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ASSESSING THE FOOD RESOURECES AND HABITAT CHARACTERISICS OF FIVE DIFFERENT WETLAND AND ADJACENT HABITATS USING FORAGING GUILDS OF AVIAN SPECIES IN MALAYSIA

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ABSTRACT

Foraging guilds provide information on the food resources and the condition of a particular habitat. However, few studies have been done to examine the foraging guilds of avian species particularly in the wetland habitats. The main objective of this study is to investigate the foraging guilds of the avian species inhabited five wetland habitats namely marsh swamp, lotus swamp, open water body, open area and shrubland. The study was conducted using point count method at five different habitats. The results indicated that marsh swamp habitat was most utilized by avian species (143.00 ± 23.86 birds ha^{-1}) while open area was least preferred (65.03 ± 9.79 birds ha^{-1}). The foraging guild Frugivore/Insectivore had the highest density (149.89 ± 20.25 birds ha^{-1}) while the Carnivore had the lowest density (0.40 ± 0.19 birds ha^{-1}). The Insectivore was the most dominant guild for migratory birds in the five habitats (marsh swamp, 1.24 ± 0.08 birds ha^{-1}; lotus swamp, 1.28 ± 0.32 birds ha^{-1}; open water body, 0.74 ± 0.12 birds ha^{-1}; open area, 2.05 ± 0.20 birds ha^{-1}; shrubland, 1.44 ± 0.15 birds ha^{-1}). The feeding guild for resident birds varied among habitats where the Carnivore/Piscivore/Insectivore was the most dominant in marsh swamp (2.22 ± 0.28 birds ha^{-1}), Frugivore/Insectivore was the most dominant in lotus swamp (2.56 ± 0.35 birds ha^{-1}), Granivore was the most dominant in open water body (4.53 ± 03.5 birds ha^{-1}) and Granivore/Insectivore was the most dominant in open area (4.52 ± 0.71 birds ha^{-1}) and shrubland (8.75 ± 0.79 birds ha^{-1}) . For resident-migrant birds Omnivore was the major feeding guild in marsh swamp (4.18 ± 0.47 birds ha^{-1}) and open water body (1.74 ± 0.66 birds ha^{-1}) while Insectivore was the most dominant guild in lotus swamp (2.37 ± 0.33 birds ha^{-1}) and open area (2.22 ± 0.21 birds ha^{-1}), and Frugivore/Insectivore was the most common guild in shrubland (0.73 ± 0.12 birds ha^{-1}). The findings of this study indicated that foraging guilds of bird species indicate the food resources and habitat characteristics of a particular habitat. Bird species are specialized in food capturing and select the available wetland and adjacent habitats in different ways depending on their foraging behaviour and niche. The distribution of avian assemblages is influenced by richness of food,

availability of foraging sites, shallow water depth, and vegetation composition and structure.

KEYWORDS :*Food Resources, Foraging guild, Wetland, Bird, Migrant, Residents.*

INTRODUCTION:

Food is a major factor for avian species to obtain energy and to perform multiple activities for survival and reproduction (Guillemain & Fritz 2002). For bird species, foraging site selection and feeding technique are important factors to exploit the food resources (Jing et al. 2007, Gatto et al. 2008). Food resources in wetland habitats are distributed sparsely and densely depending on habitat structure. The monitoring of foraging guild is an effective method to ascertain the health of particular habitat and lead to improve the habitat in the future.

Feeding guild is a group of bird species which may exploit the same foraging sites, same food resources and foraging techniques in a similar way even though they differs taxonomically (Simberloff and Dayan 1991, Somasundaram and Vijayan 2008). Birds are perhaps most conspicuous and highly motile, and sensitive to multitude habitat variables (Thorngate et al. 2006, Jing et al. 2007). Birds are bio-indicators of wetland ecosystems (Gokula and Vijayan 2000, Hobson and Bayne 2000, Loyn 2002, Gray et al. 2007). They forage on a variety of animals such as insects, centipedes, crustaceans, molluscs, amphibians, fish, reptiles, small birds, rodents and plant materials. Birds employ various foraging techniques to catch their food called feeding guild. For this purpose, the DISTANCE sampling point count is a more reliable method to examine various community parameters (Buckland 2001) in a variety of habitats such as lakes (Aborn 2007), forests (Lee & Marsden 2008) and wetlands (Nadeau et al. 2008).

Globally, habitat loss and degradation have affected the populations of many bird species (Stroud et al. 2004, Goudie 2006, Gray et al. 2007, Rendon et al. 2008) which extensively depend on wetland and adjacent habitat for food, shelter, roosting and breeding purposes. Information on foraging guilds and bird assemblage utilizing wetland and adjacent habitat is extremely important to understand the food resources and the importance of particular habitat for avian species. A detailed information on foraging guilds and food resources in different wetland and adjacent habitat is still lacking. Only few studies have been carried out on food resources and foraging guilds of bird species utilize wetland and adjacent habitats. The primary aim of this study was to determine foraging guilds of avian assemblages inhabited in five different wetland and adjacent habitats such as marsh swamp, lotus swamp, open water body, open area with scattered trees and shrublands to understand the bird assemblages and productivity of each habitat.

MATERIALS AND METHODS

Study Area

The study was carried out at five habitats (i) marsh swamp (140 hectares), (ii) lotus swamp (116 hectares), (iii) open water body (238 hectares), (iv) open area with scattered trees (55 hectares), and (v) shrublands (51 hectares) situated in different locations within the Paya Indah Wetland area. Each area varied in vegetation composition and represented specific environmental features that meet the biological needs of wetland bird as well as open country bird species.

Marsh Swamp

Marsh swamp comprised of larger lakes with shallower water dominated by lush growths of aquatic herbaceous vegetation such as sedges, reeds, rushes and grasses. The plants grow with their

stems partly in and partly out of the water. The marsh swamp is predominantly covered with aquatic plants i.e., Eleocharis dulcis, Lepironia articulata, Stenochlaena palustris, Philydrum lanuginosum, and Scleria purpurascens. The water body edges were covered with different tree species such as Acacia auriculiformis, A. mangium, Macaranga tanarius, Peltophorum pterocarpum, Cinnamonum iners, Melicope glabra and Melastoma malabathricum along the edges.

Lotus Swamp

Lotus Swamp was a shallower water pond dominated by Nelumbo nucifera, N. nouchali, N. pubescens, E. dulcis, Elodea sp., Phragmites karka reeds and Typha angustifolia while adjacent edges were covered with A. auriculiformis, A. mangium and some parts with M. malabathricum.

Open Water Body

Open water body habitat was a group of larger and deep water lakes dominated by submerged and emergent vegetation such as Nymphaea odorata, Potamogeton spp., E. dulcis, Myriophyllum spicatum, Salvinia molesta, Scirpus sylvaticus, S. californicus, S. Mucronatus, S. Maritimus, E. dulcis, S. purpurascens, Sagittaria latifolia and Hydrilla sp.

Open Area with Scattered Trees

Open areas were dry lands adjacent to the wetlands and dominated by scattered flowering and fruiting trees (i.e. Cinnamonum iners, Melicope glabra, Ficus rubiginosa, F. benjamina, Syzygium grande, S. polyanthum, Caryota mitis, Delonix regia,and Fragraea fragrans). The ground was densely covered with different grass species such as Imperata cylindrica, Cynodon dactylon, and Distichlis spicata.

Shrubland

Shrubland was also dry lands adjacent to the wetlands but dominated with an aggregation of woody plants or shrubs such as Melastoma malabathricum, Dillenia suffruticosa and young tree saplings of Acacia auriculiformis and A. mangium having less than ten feet height and 10cm dbh. The ground vegetation was dominated with grasses, i.e. Cogon Grass (I. cylindrica), Climbing Fern (S. palustris), Fern Tree (Gleichenia linearis) and Giant Weed (S. molesta).

Bird Surveys

Birds were surveyed using a distance sampling point count technique (Buckland et al., 2004) for 15 consecutive months from July, 2009 to September, 2010. A total of 188 point count stations at 300 m intervals were established within five habitats (Marsh Swamp; 43 stations, Lotus Swamp; 38 stations, Open Water Body; 40 stations, Open Area; 35 stations, and Shrub Patches; 32 stations) along the walking paths. The distance was selected to avoid double counting of the same birds at more than one station. The birds were surveyed by single observer from 0730 and 1100 hours in each month for 10 days and each point station was surveyed for 10 min. Ten-minute count enabled the researcher to record sufficient numbers of individuals with minimal efforts and disturbances (Jimenez 2000, Lee & Marsden 2008, Zakaria et al. 2009). During each survey, all bird species and individuals seen or heard were recorded. The distance from birds to observer was determined using visual estimation within the range of 100m. The flushed birds with known original positions were recorded and included in the analysis. However, flying birds were not recorded due to unknown original position. The sampling methodology was based on Buckland et al. (2004), Aborn (2007) and Nadeau et al. (2008).

Bird Density Analysis

The feeding guild densities of bird species were determined with Distance Software (Version 6.1) (Buckland et al. 2004). Bird species with fewer than five detections were not analyzed due to their low sample size, as recommended and described by Marsden (1999) and Buckland (2001).

Feeding Guilds

The feeding guilds of all the sampled bird species were categorized based on major food, foraging behaviour and habitat selection as reported by Ehrlich et al. (1988) and Degraaf et al. (1985). It was difficult to analyze feeding guild of each bird species separately, thus, we categorized birds into nine major feeding guilds which exploited the same foraging sites, same food resources and foraging techniques in a similar way. Thorngate et al. (2006) reported that bird species can be grouped into functional guilds that may reflect the exploitation of same food resources and foraging technique in a similar way in a particular habitat.

RESULTS

The results indicated that marsh swamp habitat was heavily utilized by avian species (i.e. 143.00 ± 23.86 birds ha^{-1}) and open area with scattered trees was less preferred (i.e. 65.03 ± 9.79 birds ha^{-1}). Overall, in five habitats, the highest population was recorded for guild Frugivore/Insectivore (149.89 ± 20.25 birds ha^{-1}) and lowest population was determined for Carnivore (0.40 ± 0.19 birds ha^{-1}) (Table 1).

Feeding Guild Density in Five Habitats

Three guilds i.e., Frugivore/Insectivore (57.18 ± 6.90 birds ha^{-1}), Insectivore (26.98 ± 4.94 birds ha^{-1}) and Omnivore (18.42 ± 2.64 birds ha^{-1}) were the most dominant in marsh swamp habitat. On the contrary, the Carnivore (0.11 ± 0.06 birds ha^{-1}) was the smallest guild in the marsh swamp habitat (Table 1).

Likewise, in lotus swamp habitat, three feeding guilds namely Frugivore/Insectivore (22.30 ± 3.25 birds ha^{-1}), Insectivore (14.09 ± 3.16 birds ha^{-1}) and Omnivore (12.99 ± 1.34 birds ha^{-1}) were the most dominant guilds. However, the density of two guilds, i.e. Carnivore and Carnivore/Insectivore were not calculated due to the low number of detections (Table 1).

In the open water body, the highest guild density was observed for Insectivore (18.64 ± 3.64 birds ha^{-1}), Omnivore (18.64 ± 2.68 birds ha^{-1}) and Granivore (17.38 ± 2.39 birds ha^{-1}). On the other hand, the lowest density was recorded for Carnivore/Insectivore (0.45 ± 0.13 birds ha^{-1}). However, the density of the Carnivore was not determined due to the less number of observations (Table 1).

Similar to lotus swamp habitat, Frugivore/Insectivore (23.06 ± 3.43 birds ha^{-1}) and Insectivore (16.05 ± 2.05 birds ha^{-1}) were the most dominant guilds, whereas the Carnivore and Omnivore (each 0.29 ± 0.13 birds ha^{-1}) was the smallest guild in an open area with scattered trees (Table 1).

In shrubland habitat, the highest guild densities were recorded for Frugivore/Insectivore (34.52 ± 5.14 birds ha^{-1}) and Granivore (19.86 ± 3.12 birds ha^{-1}) whereas, the lowest density was noted for Carnivore/Insectivore (1.12 ± 0.30 birds ha^{-1}). However, the density of guild Carnivore was not analyzed due to the small number of observations (Table 1).

Table 1: Feeding guild density (birds ha^{-1}) in five different wetland and adjacent habitats

Feeding Guilds	Density; birds ha^{-1} (No. of Detections of Each Group)					
	Marsh Swamp	Lotus Swamp	Open Water Body	Open Area with Scattered Trees	Shrub Patches	Total
Frugivore/Insectivore	57.18 ± 6.90 (n = 1511)	22.30 ± 3.25 (n = 279)	12.83 ± 1.53 (n = 257)	23.06 ± 3.43 (n = 987)	34.52 ± 5.14 (n = 785)	149.89 ± 20.25 (n = 3819)
Insectivore	26.98 ± 4.94 (n = 934)	14.09 ± 3.16 (n = 224)	18.64 ± 3.64 (n = 345)	16.05 ± 2.05 (n = 495)	11.98 ± 1.02 (n = 320)	87.74 ± 14.81 (n = 2318)
Omnivore	18.42 ± 2.64 (n = 1548)	12.99 ± 1.34 (n = 209)	18.64 ± 2.68 (n = 535)	0.29 ± 0.13 (n = 576)	6.58 ± 1.77 (n = 233)	56.92 ± 8.56 (n = 3101)
Granivore/Insectivore	13.86 ± 2.71 (n = 744)	8.34 ± 2.49 (n = 117)	11.54 ± 2.75 (n = 139)	11.47 ± 1.60 (n = 314)	16.99 ± 2.13 (n = 215)	62.02 ± 11.68 (n = 1529)
Granivore	12.26 ± 2.82 (n = 744)	6.75 ± 1.72 (n = 89)	17.38 ± 2.39 (n = 119)	10.22 ± 1.19 (n = 434)	19.86 ± 3.12 (n = 231)	66.47 ± 11.24 (n = 1617)
Carnivore /Piscivore/Insectivore	12.99 ± 3.40 (n = 649)	9.57 ± 1.33 (n = 167)	5.38 ± 0.34 (n = 131)	1.92 ± 0.77 (n = 194)	1.89 ± 0.37 (n = 101)	31.75 ± 6.21 (n = 1242)
Carnivore/Insectivore	0.71 ± 0.20 (n = 48)	(n = 0)	0.45 ± 0.13 (n = 12)	0.76 ± 0.25 (n = 26)	1.12 ± 0.30 (n = 20)	3.04 ± 0.88 (n = 106)
Nectarivore/Insectivore	0.49 ± 0.19 (n = 29)	0.47 ± 0.13 (n = 6)	(n = 2)	0.97 ± 0.24 (n = 31)	2.37 ± 0.22 (n = 14)	4.30 ± 0.78 (n = 82)
Carnivore	0.11 ± 0.06 (n = 5)	(n = 0)	(n = 1)	0.29 ± 0.13 (n = 15)	(n = 3)	0.40 ± 0.19 (n = 24)
Total	143.00 ± 23.86 (n = 6212)	74.51 ± 13.42 (n = 1091)	84.86 ± 13.46 (n = 1541)	65.03 ± 9.79 (n = 3072)	95.31 ± 14.07 (n = 1922)	462.71 ± 74.60 (n = 13838)

Feeding Guild Density Based on Status

The results highlighted that resident birds were the most dominant in each habitat and vagrant birds were the rarest in the study area (Table 3). Furthermore, three feeding guilds (i.e. Insectivore, Omnivore, and Carnivore/Piscivore-/Insectivore) of migrant birds were recorded in five habitats. The results showed that Insectivore was the most dominant guild of migrant birds in five habitats such as marsh swamp (1.24 ± 0.08 birds ha^{-1}), lotus swamp (1.28 ± 0.32 birds ha^{-1}), open water body (0.74 ± 0.12 birds ha^{-1}), open area with scattered trees (2.05 ± 0.20 birds ha^{-1}) and shrubland (1.44 ± 0.15 birds ha^{-1}). However, six feeding guilds of migrant birds were absent in marsh swamp, lotus swamp, seven guilds were absent in open water body, open area with scattered trees and shrubland habitats. In addition, guild Carnivore/Piscivore/Insectivore in marsh swamp and guild Omnivore in open water body and shrubland habitats were not analyzed due to low sample size (Table 2).

In marsh swamp habitat the guild Carnivore/Piscivore/Insectivore (2.22 ± 0.28 birds ha^{-1}), in lotus swamp habitat the guild Frugivore/Insectivore (2.56 ± 0.35 birds ha^{-1}), in open water body the guild Granivore (4.53 ± 03.5 birds ha^{-1}), in open area with scattered trees the guild Granivore/Insectivore (4.52 ± 0.71 birds ha^{-1}) and in shrubland habitat the guild Granivore/Insectivore (8.75 ± 0.79 birds ha^{-1}) were the most dominant feeding guilds of resident birds. In contrast, the guilds Carnivore (Marsh Swamp), Carnivore/Insectivore and Carnivore (Lotus Swamp), Nectarivore/ Insectivore and Carnivore (Open Water Body), and Carnivore (Shrubland) were not analyzed due to low number of detections (Table 3).

Four feeding guilds of Resident–Migrant birds were recorded in the five habitats. However, feeding guild varies from habitat to habitats. For example; Omnivore was major feeding guild in marsh swamp and open water body, Insectivore in lotus swamp and open area with scattered trees, and Frugivore/Insectivore in shrubland habitat. Five feeding guilds were absent in the five habitats (Table 4).

The guild density of vagrant birds was not analyzed due to low number of detections.

Table 2: Feeding guild density (birds ha^{-1}) of migrant birds in five different wetland and adjacent habitats

Feeding Guilds	Density; birds ha^{-1} (No. of Detections of Each Group)					
	Marsh Swamp	Lotus Swamp	Open Water Body	Open Area with Scattered Trees	Shrubland	Total
Frugivore/Insectivore	0	0	0	0	0	0
Omnivore	0.18 ± 0.05 (n = 13)	0.67 ± 0.21 (n = 11)	(n = 1)	1.26 ± 0.34 (n = 19)	(n = 2)	2.11 ± 0.60 (n = 46)
Insectivore	1.24 ± 0.08 (n = 208)	1.28 ± 0.32 (n = 23)	0.74 ± 0.12 (n =42)	2.05 ± 0.20 (n = 138)	1.44 ± 0.15 (n = 76)	6.75 ± 0.87 (n = 487)
Granivore/Insectivore	0	0	0	0	0	0
Granivore	0	0	0	0	0	0
Carnivore/Piscivore/Insectivore	(n = 1)	0.35 ± 0.19 (n = 6)	0	0	0	0.35 ± 0.19 (n = 7)
Carnivore/Insectivore	0	0	0	0	0	0
Nectarivore/Insectivore	0	0	0	0	0	0
Carnivore	0	0	0	0	0	0
Total	1.42 ± 0.13 (n = 222)	2.30 ± 0.72 (n = 40)	0.74 ± 0.12 (n = 43)	3.31 ± 0.54 (n = 157)	1.44 ± 0.15 (n = 78)	9.21 ± 1.66 (n = 540)

Table 3: Feeding guild density (birds ha^{-1}) of resident birds in five different wetland and adjacent habitats

Feeding Guilds	Density; birds ha^{-1} (No. of Detections of Each Group)					
	Marsh Swamp	Lotus Swamp	Open Water Body	Open Area with Scattered Trees	Shrubland	Total
Frugivore/Insectivore	2.56 ± 0.35 (n = 268)	1.41 ± 0.03 (n = 1451)	2.82 ± 0.57 (n = 243)	10.38 ± 1.69 (n = 944)	5.20 ± 0.52 (n = 734)	22.37 ± 3.16 (n = 3640)
Insectivore	1.94 ± 0.16 (n = 155)	0.99 ± 0.04 (n = 644)	1.29 ± 0.14 (n = 161)	1.23 ± 0.07 (n = 232)	0.94 ± 0.05 (n = 213)	6.39 ± 0.46 (n = 1405)
Omnivore	1.77 ± 0.05 (n = 1331)	0.82 ± 0.18 (n = 159)	2.04 ± 0.18 (n = 506)	2.62 ± 0.39 (n = 479)	0.72 ± 0.08 (n = 191)	7.97 ± 0.88 (n = 2666)
Granivore/Insectivore	2.22 ± 0.28 (n = 744)	1.04 ± 0.09 (n = 117)	1.82 ± 0.19 (n = 139)	4.52 ± 0.71 (n = 314)	8.75 ± 0.79 (n = 215)	18.35 ± 2.06 (n = 1529)
Granivore	1.72 ±0.28 (n = 744)	1.84 ± 0.86 (n = 89)	4.53 ± 0.35 (n = 119)	3.72 ± 0.62 (n = 434)	4.50 ± 0.41 (n = 231)	16.31 ± 2.52 (n = 1617)
Carnivore/Piscivore/Insectivore	2.67 ± 0.28 (n = 221)	1.94 ± 0.25 (n = 59)	0.54 ± 0.05 (n = 83)	2.12 ± 0.74 (n = 80)	0.62 ± 0.06 (n = 73)	7.89 ± 1.38 (n = 516)
Carnivore/Insectivore	0.71 ± 0.11 (n = 48)	0	0.45 ± 0. 22 (n = 12)	0.82 ± 0.21 (n = 26)	1.00 ± 0.20 (n = 20)	2.98 ± 0.74 (n = 106)
Nectarivore/Insectivore	0.36 ± 0.10 (n = 29)	0.35 ± 0.21 (n = 6)	(n = 2)	0.56 ± 0.16 (n = 31)	1.50 ±0.58 (n =14)	2.77 ± 1.05 (n = 82)
Carnivore	(n = 4)	0	0	0.27 ± 0.08 (n = 13)	(n =2)	0.27 ± 0.08 (n = 19)
Total	13.95 ± 1.61 (n = 3544)	8.39 ± 1.66 (n = 2525)	13.49 ± 1.70 (n = 1265)	26.24 ± 4.67 (n = 2553)	23.23 ± 2.69 (n = 1693)	85.30 ± 11.47 (n = 11580)

Table 4: Feeding guild density (birds ha^{-1}) of resident–migrants in five different wetland and adjacent habitats

Feeding Guilds	Density; birds ha^{-1} (No. of Detections of Each Group)					
	Marsh Swamp	Lotus Swamp	Open Water Body	Open Area with Scattered Trees	Shrubland	Total
Frugivore/Insectivore	2.25 ± 0.49 (n = 59)	1.82 ± 0.75 (n = 11)	0.29 ± 0.12 (n = 14)	0.97 ± 0.15 (n = 43)	0.73 ± 0.12 (n = 51)	6.06 ± 1.63 (n = 178)
Omnivore	4.18 ± 0.47 (n = 204)	2.14 ± 0.23 (n = 39)	1.74 ± 0.66 (n = 28)	1.78 ± 0.20 (n = 78)	0.44 ± 0.08 (n = 40)	10.28 ± 1.64 (n = 389)
Insectivore	0.84 ± 0.34 (n = 82)	2.37 ± 0.33 (n = 46)	0.50 ± 0.15 (n = 142)	2.22 ± 0.21 (n = 125)	0.64 ± 0.16 (n = 31)	6.57 ± 1.19 (n = 426)
Granivore/Insectivore	0	0	0	0	0	0
Granivore	0	0	0	0	0	0
Carnivore/Piscivore/Insectivore	1.19 ± 0.13 (n = 428)	1.59 ± 0.36 (n = 102)	0.80 ± 0.13 (n = 48)	1.00 ± 0.09 (n = 114)	0.65 ± 0.13 (n = 28)	5.23 ± 0.84 (n = 720)
Carnivore/Insectivore	0	0	0	0	0	0
Nectarivore/Insectivore	0	0	0	0	0	0
Carnivore	0	0	0	0	0	0
Total	8.46 ± 1.43 (n = 773)	7.92 ± 1.67 (n = 198)	3.33 ± 1.06 (n = 232)	5.97 ± 0.65 (n = 360)	2.46 ± 0.49 (n = 150)	28.14 ± 5.30 (n = 1713)

DISCUSSION

Monitoring food resources and habitat characteristics using foraging guilds of wetland dependent birds is an important step to examine the productivity of a particular habitat. The presence of food resources is a key factor that affects the habitat suitability of bird species and influences the reproductive success of wetland birds. The recording of the nine feeding guilds indicated that these habitats are rich in food resources and offer suitable foraging sites for a diverse avian species. Foraging guilds of avian species indicated the occurrence of a variety of food resources such as fishes, amphibians, reptiles, invertebrates (insects, worms, centipedes, millipedes, gastropods, crustaceans) and vegetable matter. Bird species detect their prey visually and tactile sensory mechanism (Ntimao-Baidu et al. 1998) and employ a variety of techniques such as probing, gleaning, nipping, stabbing, hawking, sallying, and grubbing to catch their prey. The morphological differences among the avian species reduce the inter-specific competition and increase the species persistence. In addition, vegetation structure and composition and availability of shallow water may also influence foraging guilds of avian species. Jing et al. (2007) reported that birds can change their feeding technique depending on prey richness, prey size, prey distribution and substrate structure.

The results indicated that the populations of avian species may vary from habitat to habitat depending on suitable foraging sites, productivity (food resources), and shelter from harsh weather and predators. This might be that bird species may forage on a variety of food resources and select habitat based on prey richness, diversity and distribution as reported by Ashley et al. (2000), Davis & Smith (2001) and Jing et al. (2007). Habitat selection among avian species often varies from species to species such as the higher populations was recorded in marsh swamp. For example; marsh swamp habitat was rich and diverse in herbaceous aquatic vegetation, such as emergent vegetation (sedges, rushes and reeds), ferns, grasses and submerged had created suitable microhabitats for foraging and breeding, hiding from predators and taking cover from harsh weather conditions (Fairbrain & Dinsmore 2001). The availability of abundant food sources such as invertebrates (i.e. insects and gastropods), fish (i.e. carps and catfish), amphibians (i.e. frogs and salamanders), reptiles (i.e. lizards, dragons and snakes), mammals (i.e. mice and rats), safe roosting and breeding sites, and diverse emergent and submerged vegetation (Colwell & Taft 2000, Rajpar & Zakaria 2009) attracted the birds.

The other reason could be that marsh swamp habitat was shallow in water depth. The shallow

water and moist soil are considered as important foraging sites for wetland birds (van Gils et al. 2003, Granaderio et al. 2007) due to easy access, occurrence of higher prey and also higher success of prey catch. The highest diversity of fish occurs in shallow water and higher biomass of macroinvertebrate occurs in soft mud (Li et al. 2013) which is a major diet of avian species. Stafford et al. (2010) reported that waterbird foraged on benthic and surface-dwelling invertebrates and aquatic vertebrates that mostly occurs in shallow waters.

The high avian populations was also recorded in the shrubland habitat. The shrubs dominate vegetation below five meters height under trees and along the banks of lakes, while the ground layer consists of herbaceous plants, such as grasses, reed beds of sedges and emergent vegetation. The high avian populations could be due to the diversity of fruiting and flowering trees, shrubs and grasses. The vegetation diversity and richness directly affect the species diversity and richness of birds (Canterbury et al. 1999, Soderstrom & Part 1999, Martin 2001). The trees and shrubs provided a diversity of flowers and fruits that attracted a wide array of insects such as wasps, bees, butterflies, moths, termites and caterpillars. The berries and insects were the main food resources for fruit and insect eating birds. Chetti et al. (2005) stated that insect species may prefer vegetation having dense foliage rich in fruits and flowers and moist condition. In addition, the shrubs and trees provided hiding cover for avian species from predators and harsh weather, and also offer suitable nesting sites. In addition, the surrounding areas, i.e. nearby oil palm plantations and forest reserve, might also influence the bird species abundance and diversity (Koopowitz et al. 1994, Vos & Stumpe 1995).

On the contrary, the lower feeding guild population was recorded in open areas with scattered trees. The occurrence of lower population could be that, these areas are open with scattered trees and their productivity is lower such as few fruiting and flowering trees which were planted for aesthetic value to increase the beauty of the study area. The other reason could be that the ground grasses are maintained manually and did not provide cover for avian species. It could also be that these areas are lack of water ponds and thus, may not be preferred by waterbirds. These areas are utilized only by open country birds such as doves, mynas and munias.

In addition, surrounding landscape such as peat swamp forest, oil palm plantation, private lakes and agricultural fields also influence the distribution of avian species. Habitat structure and adjacent landscape influence the distribution and diversity of avian species (Pearman 2002, Hubbard and Dugan 2003, King et al. 2010). In addition, the status of avian species will also influence avian population such as arrival and departure of migrant bird species.

Furthermore, the higher numbers and populations were recorded for resident birds and the lowest was vagrant species. This might be due to that resident birds occur and forage in these habitats throughout the year . In contrast, the lowest bird population was the vagrant birds. This could be explained by the rare presence of the vagrant birds, which only visit the study area at a certain period of time.

CONCLUSION

The findings of this study indicated that foraging guilds of bird species indicate the food resources and habitat characteristics of a particular habitat. They are specialized in food and select the available wetland and adjacent habitats in different ways depending on their foraging behaviour and niche. The distribution of avian assemblages is influenced by richness of food, availability of foraging sites, shallow water depth, and vegetation composition and structure.

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