the accurate population size of different birds is highly important to understand the bird community structures and population status of existing species in dwelling area.

RESULTS

4702 individuals were detected representing 108 species and 42 families (Table-1). The total number of species detected at each site ranged from 37 in Teluk Panglima Garang-Pulau Carey (TPG-PC) oil palm plantation to 79 in TPG-PC mangrove. The total number of individuals recorded ranged from 881 in Banting-Jugra (B-J) mangrove to 1630 in TPG-PC mangrove. According to the Shannon-Wiener Index (*H'*), the mangroves at TPG-PC and B-J were the two most diverse sites whereas the least diverse site was the oil palm plantation at TPG-PC. The evenness indices among the mangroves and oil palm plantation differed for both regions. The results showed that both mangroves were of lower evenness compared to oil palm plantation. Thus, it is confirmed that the diversity of species in mangroves area at both regions is relatively higher when compared to the oil palm plantation based on the dominance value.

Table-1. Bird species richness (S), absolute numbers of birds observed (N*)*, shannon's indices (*H'*), eveness indices (E*'*) and measures of dominance (*D*) at each study sites.

Sites	S	N	H'	E'	D
TelukPanglimaGarang-Pulau Carey					
Mangrove	79	1630	4.01	0.92	39.4
Oil Palm Plantation	37	1134	2.96	0.82	15.0
Banting-Jenjarom					
Mangrove	64	881	3.84	0.92	36.2
Oil Palm Plantation	41	1057	3.05	0.82	14.6

The species accumulation curve is a curve of rising biodiversity in which x-axis is the number of sampling units from an assemblages and y-axis is the observed species richness. The species accumulation curves rises monotonically form an asymptotic maximum number of species.

The species accumulation curves (Figure-2) illustrated the completeness of point count inventories. All graphs appeared to have reached their asymptotes during this study.

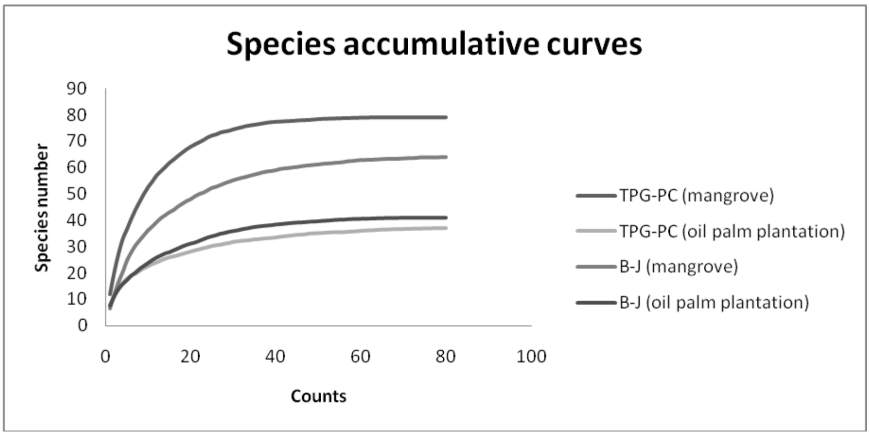

Figure-2. Species accumulation curves of bird species detected in the four study sites.

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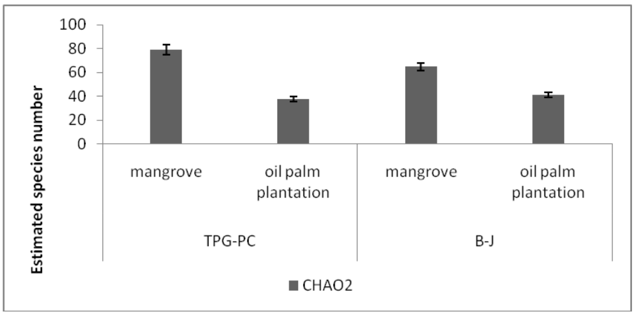
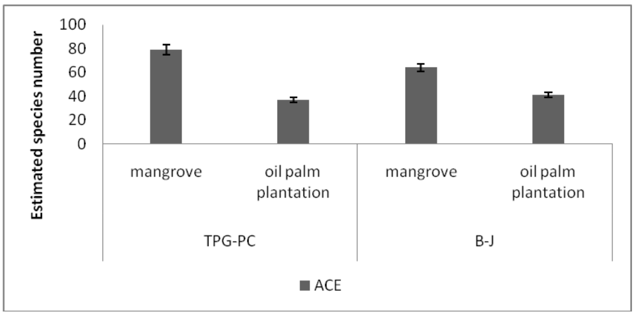
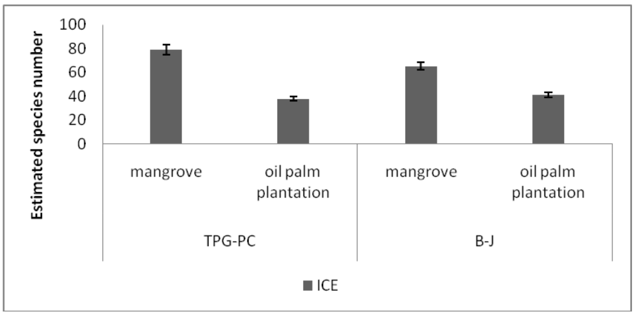
This is supported by various estimators (Figure-3) which shows that we had successfully detect almost all of avifauna in mangrove areas at TPG-PC and oil palm plantation area at B-J based on the results of the three estimators. However, according to the results of CHAO2 and ICE, we have still not managed to trace 2-3% of bird species at the area of oil palm plantation at TPG-PC and 1-2% of bird species in mangrove area at B-J. The various estimators also suggested that the oil palm plantation in both TPG-PC and B-J were less rich in bird species than their undisturbed counterparts.



(a) CHAO2



(b) ACE



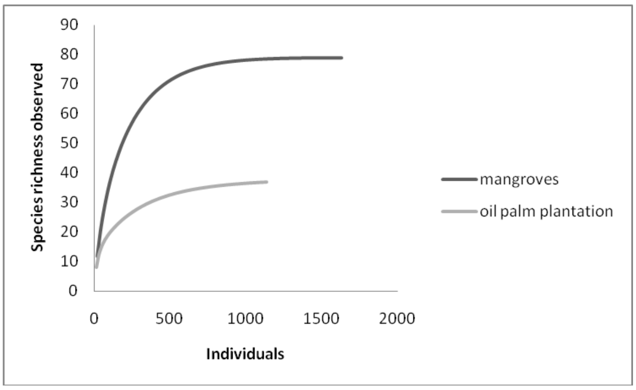
(a) ICE

Figure-3. Estimated bird species richness of the four study sites using three estimators. Bars represent standard errors.

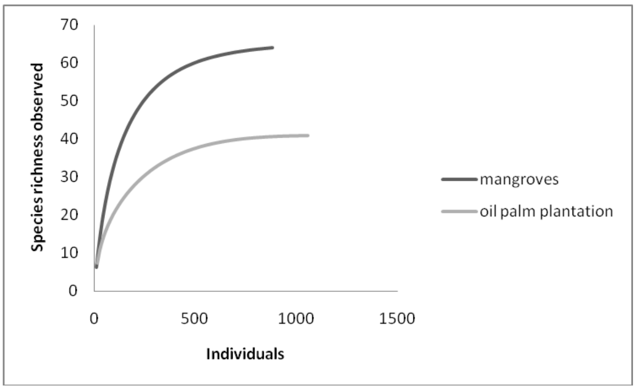
The result shows that the overall species richness in the mangrove at both regions is higher than the oil palm plantation. This is supported by the Chi-squared (χ^2) test that gives significant results for both regions; (TPG-PC: χ^2=15.21, df=1, p≤0.05) and (B-J: χ^2=5.04, df=1, p≤0.05). Number of individuals detected between mangroves and oil palm plantations also differ significantly at both regions; (TPG-PC: χ^2=89.01, df=1, p≤0.05) and (B-J: χ^2=15.98, df=1, p≤0.05). Contrastly, the overall species richness of each site type between TPG-PC (M: χ^2 =1.58, df=1, p≥0.05) and B-J (OP: χ^2 =0.21, df=1, p≥0.05) did not differ significantly.

The three most abundant species in the mangrove TPG-PC were *Acridotheres tristis*, and *Orthotomus ruficeps,* and *Amaurornis phoenicurus* with 7.12%, 3.87%, and 3.74% of the totals individuals recorded, respectively. *O. sutorius*, *A. tristis,* and *Spilopelia chinensis* are the most abundant birds at oil palm plantation TPG-PC with 11.20%, 11.11%, and 9.26% of the totals individuals recorded, respectively. The three most abundant species in the mangrove B-J were *Todiramphus chloris, O. ruficeps, and Eudynamys scolopaceus* with 6.36%, 5.56%, and 4.88% of the totals individuals respectively. At oil palm plantation B-J, *O. sutorius, Copsychus saularis,* and *Geopelia striata* are the most abundant birds with 12.77%, 11.92%, and 9.84% of the totals individuals respectively.

The rarefaction curves (Figure-4) suggested that there were more birds in terms of abundance in the oil palm plantation compared to the mangrove area at both regions. Rarefaction is a statistical interpolation method of rarefying or thinning a reference sample by drawing random subsets of individuals in order to standardized comparison of biodiversity on the basis of a common number of individuals' samples.



(a) Teluk Panglima Garang-Pulau Carey



(b) Banting-Jenjarom

Figure-4. Sample-based rarefaction curves displaying estimated bird species richness at the four study sites. X-axis is rescaled to the number of individuals observed.

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Species varied considerably in their use of habitat, and also responded differently to the same habitat in different regions. For example, the abundance of *A. tristis* at both mangroves and oil palm plantation in TPG-PC, they did not differ significantly, but it shows differences when compared between mangroves of different regions. The abundance of *A. phoenicurus* differed significantly when compared it between mangroves of different regions and between mangrove and oil palm plantation at TPG-PC. However, the result shows no significant difference in abundance of *A. phoenicurus* between mangroves and oil palm plantation at B-J. *O. sutorius* shows no differences in abundance at oil palm plantation when compared between different regions, but differ significantly in terms of abundance at mangrove of different regions. *T. chloris* did not differ significantly at mangrove when compared between TPG-PC and B-J, but differ significantly when compared between mangroves and oil palm plantation at both regions. The abundance of *C. saularis* differs significantly between mangrove and oil palm plantation at B-J but not differ significantly at TPG-PC. The abundance of *G. striata* differs significantly when compared between mangrove and oil palm plantation at B-J. Contrastly, it shows no significantly different between mangrove and oil palm plantation in terms of abundance of *G. striata* at TPG-PC.

In order of presenting the bird density results, bird species observed were grouped into four groups based on their usage of habitat as shown in Table-2.

Table-2. Group of birds based on the usage of habitats.

Groups of bird	Details
Mangrove	Species of birds that use mangroves as their habitat.
Plantation	Species of birds that use oil palm plantation or other plantation as their habitat.
Mix	Species of birds that utilize both habitats.
Others	Species of birds that are usually found at other types of habitats.

The density analysis shows that the bird density of TPG-PC at mangrove was 252.46±0.07 birdsha^{-1}that ranged from 218.27-292.01 birds ha^{-1}. The density of birds in oil palm plantation at the same region was lower than the mangrove with the reading of 198.65±0.08 birdsha^{-1}.While at the B-J, the results for the oil palm plantation has higher density with the reading of 138.46±0.11 birds ha^{-1}as compared to the mangroves (81.32±0.06 birds ha^{-1}) at the same region.

As representing the bird density according to the group of birds observed, the results (Table-3) show higher density for species of birds in category of Mangrove for the both regions at mangroves area, while in the plantation area, the highest density of bird species is from the category of Mix in TPG-PC. As in the plantation area of B-J, the highest density of bird species in the area is from the category of others.

Table-3. Bird density according to the group of birds.

Sites	**Density** (birds ha^{-1})	**Density at 95% confidence interval** (birds ha^{-1})
Teluk Panglima Garang-Pulau Carey (Mangrove)		
Mangrove	26.58±0.14	20.40-34.62
Plantation	25.65±0.13	19.97-32.95
Mix	14.99±0.08	12.79-17.55
Others	23.57±0.13	18.27-30.40
Teluk Panglima Garang-Pulau Carey (Oil Palm Plantation)		
Mangrove	18.37±0.13	14.23-23.71
Plantation	23.86±0.12	18.93-30.08
Mix	24.35±0.12	19.36-30.63
Others	12.05±0.26	7.31-19.85
Banting-Jenjarom (Mangrove)		
Mangrove	18.95±0.15	14.00-25.64
Plantation	12.31±0.22	7.96-19.04
Mix	17.63±0.10	14.60-21.30
Others	15.14±0.18	10.73-21.37
Banting-Jenjarom (Oil Palm Plantation)		
Mangrove	24.86±0.16	18.01-34.31
Plantation	28.27±0.11	22.89-34.93
Mix	14.39±0.09	12.16-17.04
Others	30.12±0.16	22.09-41.07

The highest Mangrove species density observed in TPG-PC (mangrove) was recorded for *Ardea purpurea* (23.47±0.32 birds ha^{-1}), while the highest densities of birds that fall under the category of Plantation in that area was *A.tristis* (12.48±0.18 birds ha^{-1}). For the birds that fall under the category of Mix and Others at TPG-PC (mangrove), the highest densities were recorded for *O. ruficeps* and *T. chloris* that shared the same value of density (13.74±0.21 birds ha^{-1}) and *Calidris alpina* (13.76±0.52 birds ha^{-1}) respectively. *C. alpina* or Dunlin shows higher density probably due to the time of sampling that conducted within March-April at mangrove area of TPG-PC. Dunlin is a migratory birds that flies from March to April during the winter season in Europe and certain parts in Asia to the areas with lower elevations, such as in the coastal areas of Peninsular Malaysia (Jeyarajasingam and Pearson, 2012). These birds utilize the mudflats to feed and replenish their much needed fat reserves. Contrastly, the highest density of birds in the area of plantation of the same region (TPG-PC) for the group of Mangrove is *Oriolus chinensis* (13.16±0.24 birds ha^{-1}). *A. javanicus* (12.95±0.2 birds ha^{-1}) had been recorded as the highest bird species density from the group of Plantation at the same area. *Halcyon smyrnensis* (19.28±0.26 birds ha^{-1}) was recorded for the highest density of birds under the group of Mix; while under the group of Others, *Tricholestes criniger* (5.52±0.64 birds ha^{-1}) had been recorded as a species of birds that had highest density in the respective habitat.

Similar results with species of birds that had highest density in the category of Mangrove in TPG-PC (plantation); *O. chinensis* (16.35±0.3 birds ha^{-1}) was recorded as highest density of birds in the category of Mangrove in B-J (mangrove). For the birds in the category of Plantation in that area, *Ardeola bacchus* (14.27±0.52 birds ha^{-1}) took the first place. From the observation, *A. bacchus* seems to be in a state of wintering plumage. This means that, at the time of observation, *A. bacchus* were the birds that visited Peninsular Malaysia during winter in their breeding area. Not much difference with the density value for the *O. ruficeps* in TPG-PC (mangrove), this species also showed the highest density (13.09±0.28 birds ha^{-1}) compared to other birds in the category of Mix at the mangrove area of B-J. Surprisingly, *Ixos malaccensis* (14.74±0.35 birds $ha^{-1)}$ was recorded as highest density in the category of Others at the respective habitat. This species seems to have included in the status of Near Threatened based on the IUCN Red List (IUCN, 2014). The highest density of this species may be due to the adjoining of the forest area from the mangrove fringe. This

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species were often seen perched on trees along the forest edge. *Spilornis cheela* (15.86±0.27 birds ha^{-1}) were seen as a bird with the highest density under the group of Mangrove at B-J (plantation). This species was frequently recorded through their loud called during flying before it was seen stopped roosting on trees. In the same region, *A. tristis* (17.31±0.16 birds ha^{-1}) was listed as a species with the highest density in the group of Plantation, while *O. sutorius* (15.78±0.15 birds ha^{-1}) represent the group of Mix. *Lonchura malacca* (20.87±0.37 birds ha^{-1}) was recorded as having the highest density in the group of Others. This species is often present in large flocks on weeds in areas that have aqueous features such as drains, ditches, and small rivers in the plantation area.

DISCUSSIONS

Aural and visual observations were employed for a rapid assessment of bird species in two habitat types. This method is more time efficient and enables the detection of a larger proportion of avifauna (Whitman *et al.*, 1997). One weakness of such aural-visual method is that it tends to underestimate richness and abundance of cryptic species (Bibby *et al*., 2000). However, the species accumulation curves reached asymptotes in all study sites, which indicate that the surveys were quite extensive. Our assessment clearly shows that birds in TPG-PC and B-J differed between mangroves and oil palm plantation, in both species richness and community structure (eg. dominance and density).

Teluk Panglima Garang-Pulau Carey (TPG-PC)

In TPG-PC, fewer bird species observed in mangrove area were detected in the disturbed site; oil palm plantation. Yet, it is true that these bird species that have been affected by logging are capable of recolonizing the oil palm plantation over time (Peh *et al.,* 2005). However, the higher proportion of total individuals represented by few common species, and only 35.29% of species observed in mangroves detected in oil palm plantation suggested that the recovery of avian community in the oil palm plantation was far from complete. Peh *et al.* (2005) also recorded only 73-75% shared species of primary forest birds in the logged forest. In addition, the bulk of avian diversity in the oil palm plantation was made up of birds characteristics of plantations and mix habitat of mangrove and plantation (eg: *O. sutorius, A. tristis*, *S. chinensis).* The biotic interactions (eg: interspecific competition) of the most abundance birds in oil palm plantation may or may not hinder the recovery of the other bird species composition and community structure. Most bird species found in mangrove area were still absent in the oil palm plantation despite the lack of any apparent barriers to movement between sites as the oil palm plantation was contiguous with the mangroves. This is also supported by Peh *et al*. (2005), that most of the terrestrial species that inhabit in primary forest areas were absent in the relatively logged forest even though there are adjacent between another. Only a few individuals of Malaysian Pied Fantail (*Rhipidura javanica*), Blue-tailed Bee-eater (*Merops phillipinus*), Rufescent Prinia (*Prinia rufescens*), Large-billed Crow (*Corvus macrorhynchos*), Lesser Coucal (*Centropus bengalensis*), Little-ringed Plover (*Charadrius dubius*), Pin-tailed Snipe (*Gallina gostenura*), and Barn Swallow (*Hirundo rustica*) were observed in mangrove and this implied that even if these species occurred in oil palm plantation, their presence might be negligible.

There were several stages of age of oil palm plantations as well as management and the characteristics of the study area. Oil palm plantations are classified into several age groups; <4 years, 4-7 years, and >8 years. At the age of <4 years, the study area is quite humid as the trees are still small and the leaves had no long fronds. At the age of 4-7 years, the tree is at medium height and the shady fronds provide the dim atmosphere. At this stage, the trees are produce fruits that can be harvested. This is in contrast with the area of >8 years of plants. At this stage, the trees are high and lofty. The plantation is quite sunny because the fronds are high and some of them had fell down. The management of the plantations also plays an important role in determining the presence of birds in the area. There are plantations that keep thick undergrowth and some applies the best management practices. Apart from thick undergrowth, the plantations were also left untidy with trash heaping and debris like used pesticide containers, bags of fertilizers, and food-drink leftovers. Most of the farms aged >8 years have been abandoned. Grass had grown high and other trees had grown in that area. Based on Lindenmayer and Franklin (2000), deforested area if left untouched may play a role in the conservation of widely distributed primary forest species. Smallholder plantations also may provide some opportunity to retain more diverse landscape matrix that has the potential to support a greater fraction of the original biodiversity, and also to provide a less hostile matrix through which the animals can move (Sayer *et al.,* 2012). Physical factors of the plantation also play an important role. Some of the plantations are near the water bodies such as drains, ditches, streams, and artificial pond.

These may suggest that some of the bird species are not corresponding to oil palm plantation for several factors. Few individuals of *R. javanica* had been found in the plantation that particularly conspicuous and not far from the mangrove areas. Monotonous vegetation in the plantation may also be one of the factors in determining the species and the number of attendees at respective habitat. For example, *M. phillipinus* utilizes open perches as vantage points and use tall trees for communal roosts. Based on Sayer *et al.* (2012), increased in structural heterogeneity of the plantation system is intended to increase the diversity of species. Apart from that, oil palm plantations are confined of food sources for birds. *M. phillipinus* skims low over fields in pursuit of insects. However, *P. rufescens* was difficult to observe as this species was often concealed in the bushy area. This matter has also been expressed by Najera and Simonetti (2010) that understorey vegetation in oil palm plantations increases the abundance and richness of bird communities in Guatemala. In contrast with *C. macrorhynchos,* few individuals were found perching at the top of shrubby trees or at the heap of rubbish. Few individuals of *C. bengalensis* were found hiding at the crevices of trees in the plantation near the watery areas. *C. dubius* and *G. stenura* were considered lost at the plantation area near mangrove as they were found singly. *H. rustica* was observed not flying in groups inside plantation. They were considered as layover for rest at fence or wood inside the plantation.

Banting-Jenjarom (B-J)

As for B-J, about 38.16% from the total bird species observed in mangrove were also detected in oil palm plantation. This may suggests that the recovery of avian community at oil palm plantation was slightly better from oil palm plantation in TPG-PC. This may be because of the characteristics of oil palm plantation in B-J that are near the forest edge, mostly surrounded by forested streams gardens, close to the abandoned areas of plant cultivation and there are herding cattle activities inside oil palm plantation. Such features might be a contributing factor to several bird species that are commonly found at mangrove; and utilize both mangrove and oil palm plantation as their habitat, but observed higher number of individuals in oil palm plantation. Apart from that, Peh*et al.* (2005) also noted that the fraction of primary bird fauna present in the mixed rural habitat indicates that some primary forest birds might persist in agricultural landscapes. The species are Common Tailorbird (*O. sutorius*), Oriental Magpie Robin (*C. saularis*), Black-naped Oriole (*O. chinensis*), White-throated Kingfisher (*H. smyrnensis*), Blue-throated Bee-eater (*Merops viridis*), Red Junglefowl (*Gallus gallus*), and Coppersmith Barbet (*Megalaima haemacephala*).

Mangrove vs. oil palm plantation

The results demonstrate that the oil palm plantation has the lowest species richness and absolute abundance of bird species in both TPG-PC and B-J. It is undoubtedly the case that the loss of biodiversity on a large scale accompanies the conversion of natural forests to oil palm plantation (Edwards *et al*., 2012; Jambari *et al.* 2012). This finding is also consistent with the long-term studies in Peninsular Malaysia by Wong (1986) which showed that the species richness was lower in the 25-year-old regenerating logged forest. The majority of the bird species observed at mangrove seemed to be clearly confined to the mangrove area. The observations of shared species showed that their behavior was dominated by movement in the oil palm plantation rather than foraging and nesting. This implies that the oil palm plantation may not serve as a functional habitat for many bird species. The lower bird species in both TPG-PC and B-J oil palm plantation maybe because of lacked large trees, dead trees and dense canopy. However, some bird species were able to persist in oil palm plantation because of higher resource abundance (fruiting intensities) in the oil palm plantation, especially in smallholder plantation. Diversity of crop density and uncultivated borders between smallholdings could contribute in supporting some biodiversity (Sayer *et al*., 2012). The data on the most common bird species in a particular habitat also varied in different locations. Such variation within a particular habitat type could be related to the differences in landscape composition and configuration. Therefore, oil palm estates industries can be established in ways that make allowances for biodiversity (Koh *et al*., 2009), in particular by retaining forests in riparian areas and on steep slopes, or by allocating aside areas of High Conservation Value Forests. However, the number of species that can truly survive in the oil palm plantation is even lower because:

(i) Since the survey sites were near the mangroves, it is likely that some species that spend most of the time in the mangrove use the oil palm plantation only because of its close proximity to the mangrove.

(ii) Some species may commute to oil palm plantation to exploit food resources but depend on the mangrove for all other aspects of lifecycles (Jeyarajasingam and Pearson, 2012).

CONCLUSIONS

Many bird species in the undisturbed area; for this case is mangrove is critical importance for their long-term survival. The vegetation structure may affect the distribution of bird species. There are bird species identified of which listed as nearly threatened and endangered at both sites. The species are Puff-backed Bulbul (*Pycnonotus eutilotus*), Black Magpie *(Platysmurus leucopterus*), White-chested Babbler *(Trichastoma rostratum),* Green Iora *(Aegithina viridissima),* Brown-backed Flowerpecker (*Dicaeum everetti*), Scarlet-breasted Flowerpecker (*Prionochilus thoracicus*), Black-bellied Malkoha (*Phaenicophaeus diardi*), Streaked Bulbul (*Ixos malaccensis)*, Painted Stork *(Mycteria leucocephala*) and Storm's Stork (*Ciconia stormi*). Those species should therefore have high priority for conservation and monitoring. The Inventories of bird species in the oil palm plantation and natural habitat (mangrove) may be useful in predicting the bird changes under various human disturbances, and ultimately protecting the Malaysian avifauna.

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