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Home range and activity patterns of Sunda scops owl in Peninsular Malaysia

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Abstract. The Sunda scops owl *Otus lempiji* is commonly found in many wooded habitat types in Malaysia. However, as with other owl species in Southeast Asia, there is a lack of published ecological studies. We examined the home range and activity patterns of six adult Sunda scops owls based on radio-telemetry in an isolated forest, namely Ayer Hitam Forest Reserve, Selangor, Peninsular Malaysia from December 2012 to June 2013. Mean minimum convex polygon and harmonic mean home range areas of the owls were 2.40 ± 0.28 SD ha and 4.00 ± 0.78 SD ha, respectively. The birds exhibited territorial behaviour with little overlapping of home ranges. Movements (the means of inter-fix speed) were not associated with lunar illumination nor with time. This study provided baseline information on the spatial requirements of the Sunda scops owl in a lowland forest.

Key words. Sunda scops owl, *Otus lempiji*, home range, territorial behaviour

INTRODUCTION

The Oriental region has a high diversity of owl species, particularly in the case of genus *Otus* (Strigidae; Konig & Weick, 2008). However, the species limits for the genus remain unresolved (White & Kiff, 2000; Penhallurick, 2002; Lok et al., 2009) and many species are still little studied, including the common ones. To date, only limited published information on *Otus* is available in Southeast Asia, including on phylogeny (Miranda et al., 1997; Miranda et al., 1998; Wink & Heidrich, 2000; Miranda et al., 2011), vocalisations (Marshall, 1978; Becking, 1994; Hutchinson et al., 2007), local abundance (Kemp et al., 2007), occurrence (Sheldon et al., 1983; Nijman, 2004) and nesting (Leadprathom et al., 2009), as well as feeding accounts (Lok et al., 2009). In the last two decades, there have also been publications of species discoveries (Lambert & Rasmussen, 1998; Sangster et al., 2013) and a rediscovery (Widodo et al., 1999) of the genus in the archipelago of Indonesia. In the case of radio-telemetry studies, there are not yet any published findings for the genus in this part of the world.

As part of the Oriental region, Malaysia has a total of six resident *Otus* species (MNS-BCC, 2005) of which one falls under the category Vulnerable (i.e., white-fronted scops owl *Otus sagittatus*) and two are listed as Near Threatened (i.e., reddish *Otus rufescens* and Mantanani scops owls *Otus mantananensis*). The Sunda scops owl *Otus lempiji* is a common owl species in Malaysia, found in many habitat types, including suburban areas, plantations and forests (Lok et al., 2009; Puan, 2013). The owl seems to be attracted to human habitation and cultivated areas, which may be associated with the availability of prey (i.e., small vertebrates and insects) (Marks et al., 1999). Unlike many owl species that rely on undisturbed forest habitats (Marcot, 1995), the wide distribution of Sunda scops owl and its persistence in disturbed habitats may indicate that the species is less likely to be affected by forest disturbance. Yet, such speculation could only be answered if ecological information such as the spatial requirements as well as intra- and inter-specific interactions of the owl are available. As a small-sized, understory predatory bird, intraguild predation may occur on the Sunda scops owl.

Despite being common, there is a lack of ecological studies on the Sunda scops owl in Southeast Asia, as with many owl species in this region. Based on radio-telemetry, this study examined the home range size and activity patterns of the Sunda scops owl in an isolated forest in Peninsular Malaysia. By assessing both home range size and activity of the species, this may serve as an information baseline in understanding the complex ecological interactions and food web of which the Sunda scops owl is part.

METHODS

Study site. The study site, Ayer Hitam Forest Reserve (2°80'N, 101°39'E; Fig. 1) is located in Selangor state in Peninsular Malaysia. It is a logged-over forest which has lost about 70% of its original land area since the 1950s (Awang Noor et al., 2007). The forest has now become isolated and is densely surrounded by residential areas. With the current land area of 1,176 ha, the geology of the area is characterised

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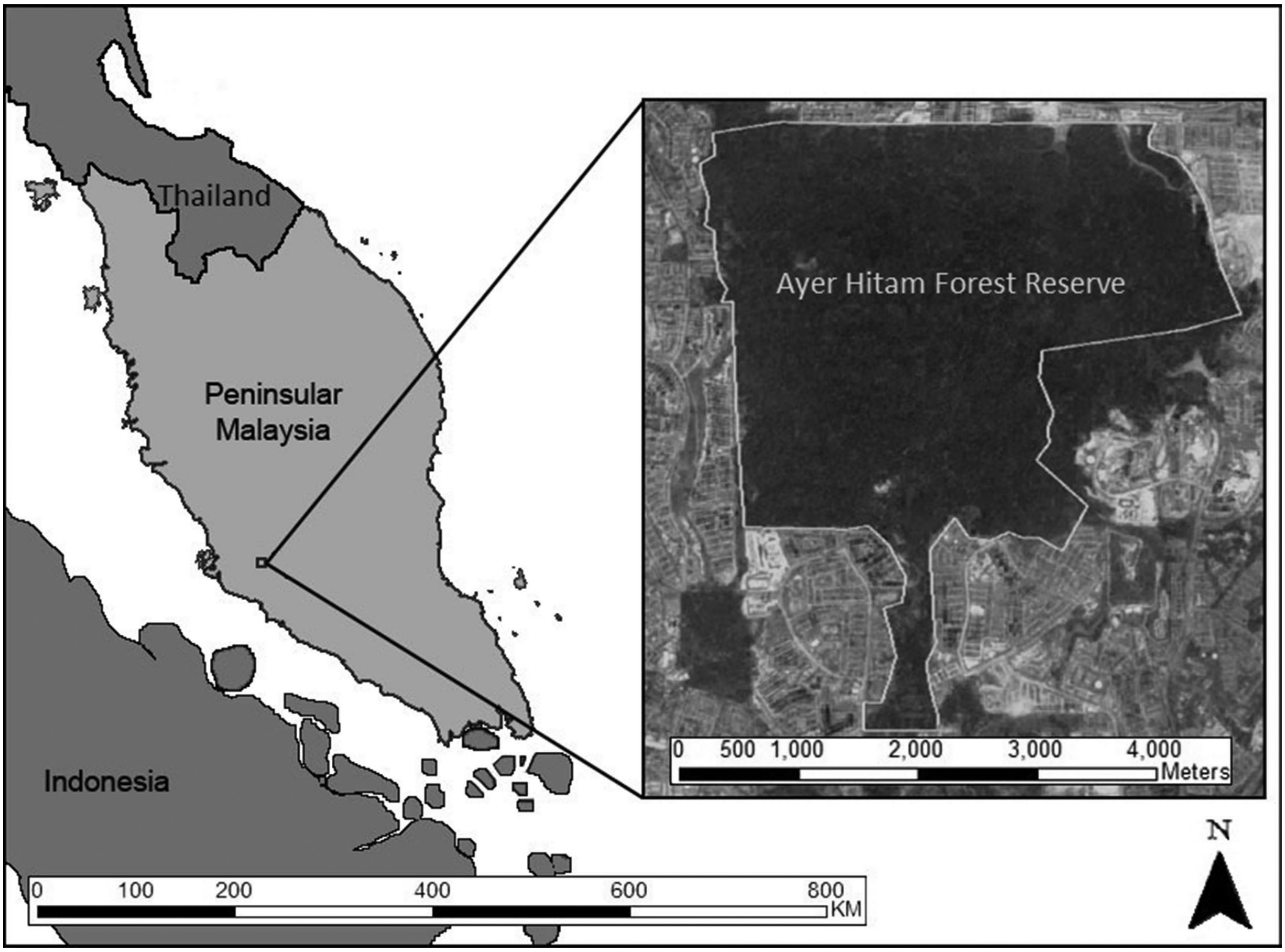

Fig. 1. Location of Ayer Hitam Forest Reserve, Selangor, Peninsular Malaysia.

by a combination of alluvium-colluvium soil, derived from metamorphic rocks, with a sandy clay loam soil texture and two main rivers, namely the Rasau and Bohol Rivers (Lai & Samsuddin, 1985). The annual mean temperature and relative humidity are 26.6°C and 83%, respectively. The Sunda scops owl is one of the five resident owl species recorded in the forest (Zakaria et al., 2008).

Radio-telemetry. In an attempt to capture neighbouring birds to allow intraspecific comparison of home ranges, four mist-nets (10 m × 4 m; 30 mm mesh) were deployed at each of the three sampling points, spaced approximately 500 m apart. To increase the capture rate, tape playbacks were used occasionally to attract birds to the nets. Feather samples were taken from birds for molecular sexing. Each owl captured was then banded and mounted with a backpacked transmitter (weighing approximately 1.8–2.1 g) using Teflon ribbon. With frequencies between 150.05–150.10 MHz band and a pulse rate of 32 ppm, each transmitter can be detected within 100 m radius and lasted for approximately 72 ± 1.5 days on average. All birds were located through triangulation or by direct observation, whenever possible. Triangulation was made using a single 3-element folding Yagi antenna combined with a hand-held receiver (Model TRX-16S, Wildlife Materials Inc., Murphysboro, Illinois). Radio locations including Global Positioning System (GPS) coordinates and a compass bearing were obtained and were plotted on digital map using ArcGIS version 10.0 (ESRI, Redlands, California).

Prior to the actual survey, a pilot study was carried out by tracking two owls for a period of two weeks to determine the minimum number of radio-fixes required to define the home range of individual bird through incremental area analysis (Harris et al., 1990). Following this, all owls but one were radio-tracked for at least 10–16 cumulative days from dusk (1730 h) to dawn (0730 h) until sufficient fixes were obtained or until battery failure. After discovering that the owls generally stayed within the activity radius of a certain location or tree stand during the night, two to three triangulations per owl were made each night. Individual birds in different territories were tracked in predetermined order and on average more than two owls were tracked per night, weather permitting. This yielded a total of 40–60 fixes per bird (except one individual), which is considered the minimum required fixes for home range measurement (Kenward, 1987). During the survey, direct observation of birds was difficult as they foraged mostly at the understory level, moving through the dense undergrowth of the forest. Attempts were made to obtain radio-fixes during daylight hours to confirm the roost site of the birds. The time of night and moon phases were also recorded during the survey. Due

Table 1. Summary of track periods, home ranges and core areas of Sunda scops owls based on minimum convex polygon and harmonic mean methods.

Bird ID[1]	Transmitter Frequency	Track Period (No. of Days)	No. of Fixes	Home Range (ha)			
				95% HM	50% HM	95% MCP	50% MCP
M1	150.065	11–15 October 2012 (5)	23	4.50	1.13	2.79	0.64
M2	150.085	19 January–4 February 2013 (16)	67	3.65	0.95	2.69	0.69
M3*	150.105	20–29 April 2013 (10)	53	4.43	1.28	2.37	0.90
M4*	150.115	27 April–11 May 2013 (10)	49	5.06	1.17	2.29	0.84
M5	150.095	3–14 June 2013 (13)	51	3.39	1.32	2.23	0.95
M6	150.058	3–16 June 2013 (13)	54	2.98	1.09	2.05	0.85
Mean		11.5 days	49.5	4.00	1.16	2.40	0.81
SD				0.78	0.13	0.28	0.12

[1]All birds were males, except two of unknown sex (*).

Table 2. Movement patterns of Sunda scops owl based on inter-fix distances and speeds.

Bird ID	Inter-fix Distances (m)		Inter-fix Speeds (m hr^{-1})	
	Mean	SE	Mean	SE
M1	90.21	12.51	39.49	12.04
M2	76.12	5.62	27.42	3.90
M3	81.13	6.95	31.68	4.72
M4	69.70	6.06	43.54	14.00
M5	66.90	5.65	41.18	11.26
M6	78.19	6.37	36.33	5.88
Overall	75.81	2.71	35.74	3.53

to the hazy weather during the survey period, measurement of cloud cover was excluded in this study.

Home range estimation. The minimum convex polygon (MCP) and harmonic mean (HM) methods were used for home range estimation through Biotas 2.0 (Ecological Software Solutions Inc., Sacramento, California). The MCP delineates the smallest polygon containing all the location points for each bird, although it is sensitive to outliers (Osborne, 2004) and does not indicate places where activities were concentrated, as the HM method does. Under the HM method, the area where activities were concentrated was assumed to be the defended territory perimeter of a bird that exhibits territorial behaviour. By convention, 95% and 50% of the utilised area calculated with both the MCP and HM methods are regarded as home and core ranges, respectively (Kenward, 1987; Harris et al., 1990).

Due to unequal numbers of observations, we used unbalanced analysis of variance to compare the inter-fix speed over different moon phases, i.e., new, crescent, half, gibbous and full moon. Prior to analyses, the distance data were log-transformed and the inter-fix speed data were square-root-transformed as both variables did not have normal distribution (Shapiro-Wilk test for normality, $P < 0.001$). A simple linear regression was used to determine the relationship between flying speed and time. A Mann-Whitney U test was performed to test for a significant difference in home range estimation through the MCP and HM methods. Comparison of home ranges between male and female birds cannot be made as no confirmed females were caught.

RESULTS

From October 2012 to June 2013, a total of six adult Sunda scops owls (i.e., four males and two birds of unknown sex) were captured and radio-tracked. The average home range size of individual owls calculated based on the MCP method was 2.40 ± 0.28 SD ha whereas the average core area was 0.81 ± 0.12 SD ha. Each individual was tracked for an average of 11 days (Table 1). Based on the HM method, it was estimated at 4.00 ± 0.78 SD ha and 1.16 ± 0.13 SD ha for home range and core areas, respectively. Estimation of home ranges and core areas was found to be significantly higher through the HM than that of the MCP method (Mann-Whitney U test, $Z = -2.882$, $P = 0.004$ for 95% estimation of home range and $Z = -2.807$, $P = 0.005$ for 50% estimation of core area). The owls' home ranges overlapped very little based on 95% HM (Fig. 2) with overlaps ranging from 0.01–0.34 ha or 0.20–11.80%, even in the case of males (i.e., M2, M5 and M6). The overlaps of home ranges were almost absent based on 95% MCP.

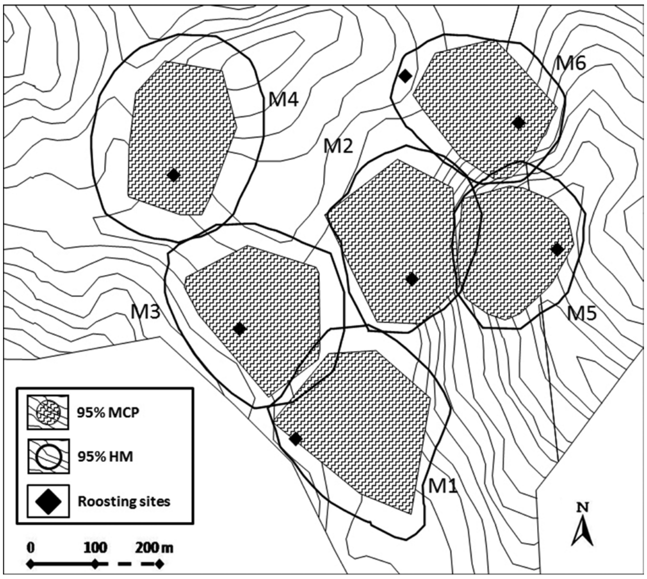

Fig. 2. Home range pattern generated by each of the six radio-tracked owls, based on 95% MCP (shaded area) and HM (non-shaded area) methods.

Average movement speed between fixes was 35.74 ± 3.53 SE m hr^{-1} (Table 2). There was no significant difference in terms of inter-fix speed over different moon phases ($F_{4,286}$ = 0.400, P = 0.808), nor a relationship between the speed and time of night (r < 0.001, P < 0.001). Birds seemed to forage both at the edge and interior parts of their activity range throughout the night, with a few stationary hunting spots, although most fixes were still obtained from the core area.

DISCUSSION

Since there were no published radio-telemetry studies on congeneric species in Southeast Asia, we compared the home range estimated for the Sunda scops owl with species from other regions. With similar body size, the home ranges of the Daito scops owl *Otus elegans interpositus* of 0.8–3.2 ha (Akatani et al., 2011) and European scops owl *Otus scops* of 1.6 ha (Galeotti & Gariboldi, 1992) were within the range estimated for the Sunda scops owl in this study. The relatively smaller Sokoke scops owl's *Otus ireneae* average home range was estimated at 8.8 ha (Virani, 2000), which was higher than that of the Sunda scops owl. However, it should be noted that the vegetation structure of the abovementioned studies was very different from that of our study (i.e., a logged over tropical lowland forest with dense undergrowth and horizontal visibility rarely exceeding 10 m). As such, we believe direct disturbance to the birds' normal behaviour was minimal, regardless of the transmitter detection radius of 100 m. The birds' movement patterns further confirmed this, as most individuals frequented areas where repeated surveys were made.

Based on radio-tracking data, it was demonstrated that Sunda scops owls forage strictly at night and can only be detected at their roost site(s) during the day. Except for one individual (i.e., M6) with two roost sites, all other birds roosted at a single tree within their foraging areas, although not necessarily at the middle of their home range (Fig. 2). Activity periods began at dusk and ended before dawn, while calling occurred mostly between 2300–0300 h. We suspected such behaviour could be associated with the interspecific interaction between Sunda scops owl and the resident Brown Boobook (*Ninox scutulata*), which often called soon after dusk and prior to dawn, forcing the Sunda scops owl to call late at night. Such calling or signalling appeared to occur at a fixed location during this time frame, as most birds were detected at the same spot (usually from a higher stratum of a tree different from that they roosted) within their home range. This suggests territory proclamation mostly occurred in the middle of the night, during which birds became less active in foraging. However, this was not reflected by the changes in inter-fix speed over time. A possible territorial behaviour was also demonstrated by two male birds that were captured when tape playbacks were used, suggesting an attempt by these birds to defend their territory from trespassers. Although counter singing was frequently observed in the study, the presence of specific territorial behaviour of the owl such as aggressive territorial defence (similar to Severinghaus, 2000) awaits further investigation.

Since our survey was conducted mainly during the breeding season of the owl, further surveys may be needed during the non-breeding season so as to allow comparison of territoriality between the two seasons. Even without nesting accounts, we determined the possible breeding months of the birds based on the capture of fully fledged juveniles and the relatively higher frequency of calling (Pilla, unpublished data), which fell within the breeding period specified in Konig & Weick (2008).

Our study reported the home range, possible territorial behaviour and intraspecific interaction for the Sunda scops owl, although no clear relationship was found between the owls' flying speed and lunar illumination. We suspected that nocturnal illumination may have been affected by the ambient light resulting from cloud cover (Ibarra et al., 2014) and possibly the hazy conditions occurring during this study. This may confound observation of the owl's activity patterns in relation to moon phases. Nonetheless, as this is the first published radio-telemetry study on the species, and indeed for the genus *Otus* in this region, such results can serve as an ecological baseline, facilitating the study of other little known species such as the Near Threatened Reddish scops owl, which is often sympatric with Sunda scops owl.

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