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DENSITY AND DIVERSITY OF NOCTURNAL BIRDS IN OIL PALM SMALLHOLDINGS IN PENINSULAR MALAYSIA

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ABSTRACT

Over the past half century, oil palm cultivation has been expanding rapidly throughout many developing countries. Due to its economic importance, large tracts of natural land have been converted into oil palm cultivations and where increasing sightings of nocturnal birds have been made. A survey of nocturnal birds was conducted to assess their density and diversity in the oil palm smallholdings in the Selangor state, Peninsular Malaysia. A total of 90 sampling points were established within three oil palm smallholdings. A total of 1408 individuals of 11 nocturnal bird species were recorded. Based on distance sampling techniques, the density of Spotted Wood-owl (Strix seloputo) *was estimated at 7 individuals 100 ha^{-1}, followed by 15 individuals for Sunda Scops-owl* (Otus lempiji)*, five for Barn Owl* (Tyto javanica) *and 79 for Large-tailed Nightjar* (Caprimulgus macrurus) *per every 100 ha. The presence of a high density of some nocturnal birds in oil palm smallholdings may be associated with the availability of food source and roosting structure that are linked to habitat heterogeneity in the oil palm smallholdings. Our study highlighted the potential of nocturnal bird species, other than the Barn Owl, as biological control agents in the agricultural areas.*

Keywords: nocturnal birds, oil palm smallholdings, density, abundance, biological control.

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INTRODUCTION

Nocturnal birds have been said to play ecological roles in an ecosystem similar to what their diurnal counterparts do during daytime. In Peninsular Malaysia, there is a total of 21 resident nocturnal bird species comprising of two taxonomic orders, namely Strigiformes and Caprimulgiformes. They occupy various habitat types ranging from highland forests (*i.e.* Mountain Scops-owl, *Otus spilocephalus*), secondary forests (Sunda Scops-owl, *Otus lempiji*), wetlands (Buffy Fish-owl, *Ketupa ketupu*) to urban parks (Barn Owl, *Tyto javanica*; Large-tailed Nightjar, *Caprimulgus macrurus*) (Wells, 1999; Puan *et al.*, 2015). All nocturnal birds recorded in Peninsular Malaysia are listed as Least Concern by International Union for Conservation of Nature (IUCN), except for Reddish Scops-owl (*Otus rufescens*), Large Frogmouth (*Batrachostomus auritus*), and Gould's Frogmouth (*Batrachostomus stellatus*) which are listed as Near Threatened whereas the White-fronted Scops-owl (*Otus sagittatus*) is vulnerable (IUCN, 2018). Either in natural or man-made habitats, each nocturnal bird plays an important ecological role in an ecosystem.

In the case of man-made habitat, previous studies revealed the potential of Barn Owl as a pest control agent (Hafidzi and Naim, 2003; Puan *et al.*, 2012; Puan, 2013). As a result, some large agricultural-based companies have begun introducing Barn Owl by providing nest boxes for these birds in order to suppress pest population in their agricultural lands (Hafidzi and Naim, 2003; Ojwang and Oguge, 2003). For instance, Felda Global Ventures (FGV) introduced a total of 16 individuals of Barn Owl in an

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oil palm plantation in Lahad Datu, Sabah, Malaysia in order to suppress rat population and to reduce the application of rodenticide. The programme was successful as the owl's population had multiplied by 638% after 20 months (Abidin *et al.,* 2016) which may be able to suppress the rodent population in the plantation. This can be possible because a fully grown Barn Owl can consume up to three rats per night (Hafidzi and Naim, 2003).

Over the past three decades, despite the fact that most previous studies focused on Barn Owl (*i.e.* Hafidzi and Naim, 2003; Naim *et al.,* 2010; Puan *et al.,* 2011; Abidin *et al.,* 2016; Salim *et al.,* 2016), there is also an increase in studies on other nocturnal birds in Malaysia over the last five years (Atikah *et al.,* 2013; 2019; Puan *et al.,* 2015; Najmi-Hanis *et al.,* 2016; Yee *et al.,* 2016; 2018; Yahya *et al.,* 2016; Chang *et al.,* 2017; Pilla *et al.,* 2018). By using point count method, Atikah *et al.* (2013) made a preliminary estimation of nocturnal bird density in oil palm smallholdings located at Tanjung Karang, Selangor, Malaysia and recorded some nocturnal bird species that were associated with forest habitats (*i.e.* Oriental Bay-owl, *Phodilus badius*; Brown Wood-owl, *Strix leptogrammica*; Dusky Eagle-owl, *Bubo coromandus* and Brown Boobook, *Ninox scutulata*) in the man-made landscape. The aim of this study was to estimate the density of nocturnal bird species in oil palm agriculture based on distance sampling.

METHOD

Study Areas

Bird sampling took place in oil palm smallholdings (approximately 5300 ha) located at Banting (2°47′48″N, 101°31′10″E), Tanjung Karang (3°24′24″N, 101°15′26″E) and Sabak Bernam (3°50′50″N, 100°53′19″E), Selangor, Peninsular Malaysia (*Figure 1*). The smallholdings involved in this study were privately owned and managed

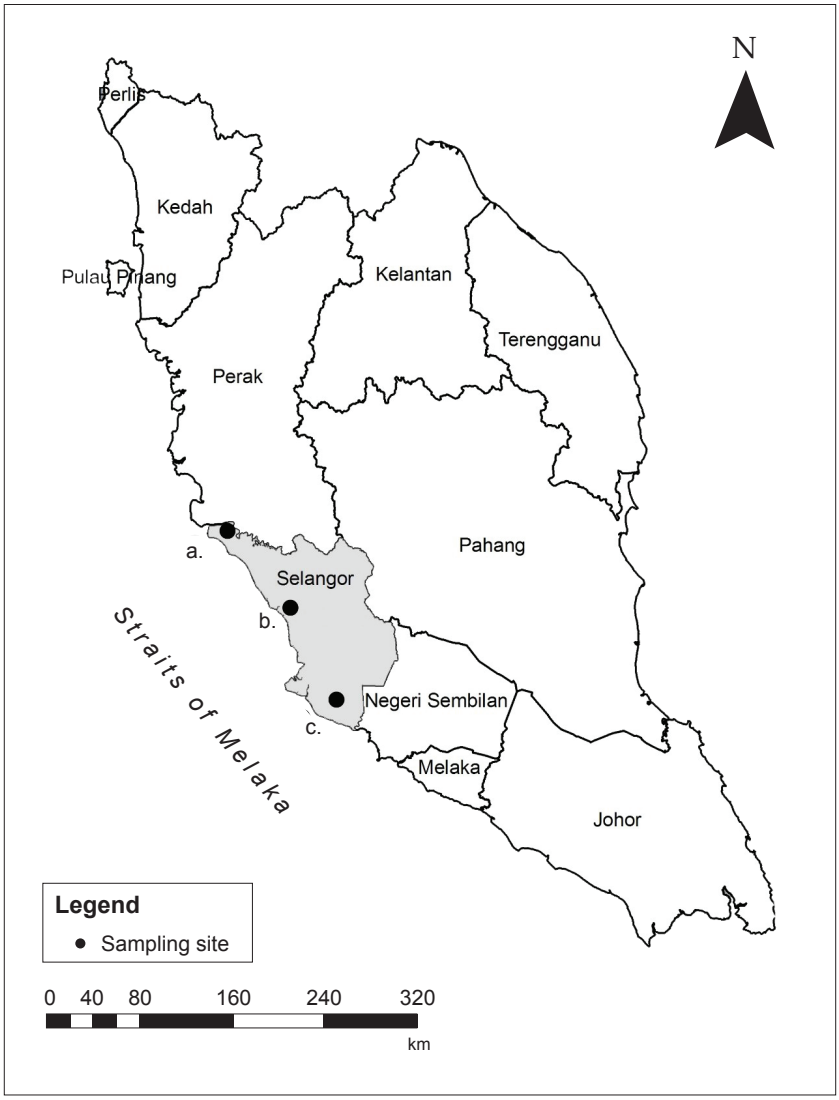

Figure 1. Locations of study areas; (a) Sabak Bernam (b) Tanjung Karang and (c) Banting in Malaysia.

by individual land owners. Each land owners owned an average of 2-5 ha pieces of land which were primarily planted with oil palms, which sometimes intercropped with other subsistence crops (*e.g.* banana, coconut and jackfruit). Oil palm fruit bunches are usually harvested twice a month, throughout the year. The study areas received an average rainfall of 2500 mm annually (MET, 2014). There were some residential areas located within the study areas.

Survey of Nocturnal Birds

Point count survey method (adapted from Ralphs and Sauer, 1995; Buskirk and McDonald, 1995) was used in this study where 30 points were placed in each of the three study sites. Survey points were established systematically on road junctions (either tarmac or dirt roads) at 800 m apart, similar to previous studies at the same sites (Ghazali *et al.*, 2016; Syafiq *et al.*, 2016; Yahya *et al.*, 2016; 2017). With the aid of playbacks (www.xeno-canto.org), a minimum of two experienced surveyors stayed at each point for 10 min and recorded all sightings and/or vocalisations of nocturnal birds (Gerhardt, 1991; Takats *et al.*, 2001; Delport *et al.*, 2002; Newton *et al.*, 2002; Kemp *et al.*, 2009). A confirmed record was only made when both surveyors agreed upon its presence. The direct distance of each record from the sampling points was also estimated. The survey was repeated six times for each of the sampling points in order to increase the encounters of targeted birds and survey effectiveness (Hausleitner and Bio, 2006). The surveys were conducted from 1900 hr-0200 hr daily.

Statistical Analyses

Shannon-Wiener H', Shannon-Weiner J' and Simpson 1-D indices were used to measure the diversity of nocturnal bird species in oil palm smallholdings. We applied bootstrap estimation on the diversity index by 100 permutations to increase the precision of the calculations. Both non-permutated and permutated estimation values of the indices were reported.

By using Conventional Distance Sampling (CDS) in distance 6.2 (University of St. Andrews, United Kingdom), the density of nocturnal birds in oil palm smallholdings were estimated. Half-normal as key functions and cosine as series expansion were selected consistently throughout each estimation. In order to increase the precision of the estimations, bootstrap at 100 permutations was applied. Both estimations of density and abundance of each selected species were carried out, along with standard error (SE), coefficient of variation (%CV), effective detection radius (EDR) and coefficient of variation) for effective detection radius (EDR%CV). Due to insufficient data, seven species (*i.e.* Savanna Nightjar, Oriental Bay-owl, Buffy Fish-owl, Brown Wood-owl, Dusky Eagle-owl, Barred Eagle-owl *Bubo sumatranus*) records had to be excluded from the analysis.

RESULTS

Nocturnal Bird Diversity

A total of 1408 individuals from 11 species (comprising nine owl and two nightjar species) were recorded in this study (*Table 1* and *Figure 2*).

TABLE 1. NOCTURNAL BIRD SPECIES RECORDED IN OIL PALM SMALLHOLDINGS AT BANTING, TANJUNG KARANG AND SABAK BERNAM, SELANGOR, PENINSULAR MALAYSIA

Family	Species	Number of encounters	Mean observation per point
Caprimulgidae	Large-tailed Nightjar (*Caprimulgus macrurus*)	454	5.044
	Savanna Nightjar (*Caprimulgus affinis*)	20	0.222
Tytonidae	Barn Owl (*Tyto javanica*)	101	1.122
	Oriental Bay-owl (*Phodilus badius*)	15	0.167
Strigidae	Spotted Wood-owl (*Strix seloputo*)	435	4.83
	Sunda Scops-owl (*Otus lempiji*)	347	3.856
	Buffy Fish-owl (*Ketupa ketupu*)	19	0.211
	Brown Wood-owl (Strix *leptogrammica*)	13	0.144
	Brown Hawk-owl (*Ninox scutulata*)	2	0.022
	Dusky Eagle-owl (*Bubo coromandus*)	1	0.011
	Barred Eagle-owl (*Bubo sumatranus*)	1	0.011
	Total	1 408	-

Large-tailed Nightjar (454 encounters) was the most abundant species recorded followed by Spotted Wood-owl (435 encounters), Sunda Scops-owl (347 encounters) and Barn Owl (101 encounters). All the species had also been previously recorded in the oil palm smallholdings located in the Selangor state (Atikah *et al.*, 2013; Azhar *et al.*, 2011; 2015). Five nocturnal species that were associated with forest habitats were recorded, namely Oriental Bay-owl, Barred Eagle-owl, Dusky Eagle-owl, Brown Wood-owl, and Brown Boobook (König *et al.*, 1999; Wells, 1999; Robson, 2011), albeit their numbers remained low.

Based on Shannon-Weiner H', the diversity index of nocturnal birds in oil palm smallholdings was calculated at 3.359, or 4.731 ± 0.004 SE based on bootstrap estimation. For Shannon-Weiner J', the evenness index was calculated at 0.988, or 0.9882 ± 0.0008 SE based on bootstrap estimation. Based on Simpson 1-D, the diversity index was calculated at 0.965 or 0.9910 ± 0.0001 SE based on bootstrap estimation.

Figure 2. Nocturnal birds recorded in study areas; a) Barn owl, b) Oriental Bay-owl, c) Spotted Wood-owl, d) Brown Wood-owl, e) Barred Eagle-owl, f) Dusky Eagle-owl, g) Brown Hawk-owl, h) Buffy Fish-owl, i) Sunda Scops-owl, j) Large-tailed Nightjar, and k) Savanna Nightjar.

Nocturnal Bird Density

By using Distance 6.0 (Thomas *et al.*, 2010), the density of Spotted Wood-owl was estimated at 0.076 ± 0.001 SE individual per hectare (%CV = 15.84, EDR = 94.291, EDR %CV = 5.04) or about seven individuals per 100 ha. The density of Sunda Scops-owl was estimated at 0.15 ± 0.026 SE individual per hectare (%CV = 16.97 EDR = 62.543, EDR %CV = 6.88), *i.e* about 15 individuals for every 100 ha. The density of Barn Owl was estimated at 0.05 ± 0.011 SE individual per hectare(%CV = 22.29 EDR = 56.52, EDR %CV = 6.02), about five individuals per 100 ha. For Large-tailed Nightjar, its density was estimated at 0.794 ± 0.108 SE individual per hectare (%CV = 13.65 EDR = 31.13, EDR %CV = 1.76), about seven to eight birds in every 10 ha (*Table 2*). For the total area of 5200 ha, we estimated the abundance of Spotted Wood-owl at 395 ± 62.574 SE individuals (%CV = 15.84) followed by Sunda Scops-owl at 797 ± 135.27 SE individuals (%CV = 16.97), Barn Owl at 263 ± 58.624 SE individuals (%CV = 22.29) and Large-tailed Nightjar at 4131 ± 563.73 SE individuals (%CV = 13.65) (*Table 3*).

DISCUSSION

Distance analysis estimated the density of four common nocturnal bird species, *i.e.* in every 100 ha of oil palm smallholdings, there were about five individuals of Barn Owl, seven Spotted Wood-owls, 15 Sunda Scops-owls, and 79 Large-tailed Nightjars. The density of Large-tailed Nightjar was the highest in the smallholdings which may be due to the availability of insects as food supply and roosting sites for the bird that can be linked to habitat structure (Yahya *et al.*, 2016).

In the case of Sunda Scops-owl, the density estimate (*i.e.* 1-2 individuals per 10 ha) is close to the estimations of Pilla *et al*. (2018) and Najmi-Hanis *et al*. (2016) in a lowland dipterocarp forest based on distance sampling and radio-telemetry methods, respectively. This is expected as the species has been known to thrive in various wooded habitats including plantations (Wells, 1999; Puan *et al.*, 2015; Yahya *et al.*, 2016). It should be noted that the survey covered breeding season of the species and involved call playbacks similar to Pilla *et al*. (2018). For the other two larger owl species, it is a little surprising that the density of Spotted Wood-owl was higher than the Barn Owl. This is unexpected as the latter is known to be abundant in oil palm plantation due to the availability of nest boxes. This calls for further investigation on whether such situation only happens in smallholdings, not in large scale oil palm plantations, as well as what factors contribute to higher density of the former in the smallholdings. Such information is essential with respect to the ecology of the species (*e.g.* interspecific interaction) as well as its potential to serve as a biological control agent in agricultural sector.

In addition, the presence of some forest associated species (*i.e.* Oriental Bay-owl, Dusky Eagle-owl and Brown Hawk-owl), although in low numbers, may also imply that smallholdings may serve as an alternative habitat for these species, at least as their hunting ground. However, it has been shown that some forest associated species may not be able to persist in oil palm agriculture (Atikah *et al.*, 2019).

TABLE 2. DENSITIES OF NOCTURNAL BIRDS IN OIL PALM SMALLHOLDINGS IN BANTING, TANJUNG KARANG AND SABAK BERNAM, SELANGOR, PENINSULAR MALAYSIA

Species	D	SE	%CV (%)	EDR	EDR %CV (%)
Spotted Wood-owl	0.76×10^{-1}	0.12×10^{-1}	15.84	94.29	5.04
Sunda Scops-owl	1.53×10^{-1}	0.26×10^{-1}	16.97	62.543	6.88
Barn Owl	0.50×10^{-1}	0.11×10^{-1}	22.29	56.52	6.02
Large-tailed Nightjar	7.94×10^{-1}	1.08×10^{-1}	13.65	31.13	1.76

Note: D - density; SE - standard error; %CV - coefficient of variations; EDR - effective distance radius; EDR %CV - coefficient of variations of effective distance variation.

TABLE 3. ABUNDANCE OF NOCTURNAL BIRDS IN OIL PALM SMALLHOLDINGS IN BANTING, TANJUNG KARANG AND SABAK BERNAM, SELANGOR, PENINSULAR MALAYSIA

Species	A	SE	%CV	95% CI	
Spotted Wood-owl	395	62.574	15.84	290	538
Sunda Scops-owl	797	135.27	16.97	573	1 110
Barn Owl	263	58.624	22.29	171	406
Large-tailed Nightjar	4 131	563.73	13.65	3 164	5 394

Note: A - abundance; SE - standard error; %CV - percentage for coefficient of variation; 95% CI - 95% confident interval.

CONCLUSION

The study indicated that oil palm smallholdings are able to support high densities of some native nocturnal birds. Yet, species that are associated with forests remained low in number. It is believed that, oil palm smallholdings with higher level of habitat complexity may be able to provide a wide range of food sources as well as roosting and/or breeding sites for the nocturnal birds (Yahya *et al.,* 2016). It is also believed that the existence of nocturnal birds in such landscape may be potentially useful to oil palm smallholders with respect to biological control of vertebrate and invertebrate pest species (Yahya *et al.,* 2016).

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