SPATIAL DISTRIBUTION OF EDIBLE BIRD NEST *(AERODRAMUS FUCIPHAGUS)* HOUSES IN PENINSULAR MALAYSIA BASED ON DIFFERENT LAND USE TYPE

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ABSTRACT. Spatial land use properties around the birdhouse contributes to the availability of swiftlet in a specific area. Our knowledge of spatial characteristics on potential land use areas for swiftlet houses is largely based on very limited data. The aim of this study was to evaluate the current distribution trend of registered swiftlet houses in Peninsular Malaysia from 2014 to 2017 and to elucidate the density of registered birdhouses based on type of land use in each state. Registered edible-bird nest swiftlet (*Aerodamus fuciphagus*) houses under the Department of Veterinary Services Malaysia (DVS) from 2014 to 2017 and multiple datasets on land use types, acquired from the Department of Agriculture (DOA) was analysed. The results showed that the total registered birdhouses from 2014 to 2017 in Peninsular Malaysia were 5,614 with Johor having the highest number cumulatively followed by Pahang, Terengganu, Kedah, Kelantan, Selangor, Pulau Pinang, Negeri Sembilan and Perak respectively. Development of new birdhouses in recent years have shifted from urban and residential areas towards inland areas including agriculture areas such as oil palm plantation and paddy field where these areas are promising as the availability of abundance feed source for the swiftlets. The findings offer crucial spatial characteristics of recommendation on potential areas for swiftlet farming in the future based on land use status throughout Peninsular Malaysia.

Keywords: Spatial distribution, birdhouses, edible bird nest, *Aerodramus fuciphagus*

INTRODUCTION

Aerodramus fuciphagus is the swiftlet species found in Malaysia which produces high value edible bird-nest (EBN) through its glutinous strand, starch like saliva and is commercially farmed all over the country (Norhayati *et al.*, 2010). The EBN industry in Malaysia has grown tremendously with escalating demands mainly from Asia's market including China, Hong Kong and Taiwan (Azahar *et al.*, 2014). Traditionally, the Chinese community believed that the consumption of this lucrative cuisine would benefit their general health, skin, enhancing the immune system and could increase the longevity of individual life span (Munirah *et al.*, 2018). It is estimated that by the fourth quarter of 2020, Malaysia's export value of EBN will be increased up to 3 billion ringgit to compare 1.15 billion ringgit in 2019. Support from the government via the Department of Veterinary Service (DVS) in ensuring swiftlet ranching is in accordance to the best practice by issuing several types of credential certificate for swiftlet premises and processing center such as the Malaysian Good Agricultural Practices (myGAP), Good Veterinary Hygiene Practice (GVHP) and Veterinary Health Mark (VHM).

During the earlier years of ranching swiftlet in Malaysia which started around the 1990's in Perak and Penang, shoplots were renovated to resemble the ambience and atmosphere of the cave, which is the natural nesting habitat of swiftlet (Azman *et al.*, 2008). Since then, the exploration of new and suitable locations from rural up to urban and coastal areas to build swiftlet houses has been done extensively due to good returns from this lucrative business. Moreover, the type of structure built for EBN farming has also evolved from shop lots, to individual free-standing buildings and custom made houses for swiftlet farming (Azman *et al.*, 2008). Several studies have been published on the factors affecting the success of swiftlet farming in Malaysia. The ability in understanding the occurrence of spatial variability surrounding birdhouses is crucial in order to have a productive swiftlet nesting rate (Ibrahim *et al.*, 2009). There are reported cases due to lack of knowledge on spatial location attributes, farmers have invested high capital into building birdhouses but have produced a devastating result when there is no swiftlet entering the house and nesting in it. The importance of environmental factors such as feeding area, current swiftlet population density and tracking area needs to be addressed so that future investments are fruitful and can result in a success story. Basically, the swiftlets' natural feeding behaviour is to forage for aerial insects while flying through orchards, paddy fields, rubber and oil palm plantations (Nutjarin *et al.*, 2017). Thus, the availability of insects as a feed source may contribute to the overall swiftlet population in certain areas. Foraged insects, mainly from the order Diptera and Hymenoptera, which are found in most of the plantation areas (oil palm and rubber) have been studied as among the main diet for swiftlet (Kamarudin *et al.*, 2011). Several studies have shown that farmers choose to build new swiftlet houses deeper in rural areas as well as in agriculture lands (oil palm, rubber, paddy) as compared with previously in urban areas and coastal areas due to decreasing insect population in the urban areas (Sharifah *et al.*, 2016).

The advancement of the Geographical Information System (GIS) has opened up opportunities to gain new insight on the geographical landscape through the processing of geographically referenced data. This may add new perspectives for the management, processing large volumes of information and presenting assistance towards the decision making process (Yaakub *et al.*, 2002). GIS has provided the rationality for the decision making process by increasing and improving geographical data accuracy. Therefore, this study was conducted to evaluate the distribution trend of registered swiftlet houses in Peninsular Malaysia from 2014 to 2017 data and to elucidate the density of registered birdhouses based on type of land use in each state. This information will be useful for swiftlet entrepreneurs and for a new spurt of growth for the edible bird nest industry.

MATERIALS AND METHOD

Data source

Data of registered swiftlet premises with the Department of Veterinary Services (DVS) Malaysia from 2014 to 2017 were used for

this study. All acquired birdhouse data have been verified via ground truthing as active birdhouses from 2014 to 2017. Data cleaning was done accordingly for all records which consists of premises owner, company name, latitude and longitude (GPS). Next, a base map consists of state, district and sub-district boundaries, road network and agriculture land use base map were obtained from the Department of Survey and Mapping Malaysia (JUPEM) and the Department of Agriculture Malaysia (DOA) for spatial analysis which includes the topological aspect, geometric and geographic properties.

Data analysis

Information consists of longitude and latitude position of registered birdhouse premises under the surveillance of DVS were then plotted using a GIS software ArcGIS version 10.2. Multiple layers of agriculture land use information from DOA which consists of three most common swiftlet farming areas, including oil palm, paddy field and human settlement areas from 2015 were constructed as additional layers for spatial analysis which includes density analysis, digital elevation model (DEM) and distance analysis were done to determine hot spot areas of built-up birdhouses overlaid to state, district and sub-district data obtained from JUPEM. World Geodetic System (WGS 84) is the projection used in order to synchronise all the digital data coordinate systems for the premises location and the secondary data layer to match the x, y of the latitude and longitude. Data were tabulated and analysis was done by using standard statistical software SPSS version 20 as well as spatial statistical tools from ArcGIS version 10.8.

RESULTS AND DISCUSSION

Birdhouse registration trends

Figure 1 shows an increment in the trend of birdhouses in Peninsular Malaysia from 2014 to 2017. A total of 5,614 birdhouses was registered in 2017, compared with 4,777 birdhouses in 2016. However, despite the increment there has been a slight decrease in the average of annual birdhouse registered with 17.52% from 2016 to 2017. Notably, the rate was lower compared to that of 25.58% and 53.33% during 2015 to 2016 and 2014 to 2015 respectively. The significant reduction in total percentage of registered birdhouses due to the increasing number of new birdhouses in the latter years was built towards the inland and rural areas as well as in agriculture areas (oil palm, rubber, paddy) (Sharifah *et al.*, 2016) which makes verification and registration process more challenging.

Based on Table 1, the highest cumulative registered birdhouses until 2017 is in the state of Johor with 1,265 premises followed by Pahang, Terengganu, Kedah, Kelantan, Selangor, Pulau Pinang, Negeri Sembilan, and Perak respectively. From the observation, there is no new birdhouse registered between the year 2015 and 2016 for Melaka and 2017 for Penang state. This may have been caused by the strict legislation practices enforced by both of these states in terms of building new premises for swiftlet ranching in

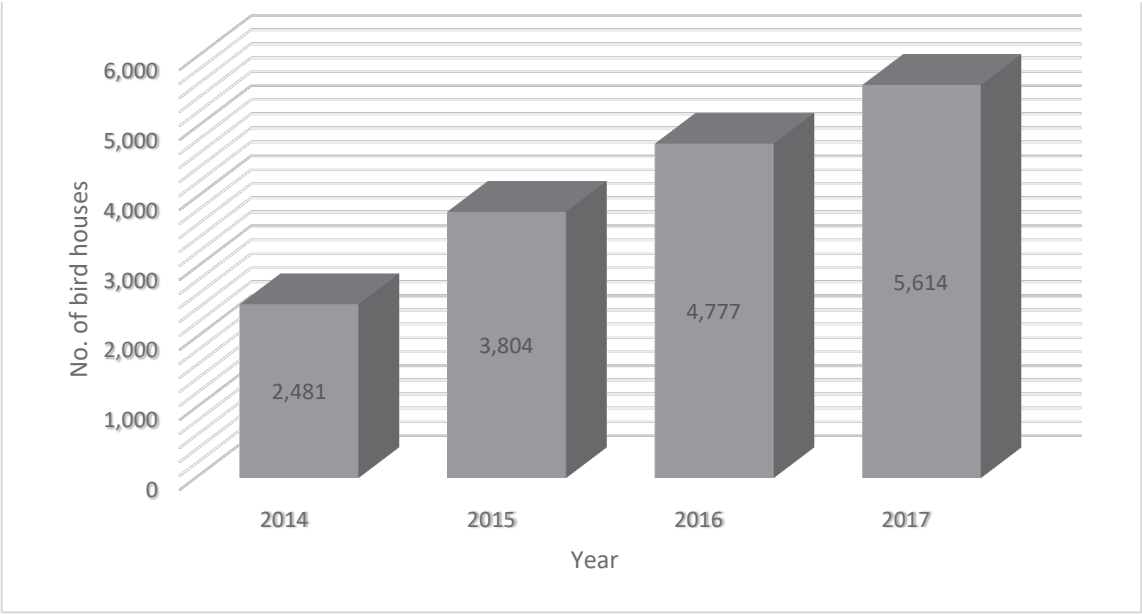

Figure 1. Total number of birdhouses, Peninsular Malaysia from 2014 to 2017.

Table 1. Cumulative birdhouse registration by state from 2014 to 2017.

State (Peninsular Malaysia)	2014	2015	2016	2017
Johor	693	1086	1188	1265
Kedah	210	236	270	299
Kelantan	160	203	232	241
Melaka	8	8	8	12
N. Sembilan	116	124	127	129
Pahang	391	528	809	922
Perak	58	75	86	116
Perlis	8	26	39	49
Pulau Pinang	126	149	156	156
Selangor	129	182	185	200
Terengganu	164	292	407	433

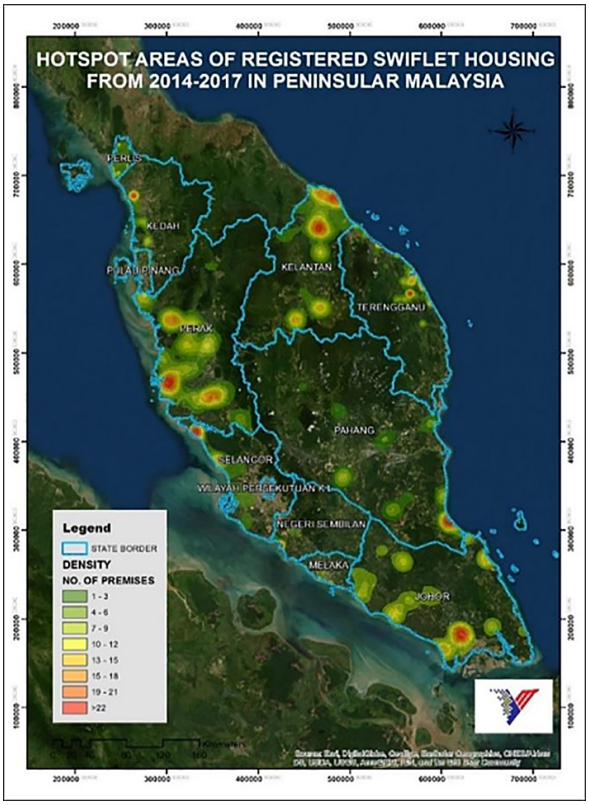

Figure 2. Density analysis of registered birdhouses from 2014 to 2017.

Table 2. Districts with most number of registered birdhouses from 2014 to 2017.

State	District
Johor	Johor Bahru, Mersing
Kedah	Kota Setar
Kelantan	Tumpat, Bachok, Machang, Kota Bharu, Tanah Merah
Melaka	Melaka Tengah
N. Sembilan	Port Dickson
Pahang	Rompin, Temerloh
Perak	Matang, Manjung, Hilir Perak, Batang Padang
Perlis	NA
Pulau Pinang	Seberang Perai Utara, Seberang Perai Tengah
Selangor	Sabak Bernam, Kuala Selangor
Terengganu	Marang, Kuala Terengganu, Setiu, Besut

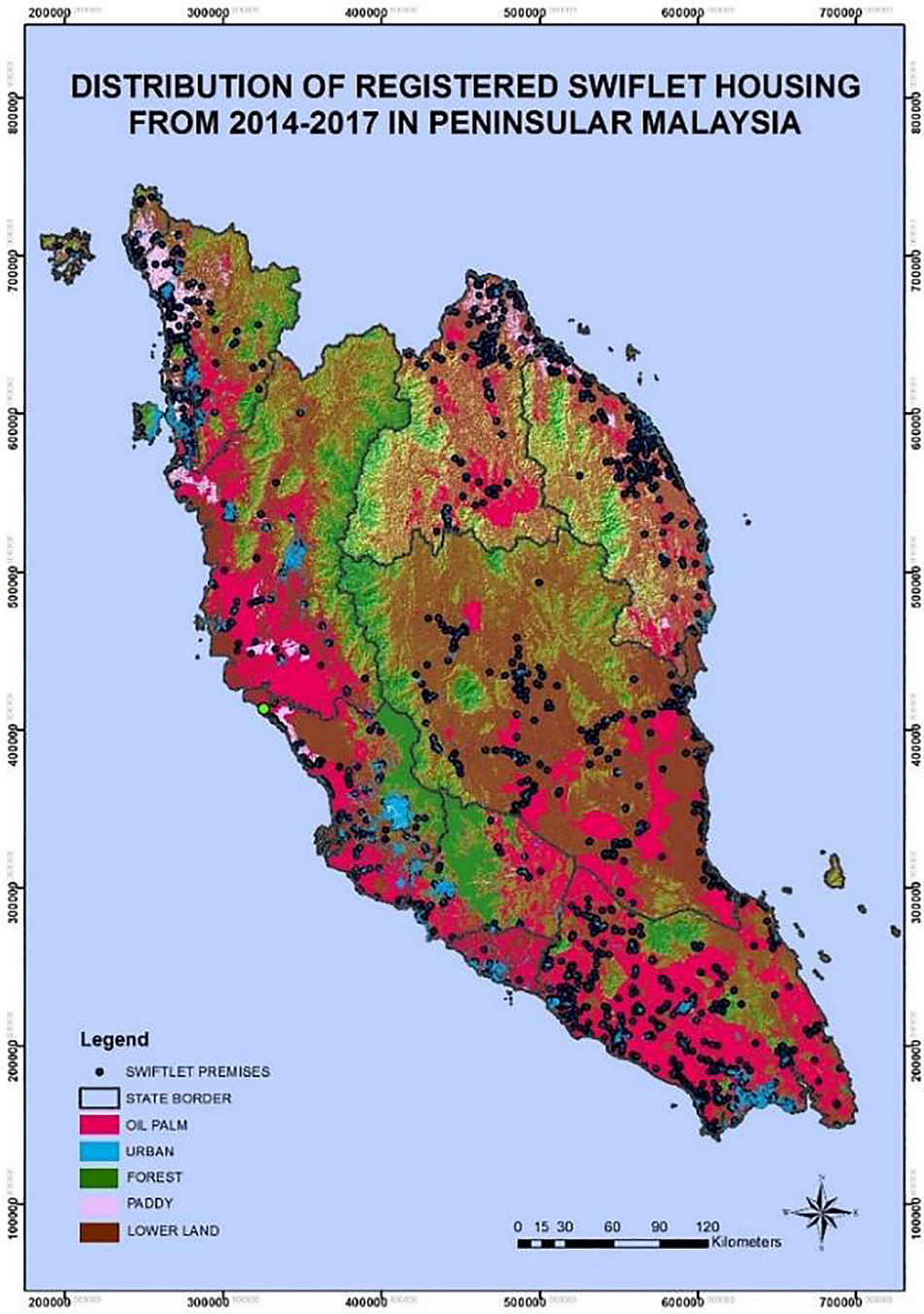

Figure 3: Distribution of registered birdhouses based on land use status in Peninsular Malaysia.

corresponding to their status as part of UNESCO World Heritage City.

Results from statistical spatial analysis done, indicates that there is a high density (hot spot) of swiftlet houses in several areas based on the state sub-district size and building distance between each birdhouses in Peninsular Malaysia (Figure 2). Among the highest dense districts detected are described in Table 2.

Interestingly, most of the dense areas with high cumulative number of swiftlet houses is in the east coast area (Kelantan and Terengganu), located along the coastal areas whereas for west coast areas (Johor, Perak and Kedah), most of the birdhouses are located in urban areas. This is expected as the development of urban areas in the west coast states is much greater in comparison with the east coast side. Besides that, study by Burhanuddin and Noor (2017) on swiftlet foraging pattern shows that anemotaxis movements by the swiftlet which utilise the wind flow to harvest insect proves why there are abundance of birdhouse built along the coastal areas mostly in Kelantan and Terengganu.

Distribution on land use type

Figure 3 represents the distribution of registered birdhouses corresponding to various types of land use, which includes oil palm, paddy and urban areas. On average, most of the active birdhouses from 2014 to 2017 are located in urban areas which constitute 45.36%, followed by coastal and inland agricultural areas (28.86%). These trends showed changes in the distribution of registered birdhouses compared to studies done by Misliah and Rafaee, 2001; and Azman *et al.*, 2008, where 88.5% registered birdhouses in urban areas and 11.5% in rural areas whereas 71.63% and 28.37% for the latter. According to these studies, close location to residential areas and easy access to roads as well as availability of basic utilities such as electricity and water supply could contribute to the high percentage of birdhouses built in urban areas.

Studies have shown that environmental factors such as the abundance of swiftlet population, humidity, temperature, light intensity and availability of feed source have urged new swiftlet farmers to invest more on inland areas for swiftlet ranching (Munirah *et al.*, 2018). A study by Sharifah *et al.*, (2016) on foraging areas for the swiftlets mainly in agriculture related areas showed that oil palm plantations could provide beneficial feed resources.

Even though Malaysia has been one of the biggest producer of world palm oil with a vast land area of planted oil palm trees which can be estimated to be more than 2.6 million hectares throughout Peninsular Malaysia alone, the result has shown that only 16.28% of the total registered birdhouses was built on oil palm plantation areas. Table 3 shows the percentage of land use coverage based on individual state size. Johor had the highest usage of land use area with 52.53% of its total area size for oil palm plantation followed by Melaka (39.71%), Negeri Sembilan (30.90%), Selangor (25.50%) and Perak (23.91%). For other states such as Penang, Perlis and Kedah, the land use was more focus on development of urban areas and paddy fields.

Table 3. Percentage of land use type according to state area size.

State	Percentage Land Use Type (%)		
	Oil Palm	Urban	Paddy
Johor	52.53	3.30	0.09
Kedah	10.52	3.16	13.92
Kelantan	10.20	0.70	3.68
Melaka	39.71	9.97	1.27
N. Sembilan	30.90	4.20	0.26
Pahang	10.76	0.53	0.03
Perak	23.91	2.29	2.21
Perlis	0.87	3.47	28.48
Penang	14.97	22.17	14.50
Selangor	25.50	6.61	2.41
Terengganu	8.34	1.37	2.57

The availability of large oil palm plantation areas may provide the potential for future exploration for developing new birdhouses as Sharifah *et al.*, (2016) reported that there was a high concentration of swiftlet foraging insect population in oil palm areas including the order of Diptera, Hymenoptera and Homoptera. In addition, oil palm areas tend to have stream and man-made ponds for irrigation purposes which would be the foraging ground as insect biomass are reportedly high around water body areas (Nutrajin *et al.*, 2017). Besides that, through this foraging activities, a certain degree of biological control for most order of insects from the order Lepidoptera (bagworms, diamondback moths and nettle caterpillars) which is considered as a pest in oil palm plantation can be done naturally, thus benefits the oil palm industry via less usage of pesticide for pest control mechanism.

CONCLUSION

The increasing numbers of newly registered birdhouse from year to year have shown a promising future for the EBN industry in Malaysia with the highest cumulative registered birdhouses located in Johor followed by Pahang, Terengganu, Kedah, Kelantan, Selangor, Pulau Pinang, Negeri Sembilan, and Perak, respectively. Development of new birdhouses nowadays have shifted from urban and residential areas towards inland areas. Agriculture areas can be further explored such as oil palm areas as the abundance of insects as feed resources may attract swiftlet population as their foraging ground. From this study, new insights can be obtained on

future plans and policy making for the EBN industry in Malaysia. To ensure successful housing of EBN, it is important to capture the traceability of bird's nest production data so that better understanding of the current trend of the swiftlet farming can be accomplished.

REFERENCES

1. Azahar, I., Abdul-Aziz, A. and Munirah, A.R. (2014). An overview of the study of the right habitat and suitable environmental factors that influence the success of edible bird nest production in Malaysia. *Asian J. of Agri.. Res*. 8(1), 1-16.
2. Azman, O., Siti, H. Y., Norazlinda, A.R. and Nor, A.A. (2008). Distribution of edible-nest swiftlet (*Aerodramus fuciphagus*) birdhouse in Peninsular Malaysia. *J. Wildlife and Parks,* 25, 8-11.
3. Burhanuddin, M. and Noor, H.M. (2017). Ranging behaviour of edible nest swiftlet (*Aerodramus* sp.) in Kuala Langat District, Selangor, Malaysia. *Malaysia App. Bio.*, 46(2), 59-66.
4. Ibrahim, S.H., Teo, W.C. and Baharun, A. (2009). A study on suitable habitat for swiftlet farming. *UNIMAS E-Journal of Civil Engineering*, 1(1), 1-7.
5. Kamarudin, M.I. and Anum, M. (2011). Foraging activity of *Aerodramus fuciphagus* swiftlet over oil palm canopy and its effect on *Elaeidobius* spp. pollinator population. *Proceedings 32nd Annual Conference of Malaysian Society of Animal Production. Tawau, Sabah.*
6. Misliah, M.B. and Rafaee, A.H.M. (2001). *Overview of birdhouse in Peninsular Malaysia*. In: Technical Workshop on The Commercial Viability of Birdhouses for *Aerodramus fuciphagus*, the edible white-nest swiftlet. Penang, April, 2001.
7. Munirah, A.R., Puspa, L.G. and Chong, J.L. (2018). Environmental parameters in successful edible bird nest swiftlet houses in Terengganu. *J. Sustainability Sci. and Mgmt.*, 13(1), 127-131.
8. Norhayati, M.K., Azman, O. and Wan, N.W.M. (2010). Preliminary study of the nutritional content of Malaysian edible bird's nest. *Malaysian J. Nut.,* 16(3), 389-396.
9. Nutjarin, P., George, A.G., Dianne, H.B. and Sara, B. (2017). Wetland, forest and open paddy land are the key foraging habitats for Germain's swiftlet (*Aerodramus inexpectatus germani*) in southern Thailand. *Trop. Conserv. Sci.,* 10, 1-12.
10. Sharifah, F.S.A.R., Hafidzi, M.N. and Maisarah, B. (2016). Diversity of the insect in the diet of edible nest swiftlets in oil palm plantations. *J. Biodivers. and Environmental Sci.,* 8 (4): 39-48.
11. Yaakup, A., Sulaiman, S., Musa, N., Ahmad, M. and Ibrahim, M.Z. (2002). *GIS as tools for monitoring the urban development in metropolitan region: A case of Klang Valley Region, Peninsular Malaysia.*

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