SPECIES ABUNDANCE OF WATERBIRDS AND TERRESTRIAL BIRDS BASED ON MIST-NETTING METHOD AT PAYA INDAH WETLAND RESERVE, PENINSULAR MALAYSIA

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ABSTRACT

Waterbirds and terrestrial birds are significant component of freshwater wetland ecosystem. The objectives of this study was to determine and compare the species composition and relative abundance of waterbirds and terrestrial birds using mist-netting method at Paya Indah Wetland Reserve, Peninsular Malaysia. A total of 1,478 bird individuals that belong to 65 species (18 waterbirds and 47 terrestrial birds) and 33 families (6 waterbird families and 27 terrestrial bird families) were recorded during 105 netting days within December, 2007 to November, 2008. White-throated Kingfisher (*Halcyon smyrnensis*) 66 captures; 32.84% and Yellow Bittern (*Ixobrychus sinensis*); 49 captures; 24.38% were the two most abundant waterbird species while Yellow-vented Bulbul (*Pycnonotus goiavier*) 379 captures; 29.68% and Peaceful Dove (*Geopelia striata*) 152 captures; 11.90% were the two most abundant terrestrial bird species in the study area. In contrast, eight waterbird and nine terrestrial bird species were the rarest in the study area. The relative abundance of terrestrial birds and waterbirds was significantly different (i.e. $F_{1, 92} = 6.24$, $P < 0.05$) in the wetland reserve. The results of this study indicated that this wetland reserve is highly attractive habitat for wide array of waterbird and terrestrial bird species.

KEYWORDS: Wetland, Waterbird, Terrestrial Birds, Mist-net, Relative Abundance

INTRODUCTION

Wetland is defined as "Land inundated with temporary or permanent water that is usually slow moving or stationary, shallow, fresh, brackish or saline, where the inundation determines the type and productivity of soils and the plant and animal communities" (the Ramsar Convention, 1971). Wetlands are inundated shallow or deep water areas covered with interspersed submerged or emergent vegetation (Casado & Montes, 1995). The global wetland size may range between 5.3 – 12.8 million km^2 (Zedler & Kercher, 2005). It has been estimated that almost 86% of the world's total wetland areas occur in tropical, subtropical and boreal regions, while the remaining 14% areas in temperate regions. Freshwater wetlands are an integral part of Malaysia's landscape. They play a significant role in maintaining and delivering the biodiversity. The total natural wetland areas of Malaysia are 3.5 to 4.0 million ha or 10% of the total land area (Aik, 2002).

A wide range of techniques have been used to trap live birds such as mist-net, carpet net, clap-net, whoosh-net, drop-net and cannon-net to determined and monitor the species composition and relative abundance. The mist-netting method is frequently used to trap the birds as compared to other methods. It is vertically erected, fine invisible net made of nylon, supported horizontally as net shelves between a series of strings set

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apart 50 cm which can be attached to vertical poles via strong loops. Mist-nets have been widely used in different habitats such as peat swamp forest wetland birds (Rajpar & Hussin, 2008), tropical lowland rainforest birds (Hussein *et al*., 2008), tropical rainforest canopy birds and national park birds (Rahman, 2002; Rahman *et al.,* 2002), Bay (Ronconi *et al*., 2010), lake (Pollock & Paxton, 2006) and sea (Bowman, 2007) to catch wide range of bird species such as Eared Grebes, American Coots, Blue-winged Teal (Breault & Cheng, 1990), Great Shearwaters, Sooty Shearwaters, Red-necked Phalaropes, Red Phalaropes (Ronconi *et al*., 2010), Willow Flycatchers (Pollock & Paxton, 2006) and sea ducks (Bowman, 2007).

The capturing of birds through nets provides the data on species composition, relative abundance, distribution, survivorship and recruitment. However, it is time intensive and requires greater efforts to install (Humphrey *et al.,* 1968; Myres & Pardieck, 1993). Little information is available on avian species composition and relative abundance in wetlands. Hence, determining and monitoring the species composition and relative abundance is highly important to understand the status of waterbirds and terrestrial birds for effective conservation and better management (Taylor & Pollard, 2008). The term “water bird” refers to bird species that entirely depends on wetlands for variety of activities such as foraging, nesting, loafing, and moulting (Rajpar and Zakaria, 2009) whereas “terrestrial bird” refers to bird species that does not fully depend on the wetland habitats but may use in search of food, shelter and loaf (Rajpar and Zakaria, 2010). The main objective of this study was to examine the species composition and relative abundance of waterbirds and terrestrial birds using mist-nets in freshwater wetland ecosystem.

MATERIALS AND METHODS

Study Site

Paya Indah (a Malay translation of “beautiful swamp”) Wetland Reserve encompasses 3050ha of area, out of which 450ha are under the administration of the Department of Wildlife and National Parks, Peninsular Malaysia. The study area is located within the quadrant of 101°10′ to 101°50′ longitude and 2°50′ and 3°00′ latitude (Fig.1).

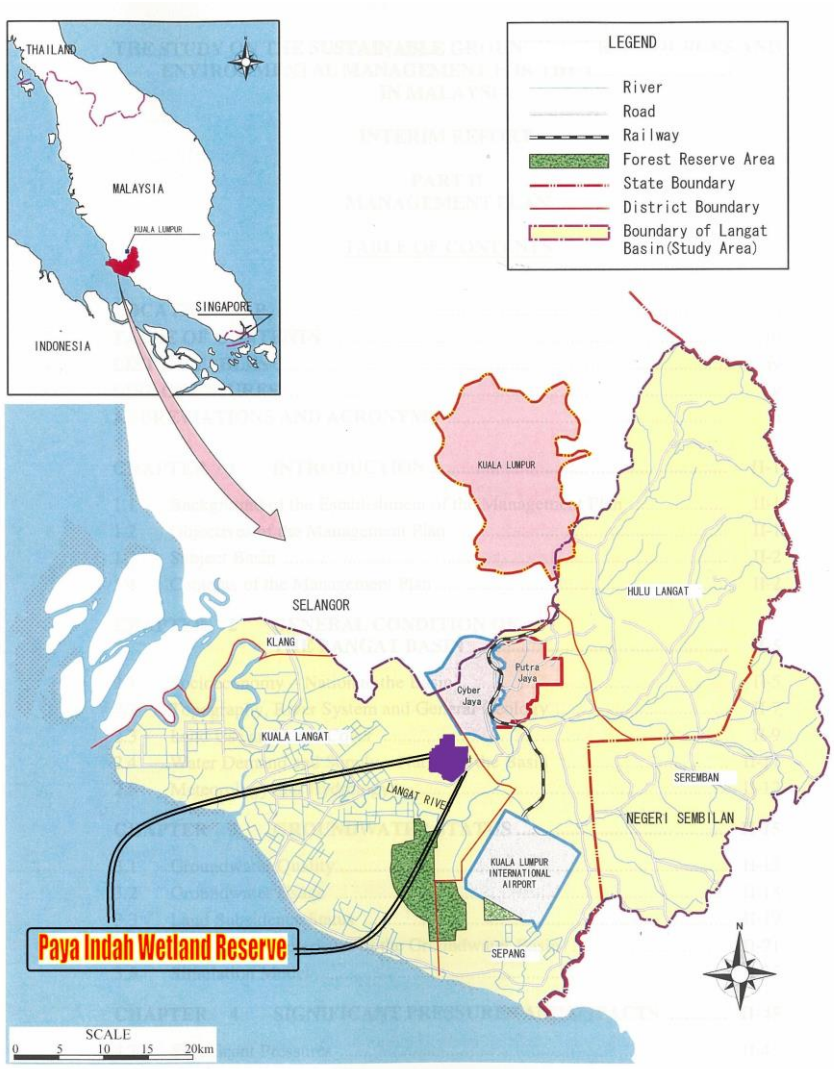

Fig.1. Location map of Paya Indah Wetland Reserve, Selangor Peninsular Malaysia

Mist Netting

In this study, the mist netting method was used to catch the wetland birds at Paya Indah Wetland Reserve, Peninsular Malaysia. Ten mist nets, measuring 14m x 4m with three pockets were used to catch the birds in the study location. In dry land, the lower fringe of nets touches the grounds while in water the lower fringe of nets touches the surface of water. The netting was done for a total of 105 days. The nets were fixed and stretched between two bamboo poles randomly throughout the area at different locations such as the open terrestrial areas, along the paths and one to three feet inside the water. The nets were open at 0700 hrs and closed at 1900 hrs. They were placed for

three days at the same location before they were moved to other locations and monitored every two-hour interval. Three days of netting was sufficient to capture most of the birds, because after three days, the birds might become familiar with the mist nets (Robbins *et al*., 1992). Each individual bird was marked with a numbered aluminium ring at the right tarsus before it was released.

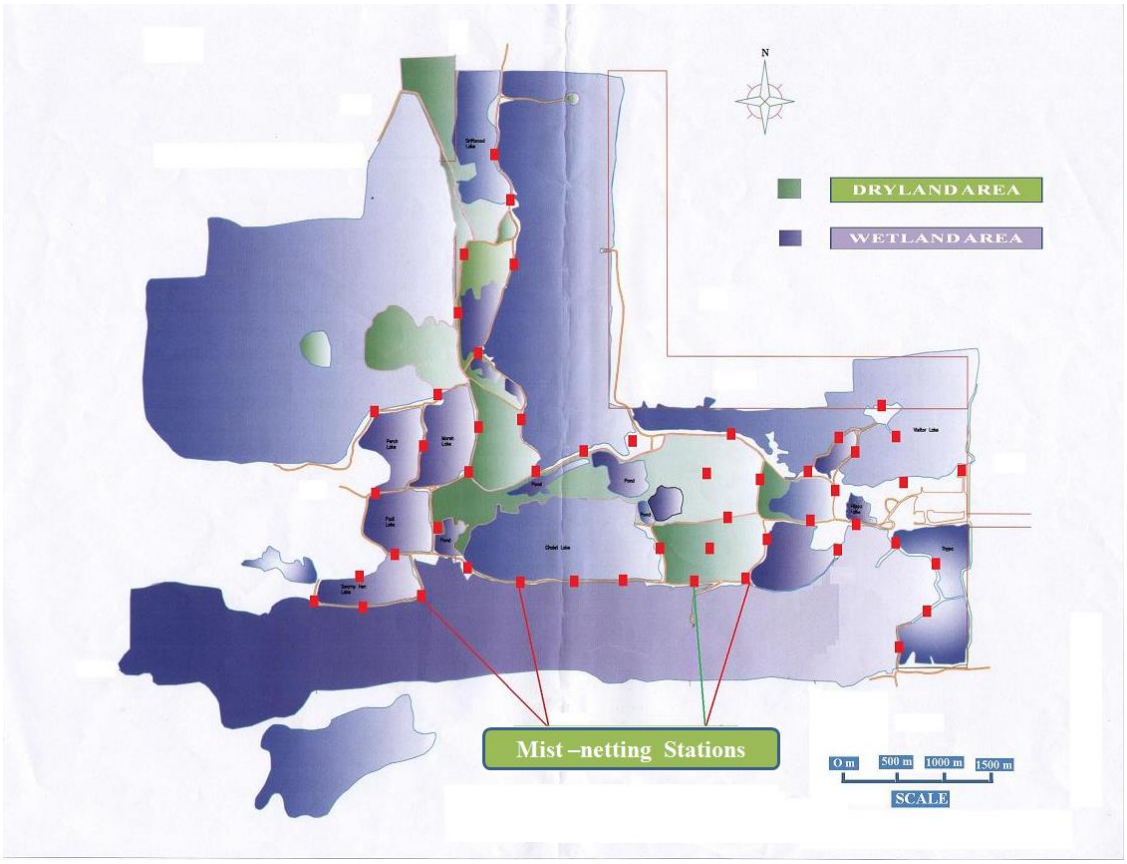

Fig. 2. Location of mist netting stations at Paya Indah Wetland Reserve, Peninsular Malaysia.

Data Analysis

Relative Abundance

The relative abundance (%) of bird species was determined using the following expression: n/N x 100 (where n is the number of a particular captured bird species and N is the total number captured of all species) (Zakaria *et al.*, 2009). The results were compared using analysis of variance (ANOVA) and Tukey's (HSD) test to determine the significance of difference.

RESULTS

Species Composition and Relative Abundance

The mist netting method captured a total of 1,478 bird individuals that belong to 65 species and 33 families during 105 days within December, 2007 to November, 2008 at Paya Indah Wetland Reserve, Peninsular Malaysia (Table 1 and 2). The results showed that out of 65 bird species, 18 species belong to waterbirds and 47 species belong to terrestrial birds.

Species Composition and Relative Abundance of Waterbirds

The mist netting method captured a total of 201 individuals of waterbirds (13.60% of all captures) that belong to 18 species and six families. White-throated Kingfisher (*Halcyon smyrnensis*; 66 captures; 32.84%) and Yellow Bittern (*Ixobrychus sinensis*; 49 captures; 24.38%) were the two most abundant waterbird species, while Common Moorhen (*Gallinula chloropus*), White-browed Crake (*Porzana cinerea*), Ballion's Crake (*Porzana pusilla*), Water Cock (*Gallicrex cinerea*), Slaty-breasted Crakes (*Gallirallus striatus*), Black-caped Kingfishers (*Halcyon pileata*), Stork-billed Kingfishers (*Pelargopsis capensis*) and Pacific Golden Plover (*Pluvialis fulva*) were the rarest waterbird species captured (0.49% each) (Table 1).

Table 1. List of waterbird species with relative abundance based on mist-netting method at Paya Indah Wetland Reserve, Peninsular Malaysia

Rank	Family Name	Common Name	Scientific Name	Total Individuals	%
1	Alcidinidae	White-throated Kingfisher	*Halcyon smyrnensis*	66	32.84
2	Ardeidae	Yellow Bittern	*Ixobrychus sinensis*	49	24.38
3	Rallidae	White-breasted Waterhen	*Amaurornis phoenicurus*	23	11.44
4	Ardeidae	Cinnamon Bittern	*Ixorbychus cinnamoneus*	19	9.45
5	Charadriidae	Red-wattled Lapwing	*Vanellus indicus*	12	5.97
6	Ardeidae	Schrenck's Bittern	*Ixobrychus eurhythmus*	11	5.47
7	Scolopacidae	Pintail Snipe	*Gallinago stenura*	6	2.99
8	Ardeidae	Little Heron	*Butorides striatus*	3	1.49
9	Ardeidae	Purple Heron	*Ardea purpurea*	2	0.99
10	Anatidae	Lesser Whistling Duck	*Dendrocygna javanica*	2	0.99
11	Rallidae	Common Moorhen	*Gallinula chloropus*	1	0.49
12	Rallidae	White-browed Crake	*Porzana cinerea*	1	0.49
13	Rallidae	Ballion's Crake	*Porzana pusilla*	1	0.49
14	Rallidae	Water Cock	*Gallicerx cinerea*	1	0.49
15	Rallidae	Slaty-breasted Crake	*Gallirallus striatus*	1	0.49

Rank	Family Name	Common Name	Scientific Name	Total Individuals	%
16	Alcidinidae	Black-caped Kingfisher	*Halcyon pileata*	1	0.49
17	Alcidinidae	Stork-billed Kingfisher	*Pelargopsis capensis*	1	0.49
18	Charadriidae	Pacific Golden Plover	*Pluvialis fulva*	1	0.49
			Total	**201**	

Species Composition and Relative Abundance of Terrestrial Birds

The mist netting method captured a total of 1,277 individuals of terrestrial birds (86.40% of all captures) that belong to 47 bird species and 27 families. Yellow-vented Bulbul (*Pycnonotus goiavier*; 379 captures; 29.68%), Peaceful Dove (*Geopelia striata*; 152 captures; 11.90%) and Baya Weaver (*Ploceus philippinus*; 141 captures; 11.04%) were the three most abundant terrestrial birds, while Dollar Bird (*Eurystomus orientalis*), Ashy Tailorbird (*Orthotomus ruficeps*), Asian Brown Flycatcher (*Muscicapa dauurica*), Zitting Cisticola (*Cisticola juncidis*), Blue-breasted Quail (*Coturnix chinensis*), Arctic Warbler (*Phylloscopus borealis*), Besra (*Accipiter virgatus*), Violet Cuckoo (*Chrysococcyx xanthorhynchus*) and Oriental Scops Owl (*Otus sunia*) were the rarest terrestrial species in the study area (0.08% each) (Table 2).

Table 2. List of terrestrial bird species with relative abundance based on mist-netting method at Paya Indah Wetland Reserve, Peninsular Malaysia

Rank	Family Name	Common Name	Scientific Name	Total Individuals	%
1	Pycnonotidae	Yellow-vented Bulbul	*Pycnonotus goiavier*	379	29.68
2	Columbidae	Peaceful Dove	*Geopelia striata*	152	11.90
3	Ploceidae	Baya Weaver	*Ploceus philippinus*	141	11.04
4	Columbidae	Pink-necked Green Pigeon	*Treron vernans*	96	7.52
5	Turdidae	Oriental Magpie Robin	*Copsychus saularis*	49	3.84
6	Caprimulgidae	Large-tailed Nightjar	*Caprimulgus macrurus*	48	3.84
7	Rhipiduridae	Pied Fantail	*Rhipidura javanica*	39	3.05
8	Columbidae	Spotted Dove	*Streptopelia chinensis*	35	2.74
9	Motacillidae	Richard's Pipit	*Anthus richardi*	31	2.43
10	Laniidae	Brown Shrike	*Lanius cristatus*	31	2.43
11	Sylviidae	Oriental Reed Warbler	*Acrocephalus orientalis*	27	2.11
12	Estrildidae	Black-headed Munia	*Lonchura malacca*	21	1.64
13	Meropidae	Blue-tailed Bee-eater	*Merops philippinus*	20	1.57
14	Estrildidae	Scaly-breasted Munia	*Lonchura punctulata*	19	1.49

Rank	Family Name	Common Name	Scientific Name	Total Individuals	%
15	Aegithinidae	Green Iora	*Aegithina virdissima*	19	1.49
16	Campephagidae	Pied Triller	*Lalage nigra*	17	1.33
17	Meropidae	Blue-throated Bee-eater	*Merops viridis*	15	1.17
18	Caprimulgidae	Savanna Nightjar	*Caprimulgus affinis*	14	1.10
19	Picidae	Common Flameback	*Dinopium javanense*	13	1.02
20	Cisticolidae	Yellow-bellied Prinia	*Prinia flaviventris*	11	0.86
21	Sturnidae	White-vented Myna	*Acridotheres grandis*	10	0.78
22	Cuculidae	Plaintive Cuckoo	*Cacomantis merulinus*	10	0.78
23	Turnicidae	Barred Button Quail	*Turnix suscitator*	10	0.78
24	Cuculidae	Lesser Coucal	*Centropus bengalensis*	8	0.63
25	Nectariniidae	Brown-throated Sunbird	*Anthreptes malacensis*	7	0.55
26	Sylviidae	Common Tailorbird	*Orthotomus sutorius*	6	0.47
27	Pycnonotidae	Olive-winged Bulbul	*Pycnonotus plumosus*	6	0.47
28	Hirundinidae	Pacific Swallow	*Hirundo tahitica*	5	0.39
29	Aegithinidae	Common Iora	*Aegithina tiphia*	5	0.39
30	Sturnidae	Jungle Myna	*Acridotheres fuscus*	4	0.31
31	Oriolidae	Black-napped Oriole	*Oriolus chinensis*	3	0.23
32	Nectariniidae	Olive-backed Sunbird	*Nectarinia jugularis*	3	0.23
33	Strigidae	Collard Scops Owl	*Otus lemiji*	3	0.23
34	Apodidae	Edible-nest Swiftlet	*Aerodramus fuciphagus*	3	0.23
35	Sturnidae	Common Myna	*Acridotheres tristis*	2	0.16
36	Sturnidae	Philippine Glossy Starling	*Aplonis panayensis*	2	0.16
37	Sylviidae	Inornate Warbler	*Phylloscopus inornatus*	2	0.16
38	Accipitridae	Japanese Sparrow Hawk	*Accipiter gularis*	2	0.16
39	Coraciidae	Dollar Bird	*Eurystomus orientalis*	1	0.08
40	Sylviidae	Ashy Tailorbird	*Orthotomus ruficeps*	1	0.08
41	Muscicapidae	Asian Brown Flycatcher	*Muscicapa dauurica*	1	0.08
42	Cisticolidae	Zitting Cisticola	*Cisticola juncidis*	1	0.08
43	Phasianidae	Blue-breasted Quail	*Coturnix chinensis*	1	0.08
44	Sylviidae	Arctic Warbler	*Phylloscopus borealis*	1	0.08

Rank	Family Name	Common Name	Scientific Name	Total Individuals	%
45	Accipitridae	Besra	*Accipiter virgatus*	1	0.08
46	Strigidae	Oriental Scops Owl	*Otus sunia*	1	0.08
47	Cuculidae	Violet Cuckoo	*Chrysococcyx xanthorhynchus*	1	0.08
			Total	1277	

The relative abundance of terrestrial birds and waterbirds was compared using the analysis of variance (ANOVA) and Tukey's (HSD) test. The results showed that the relative abundance of terrestrial birds and waterbirds was significantly different, i.e. $F_{1, 92} = 6.24$, $P < 0.05$ (Table 3 and 4).

Table 3. Analysis of Variance (ANOVA) of relative abundance of terrestrial birds and waterbirds based mist-netting method at Paya Indah Wetland Reserve, Peninsular Malaysia

DF	SS	MS	F	P
1	12316.8	12316.8	6.24	0.0143
92	181536	1973.22		
93	193858			

Table 4. Comparison of relative abundance of terrestrial birds and waterbirds caught by mist-netting method at Paya Indah Wetland Reserve, Peninsular Malaysia

Status of Species	Mean Value per Species	Standard Error (SE ±)
Terrestrial Birds	27.17 a	1.88
Waterbirds	4.28 b	0.73

(The mean values in columns with same letter are not significant at P = 0.05, Tukey's HSD test; Critical Value, 18.196)

DISCUSSION

In this study, the mist netting method captured 65 bird species that belong to 33 families. The capturing of 65 species showed that Paya Indah Wetland Reserve, Peninsular Malaysia, is a highly important habitat for wide array of avian species. The area seems to fulfill the requirements of daily activities of birds namely foraging, nesting, loafing, roosting and breeding (Rajpar and Zakaria, 2009).

In the waterbird species, the capturing of high numbers of kingfishers, bitterns, waterhens, lapwings, snipes and herons could be due to the occurrence of a variety of habitats (i.e. marsh swamp, lotus swamp, open water body, dryland and shrub patches) that provided diverse food for these birds. The habitats also provided shelters from predators and harsh weathers and suitable breeding and foraging sites for them. On the

other hand, the capturing of high numbers of bitterns and herons indicated that this wetland reserve was important for the waterbirds. This could be due to the presence of reed beds of emergent vegetation that created thick mats in deep water. In addition, bitterns and herons hid in the dense reed beds and used the lake edges for hunting. The capturing of three species of kingfishers also signified the fact that this wetland was a suitable habitat for kingfishers. Beside, waterhen, snipes and lapwings were also captured in good numbers. This might be due to the occurrence of suitable foraging habitats for them, such as lake edges, wet grasses and small ditches in the dry land.

Ducks and moorhens were also captured in small numbers. It could be that they preferred the open water surface for foraging. Needless to say, it was very difficult to net in the deep water due to the thick mats of vegetation that made it inaccessible to do mist netting. Crakes, water cocks and plovers were also captured in small numbers. They are migratory species and may visit this area only at a certain time of the year especially during migratory season from October to March.

In terrestrial bird species, the bulbuls and pigeons were captured in high numbers. The reason was that, these birds were the most common resident birds in the study area. This could be due to the availability of a variety of fruiting tree species (e.g. figs, syzygiums, palms, fragraeas, rhododendrons, glabras and cinnamons) and shrub species (e.g. dillenias, melastomes and papayas). The trees and shrubs provided nesting, loafing and roosting sites for the bulbuls and pigeons. Doves, weavers, munias, quails and coucals were also captured in high numbers during netting. This could be due to the presence of a variety of ground vegetations such as grasses, shrubs, herbs, ferns, sedges, reed beds and emergent vegetation that offered suitable habitats for doves, weavers, munias, quails and coucals.

Moreover, the capture of nightjars, fantails, pipits, shrikes, warblers, bee-eaters, Ioras, flycatchers, dollar birds, cisticolas, swallows, swiftlets, trillers, woodpeckers, tailorbirds and prinias in high numbers significantly showed that this wetland reserve was a highly important habitat for them. This might be due to various vegetation layers for instance, the trees, shrubs, grasses, herbs and emergent aquatic vegetation that offered different microhabitats to fulfil their needs such as food, water and shelter. Furthermore, the heterogeneity of vegetation also provided suitable loafing and nesting sites for the species in the wetland reserve.

Additionally, the capturing of two species of sunbirds also showed this wetland reserve was important for them. This could be due to the presence of flowering trees for instance, Fragraeas, Golden Shower trees, Queen's Crape-myrtles, Flamboyants or Peacock trees, Malay Apples, Coconut trees and Acacias. Moreover, the capturing of two species of owls and nightjars suggested that this wetland reserve was also a crucial habitat for these nocturnal birds. This might be due to presence of the higher abundance of mice and rats in the wetland reserve. Besides, the capturing the capturing of two species of raptors namely, hawks and besras showed that this wetland was also an important habitat for them. This could be due to the occurrence of garden lizards, mice, rats and birds that were major food sources for these species.

Overall, capturing results indicated that terrestrial birds have higher relative abundance as compared to waterbirds. Perhaps, the major reason for this is because the freshwater wetland areas are scarce or small, where the waterbirds are fully dependent on the water resources to complete their life cycles (Shine and de Klemm, 1999). In addition, each waterbird species is specialized in food type and habitat use and their relative abundance is influenced by habitat variables such as water depth, water level fluctuation, vegetation, topography, food type, food accessibility, wetland size, and wetland connectivity. In contrast, the terrestrial bird's relative abundance often influenced by vegetation composition, vegetation structure and food resources. Another reason could be that waterbirds have bigger size and their territory size requirements may vary from species to species and they are often colonial as compared to most of the terrestrial species. Freshwater may have lower biomass and activity than terrestrial habitats. Additionally, the terrestrial birds also depended on a variety of dryland habitats to complete their life cycles and they needed water just for drinking. The higher terrestrial bird relative abundance in this wetland reserve is due to the variations in dryland vegetations (e.g. trees, shrubs, grasses, herbs, climbers and ground creepers), aquatic vegetation (i.e. emerged and submerged vegetation, reeds, sedges, rushes and weeds) and vegetation layers (i.e. canopy layer, shrub layer and grass layer). The heterogeneity of vegetation had eventually created different microhabitats, such as marsh swamp, lotus swamp, open water body, dryland and shrub patches that attracted a wide array of terrestrial birds to perform multiple activities for instance, foraging, perching, loafing, nesting, hiding and roosting (Fahrig, 1997; Best *et al*., 2001; Zakaria *et al.,* 2009). Several studies have also shown that species richness is associated with habitat heterogeneity especially vegetation composition (McGuinness, 1984; Barry & Dayton, 1991).

CONCLUSION

The results of species composition and relative abundance indicated that a wide array of bird species used this wetland for different purposes such as foraging, roosting, nesting and loafing. The results highlighted further that the vegetation diversity and richness had strong and pervasive effects on the species abundance and distribution.

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