REPORT ON TERRESTRIAL FAUNA OF PUTRAJAYA WETLAND AND LAKE

Principal Investigator:	Prof. Dr. Mohamad Zakaria Hussai
Co- Principal Investigator:	Dr. Muhammad Nawaz Rajpar
Affiliation:	Faculty of Forestry, Universiti Putra Malaysia, Serdang Selongor Darul Ehsan, Peninsular Malaysia
Funding Organization	Alam Sector BhD Malaysia

INTRODUCTION

Wetlands are widely recognized as transitional areas between land and water (Lee, 1999). Globally wetland covers approximately 6 percent of the Earth's surface or 8.6 million km^2 but provide wide variety of goods and services (Mitsch and Gosselink, 1993). Loss of natural wetlands is a global phenomenon that has been a serious threat to the wildlife fauna. A common practice is to construct artificial wetlands to compensate for the loss of natural wetlands (Zhijun et al., 2004). Wetlands are areas where water play important role in the development of flora and fauna life.

The total area of natural wetlands in Malaysia is estimated about 3.5 to 4.0 million ha or 10% of the total land area. This total area of Malaysian wetlands is divided into 0.6 million ha of mangrove, 0.15 million ha of open water, 0.05 million ha of marsh and 2.7 to 3.2 million ha of freshwater peat swamp forest. In Peninsular Malaysia, wetlands are found in the States of Pahang (2.5%), Selangor (1.1%), Johor (1.1%), (Perak 1%), and Terengganu (0.8%) (Aik, 2002). Wetlands play major role in the economy of Malaysia through supporting the millions people not only for local people living in the periphery of wetlands but also other communities living outside the wetland areas through providing valuable products such as fish, fodder, timber, flood regulation and ground water recharge.

Wetlands are most productive ecosystem due to high biological diversity and productivity (Casado and Montes, 1995) and attractive to many wildlife species due to great productivity, protection from predators, abundant food resources and different breeding grounds for a large number of animals such as birds, amphibians, reptiles, fishes and mammals. The species

richness and relative abundance of animals depend on wetland characteristics such as size, water level, quality of water, availability and distribution of food resources, presence of suitable roosting and nursery sites (Wiens, 1989). Moreover, variation in habitat condition may also cause changes in relative abundance of fauna (Caziani and Derlindati, 2000).

Birds are important component of wetland ecosystem and may visit different areas in search of food, roost, shelter and breed purpose (Kushlan, 1993). The presence or absence may show the ecological conditions of wetland areas and promptly response to any change in habitat and climate (Krebs et al. 1999). Approximately 460 native and 215 migratory bird species occurred in Malaysia. Many of them are endemic to Malaysia and show distinct habitat preferences. Malaysia threatened bird species such as Storm's Stork (*Ciconia stromi*), Spotted Greenshank (*Tringa guttifer*), Chinese Egret (*Egretta eulophotes*), Milky Stork (*Mycteria cinerea*), Lesser Adjutant (*Lepotilos javanicus*), Spoon-billed Sandpiper (*Euryorhynchus pygmeus*), and Hook-billed Bulbul (*Setornis ciniger*) extensively depends on wetlands for their survivals (Aik, 2002).

There are a number of wetland fauna that requires a better level of monitoring population estimates, habitat requirements and impacts of disturbance and habitat loss due to anthropogenic activities that cause threats to their sustainability and survival.

MATERIAL AND METHOD

Study Area

Putrajaya wetland is first man-made wetland and integral part of Malaysia's landscape and it was constructed in 1997 by damming the upper reaches of Sungai Chua as efficient water treatment to trap the sediment and nutrients of surrounding catchments run-off before it enters into lake. The wetland straddles the water courses of Sungai Chua, Sungai Bisa and three tributaries. The wetland has been planted by with variety of aquatic plants, fruiting trees and ornamental plants to attract diversity of fauna and to increase aesthetic beauty.

The aquatic vegetation consists of *Eleocharis variegate, Eriocaulon longifolium, Fimbristlis globulosa, F. miliacea, Hanguana malayna, Ludwigia adscendens, L. octovalvis, Monochoria hastate, Philydrum langinosum, Polygonum barbatum, Sacchrum spontaneum, Scleria*

sumatrensis, Eleocharis dulcis, Fuirena umbellate, Lepriona articulate, Scripus mucronatus, Scleria sumatrensis, Typha augustifolia and *Phragmites karka.* Tree species consists of *Alstonia macrorrhiza, A. spathulata, Colocasia esculenta, Commelina nudiflora, Crinum asiaticum, Dillenia suffritcosa, Cyperus halpan, C. compactus, C. digitatus, Eugenia longifolia, E. aquea, Eriocaculon longifolia, Caryota mitis, Centella asiatica, Fagrea fagrans, Ficus benjamina, F. microcarpa, Ixora javanica, I. umbellate* and *Shorea parvifolia*.

Putrajaya wetland acts as biofilter removing sediments and pollutants from water coming adjacent landscape. As water moves slowly through the vegetation, suspended solids settle to the bottom. Wetland plants such as *Phragmites, Scripus, Typha* and other reeds absorb and assimilate some of these substances and other nutrients from both bottom materials and water.

Plants also increase soil or other root-bed medium hydraulic conductivity. As roots and rhizomes grow they are thought to disturb and loosen the medium increasing its porosity. When roots decay they leave behind ports and channels known as macro pores which are effective in channelling water through the soil. Vegetation in a wetland provides a substrate (roots, stems and leaves) upon which countless micro-organism can grow as they break down organic materials. This community of microorganisms is known as the periphyton. The periphyton and natural chemical processes are responsible for approximately 90 percent of pollutant removal and waste breakdown. Aquatic vegetation may play an important role in phosphorus removal as reported by Breen (1990), Guntensbergen (1989) and Rogers et al. (1991).

Bird Census

Bird surveys were carried out at Putrajaya Wetland and Lake using distance sampling point count and mist-netting methods from March 2009 to May 2009. Sixty one point count stations 400m apart were established within the area. The purpose of using 400 m interval was to avoid the double counting of the same species at more than one station. Each point count station was surveyed four consecutive months to obtain reliable estimates and reduces the biasness. The bird species was recorded for ten minutes time period at each point count station. Ten minute count enables to detect many bird species with minimal efforts and

disturbance. The species seen or heard and the distance from point station to bird's position was recorded. The original position of flushed species were also recorded. The survey was conducted between 0710 hrs and 1100 hrs. The methodology was followed as described by Petit *et al.* (1995) Smith *et al.* (1993), Blonde *et al.* (1981), Bibby *et al.* (1992), Dawson *et al.* (1995), Buckland *et al*. (2004) and Nadeau *et al.* (2008).

In addition three days mist-netting was also employed to sample the bird species. Five mist-nets (14 m x 4 m with 3 pockets) were used to catch the bird species. The survey was carried out at from 0730 hrs to 1130 hrs. The nets were fixed and the entangled birds were identified and released carefully.

DATA ANALYSIS

1. The relative abundance (%) of bird species was determined using expression:

$$n/N \times 100$$

(Where n is numbers of particular recorded/captured bird and N is total recorded/captured bird species).

2. Species diversity, species richness and evenness were determined using Species Diversity Indices Software (Henderson and Seaby, 2007).

3. The trophic structures of all bird species were also determined based on foraging behaviour.

RESULTS

Bird Records

A total of 5598 bird observations belong to 77 species and 35 families were detected during four consecutive months using distance sampling point count method from March to June 2009. A total of 5112 bird observations belong to 76 species that represent 35 families were recorded in wetland areas while 486 bird observations belong to 32 species that represent 21 families were recorded in lake areas. Overall, the results show that *Pycnonotus goiavier* (683 observations), *Ardea purpurea* (508 observations), *Nycticorax nycticorax* (420 observations) and *Treron vernans* (410 observations) were the four most abundant bird species with high

number of observations. Vice versa, *Phylloscopus borealis*, *Elanus caeruleus*, *Alcedo atthis*, *Gallinago stenura*, *Sturnus sericeus*, *Dicaeum cruentatum*, *Haliaeetus leucogaster* and *Anthreptes chrysogenys* were the rarest bird species with only one observation each. (Table 1).

Table 1. List of bird species detected in Putrajaya Wetland and Lake using distance sampling point count method.

S. No	Species Name	Wetland	Lake	Total	%
1.	Arctic Warbler	1	0	1	0.017
2.	Ashy Drongo	2	0	2	0.035
3.	Ashy Tailorbird	46	8	54	0.964
4.	Asian Koel	12	10	22	0.392
5.	Barred Button Quail	2	0	2	0.035
6.	Baya Weaver	124	23	147	2.625
7.	Black Baza	2	0	2	0.035
8.	Black-crowned Nightheron	420	0	420	7.502
9.	Black-naped Oriole	126	26	152	2.715
10.	Black-shouldered Kite	1	0	1	0.017
11.	Blue-tailed bee-eater	9	1	10	0.178
12.	Brown Shrike	16	4	20	0.357
13.	Brown-throated Sunbird	47	26	73	1.304
14.	Cattle Egret	81	0	81	1.446
15.	Common Flameback	4	1	5	0.089
16.	Common Iora	104	24	128	2.286
17.	Common Kingfisher	1	0	1	0.017
18.	Common Moorhen	6	0	6	0.107
19.	Common Myna	225	48	273	4.876
20.	Common Sandpiper	2	0	2	0.035
21.	Common Tailorbird	11	0	11	0.195
22.	Copper-smith Barbet	2	0	2	0.035
23.	Emerald Dove	5	1	6	0.107
24.	Eurasian Tree Sparrow	117	9	126	2.250
25.	Great Egret	17	0	17	0.303
26.	Great White Pelican	24	0	24	0.428
27.	Greater Coucal	3	0	3	0.053
28.	Green Iora	32	6	38	0.678
29.	Grey Heron	207	0	207	3.697

30.	House Crow	24	15	39	0.696
31.	Javan Pond Heron	3	0	3	0.053
32.	Jungle Myna	286	50	336	6.002
33.	Large-billed Crow	3	2	5	0.089
34.	Lesser Coucal	2	0	2	0.035
35.	Little Egret	21	0	21	0.375
36.	Little Heron	19	0	19	0.339
37.	Little Spiderhunter	6	2	8	0.142
38.	Long-tailed Parakeet	3	0	3	0.053
39.	Long-tailed Shrike	0	8	8	0.142
40.	Milky Stork	4	0	4	0.071
41.	Olive-backed Sunbird	12	2	14	0.250
42.	Olive-winged Bulbul	4	0	4	0.071
43.	Oriental Magpie Robin	124	17	141	2.518
44.	Oriental Reed Warbler	13	0	13	0.232
45.	Pacific Swallow	26	0	26	0.464
46.	Painted Stork	109	0	109	1.947
47.	Peaceful Dove	149	14	163	2.911
48.	Philippine Glossy Starling	212	39	251	4.483
49.	Pied Fantail	105	9	114	2.036
50.	Pied Triller	4	0	4	0.071
51.	Pink-necked Green Pigeon	403	7	410	7.324
52.	Pintail Snipe	1	0	1	0.017
53.	Plaintive Cuckoo	4	0	4	0.071
54.	Purple Heron	508	0	508	9.074
55.	Purple Swamphen	70	0	70	1.250
56.	Purple-backed Starling	1	0	1	0.017
57.	Red Junglefowl	89	0	89	1.589
58.	Red-wattled Lapwing	7	0	7	0.125
59.	Richard's Pipit	52	5	57	1.018
60.	Rock Pigeon	49	0	49	0.875
61.	Rufous Woodpecker	3	0	3	0.053
62.	Scaly-breasted Munia	58	2	60	1.071
63.	Scarlet-backed Flowerpecker	1	0	1	0.017
64.	Speckled Piculet	6	0	6	0.107
65.	Spotted Dove	179	20	199	3.554
66.	Sunda Pygmy Woodpecker	2	0	2	0.035

67.	White-bellied Fish Eagle	1	0	1	0.017
68.	White-breasted Waterhen	109	11	120	2.143
69.	White-headed Munia	30	0	30	0.535
70.	White-rumped Munia	2	0	2	0.035
71.	White-throated Kingfisher	24	6	30	0.535
72.	White-vented Myna	28	18	46	0.821
73.	Yellow Bittern	31	0	31	0.553
74.	Yellow-bellied Prinia	56	2	58	1.036
75.	Yellow-eared Spiderhunter	1	0	1	0.017
76.	Yellow-vented Bulbul	613	70	683	12.200
77.	Zitting Cisticola	6	0	6	0.107
	Total	**5112**	**486**	**5598**	100

In addition, five bird species were recorded as opportunistic observations in wetland areas (Table 2).

Table 2. Bird species recorded outside survey period (opportunistic observations)

S. No	Common Name	Scientific Name
1	Cinnamon Bittern	*Ixobrychus sinensis*
2	Crested-serpent Eagle	*Spilornis cheela*
3	House Swift	*Apus affinis*
4	Brahminy Kite	*Haliastur indus*
5	Water Cock	*Gallicrex cinerea*

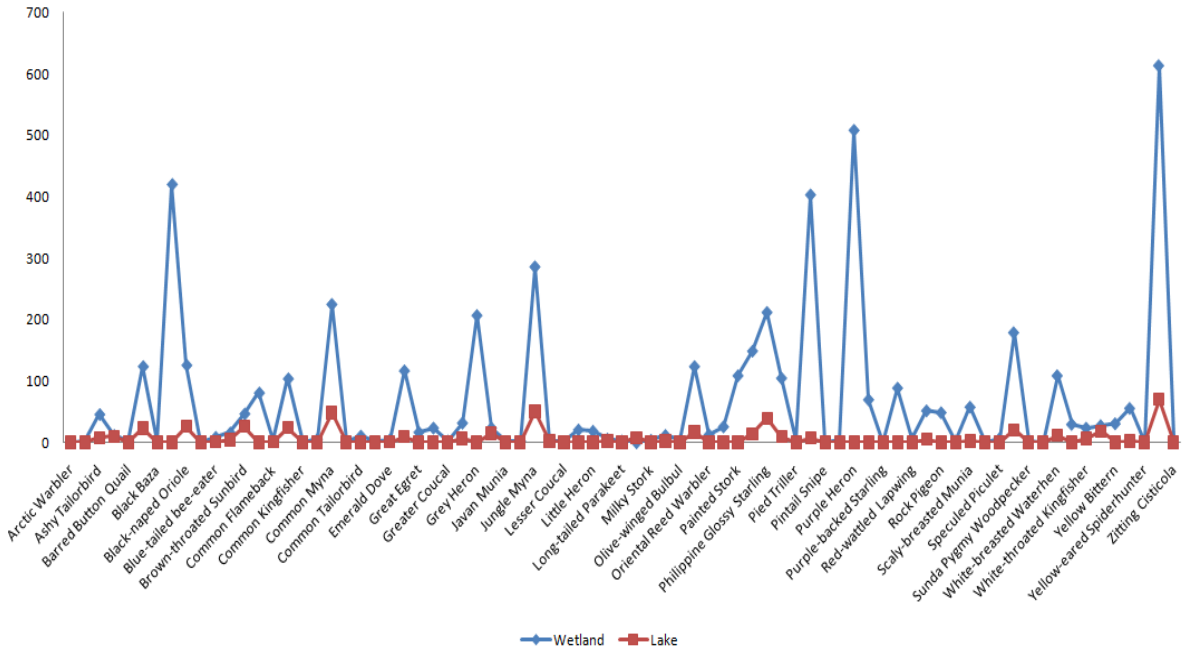


Figure 1. Comparison of bird species in Putrajaya wetland and lake

The result shows that Ardeidae (9 species) was the most dominant family with highest number of species followed by Columbidae (5 species), Sturnidae (5 species), Cuculidae (4 species), Nectariniidae (4 species), Picidae (4 species) and Sylviidae (4 species). While Campephagidae, Charadriidae, Dicaeidae, Dicruridae, Hirundinidae, Megalaimidae, Meropidae, Motacicapidae, Oriolidae, Passeridae, Pelecanidae, Phasianidae, Ploceidae, Psittacidae, Rhipoduridae, Turdidae and Turnicidae were the rarest families with only one species each (Table 3).

Table 3. List of bird families and frequency of detection in Putrajaya Wetland and Lake using distance sampling point count method.

Family Name		Species Common Name	Species Scientific Name	Frequency	%
Accipitridae				4	0.071
	1	Black Baza	*Aviceda leuphotes*		
	2	Black-shouldered Kite	*Elanus caeruleus*		
	3	White-bellied Fish Eagle	*Haliaeetus leucogaster*		
Aegithinidae				166	2.965
	1	Common Iora	*Aegithina tiphia*		
	2	Green Iora	*Aegithina virdissima*		
Alcidinidae				31	0.553
	1	Common Kingfisher	*Alcedo atthis*		

	2	White-throated Kingfisher	*Halcyon smyrensis*		
Ardeidae				1307	23.347
	1	Black-crowned Nightheron	*Nycticorax nycticorax*		
	2	Cattle Egret	*Bubulcus ibis*		
	3	Great Egret	*Chasmerodius albus*		
	4	Grey Heron	*Ardea cinerea*		
	5	Javan Pond Heron	*Ardeola speciosa*		
	6	Little Egret	*Egretta garzetta*		
	7	Little Heron	*Butorides striatus*		
	8	Purple Heron	*Ardea purpurea*		
	9	Yellow Bittern	*Ixobrychus sinensis*		
Campephagidae				4	
	1	Pied Triller	*Lalage nigra*		
Charadriidae				7	0.125
	1	Red-wattled Lapwing	*Vanellus indicus*		
Ciconiidae				113	2.018
	1	Milky Stork	*Mycteria cinerea*		
	2	Painted Stork	*Mycteria leucocephala*		
Cisticolidae				64	1.143
	1	Yellow-bellied Prinia	*Prinia flaviventris*		
	2	Zitting Cisticola	*Cisticola juncidis*		
Columbidae				827	14.773
	1	Emerald Dove	*Chalcophaps indica*		
	2	Peaceful Dove	*Geopelia striata*		
	3	Pink-necked Green Pigeon	*Treron vernans*		
	4	Rock Pigeon	*Columba livia*		
	5	Spotted Dove	*Streptopelia chinensis*		
Corvidae				44	0.785
	1	House Crow	*Corvus splendens*		
	2	Large-billed Crow	*Corvus macrorhynchos*		
Cuculidae				31	0.553
	1	Common Asian Koel	*Eudynamys scolopacea*		
	2	Greater Coucal	*Centropus sinensis*		
	3	Lesser Coucal	*Centropus bengalensis*		
	4	Plaintive Cuckoo	*Cacomantis merulinus*		
Dicaeidae				1	0.017
	1	Scarlet-backed Flowerpecker	*Dicaeum cruentatum*		
Dicruridae					
	1	Ashy Drongo	*Dicrurus leucophaeus*	2	0.035

Estrildidae				92	1.643
	1	White-rumped Munia	*Lonchura striata*		
	2	Scaly-breasted Munia	*Lonchura punctulata*		
	3	White-headed Munia	*Lonchura maja*		
Hirundinidae				26	0.464
	1	Pacific Swallow	*Hirundo tahitica*		
Laniidae				28	0.500
	1	Brown Shrike	*Lanius cristatus*		
	2	Long-tailed Shrike	*Lanius schach*		
Megalaimidae				2	0.035
	1	Coppersmith Barbet	*Megalaima haemacephala*		
Meropidae				10	0.178
	1	Blue-tailed bee-eater	*Merops philippinus*		
Motacicapidae				57	1.018
	1	Richard's Pipit	*Anthus richardi*		
Nectariniidae				96	1.714
	1	Brown-throated Sunbird	*Anthreptes malacensis*		
	2	Little Spiderhunter	*Arachnothera longirostra*		
	3	Olive-backed Sunbird	*Nectarinia jujularis*		
	4	Yellow-eared Spiderhunter	*Anthreptes chrysogenys*		
Oriolidae				152	2.715
	1	Black-naped Oriole	*Oriolus chinensis*		
Passeridae				126	0.285
	1	Eurasian Tree Sparrow	*Passer montanus*		
Pelecanidae				24	0.428
	1	Great White Pelican	*Pelecanus onocrotalus*		
Phasianidae				89	1.589
	1	Red Junglefowl	*Gallus gallus*		
Picidae				16	0.285
	1	Common Flameback	*Dinopium javanense*		
	2	Rufous Woodpecker	*Celeus brachyrurus*		
	3	Speckled Piculet	*Picumnus innominatus*		
	4	Sunda Pygmy Woodpecker	*Dinopium moluccensis*		
Ploceidae				147	2.625
	1	Baya Weaver	*Ploceus philippinus*		
Psittacidae				3	0.053
	1	Long-tailed Parakeet	*Psittacula longicauda*		
Pycnonotidae				687	12.272
	1	Olive-winged Bulbul	*Pycnonotus plumosus*		

	2	Yellow-vented Bulbul	*Pycnonotus goiavier*		
Rallidae				196	3.501
	1	Common Moorhen	*Gallinula chloropus*		
	2	Purple Swamphen	*Porphyrio porphyrio*		
	3	White-breasted Waterhen	*Amaurornis phoenicurus*		
Rhipoduridae				114	2.036
	1	Pied Fantail	*Rhipidura javanica*		
Scolopacidae				3	0.053
	1	Common Sandpiper	*Tringa hypoleucos*		
	2	Pintail Snipe	*Gallinago stenura*		
Sturnidae				907	16.202
	1	Common Myna	*Acridotheres tristis*		
	2	Jungle Myna	*Acridotheres fuscus*		
	3	Philippine Glossy Starling	*Aplonis panayensis*		
	4	Purple-backed Starling	*Sturnus sericeus*		
	5	White-vented Myna	*Acridotheres grandis*		
Sylviidae				79	1.411
	1	Arctic Warbler	*Phylloscopus borealis*		
	2	Ashy Tailorbird	*Orthotormus ruficeps*		
	3	Common Tailorbird	*Orthotormus sutorius*		
	4	Oriental Reed Warbler	*Acrocephalus orientalis*		
Turdidae				141	2.518
	1	Oriental Magpie Robin	*Copsychus saularis*		
Turnicidae				2	0.035
	1	Barred Button Quail	*Turnix suscitator*		

For comparison, the result clearly shows that Ardeidae was the most dominant family with nine species in wetland area and Campephagidae, Charadriidae, Dicaeidae, Dicruridae, Hirundinidae, Laniidae, Megalaimidae, Meropidae, Motacicapidae, Oriolidae, Passeridae, Pelecanidae, Phasianidae, Ploceidae, Psittacidae, Rhipoduridae, Turdidae and Turnicidae were rarest families with only one species each. However, Columbidae (4 species) and Sturnidae (4 species) were the most abundant families in lake areas and Alcidinidae, Cisticolidae, Cuculidae, Estrildidae, Meropidae, Motacicapidae, Oriolidae, Passeridae, Picidae, Ploceidae, Pycnonotidae, Rallidae, Rhipoduridae, Sylviidae and Turdidae were the rarest families with only one species each (Table. 4)

Table 4. Comparison of bird families in Putrajaya wetland and lake

Family Name	Wetland		Lake			
	No. of Species	%	No. of Species	%	Total Species	%
Accipitridae	3	3.947	0	0	3	3.896
Aegithinidae	2	2.631	2	2.631	2	2.597
Alcidinidae	2	2.631	1	1.315	2	2.597
Ardeidae	9	11.842	0	0	9	11.688
Campephagidae	1	1.315	0	0	1	1.298
Charadriidae	1	1.315	0	0	1	1.298
Ciconiidae	2	2.631	0	0	2	2.597
Cisticolidae	2	2.631	1	1.315	2	2.597
Columbidae	5	6.578	4	5.263	5	6.493
Corvidae	3	3.947	2	2.631	2	2.597
Cuculidae	4	5.263	1	1.315	4	5.194
Dicaeidae	1	1.315	0	0	1	1.298
Dicruridae	1	1.315	0	0	1	1.298
Estrildidae	3	3.947	1	1.315	3	3.896
Hirundinidae	1	1.315	0	0	1	1.298
Laniidae	1	1.315	2	2.631	2	2.597
Megalaimidae	1	1.315	0	0	1	1.298
Meropidae	1	1.315	1	1.315	1	1.298
Motacicapidae	1	1.315	1	1.315	1	1.298
Nectariniidae	4	5.263	3	3.947	4	5.194
Oriolidae	1	1.315	1	1.315	1	1.298
Passeridae	1	1.315	1	1.315	1	1.298
Pelecanidae	1	1.315	0	0	1	1.298
Phasianidae	1	1.315	0	0	1	1.298
Picidae	4	5.263	1	1.315	4	5.194
Ploceidae	1	1.315	1	1.315	1	1.298
Psittacidae	1	1.315	0	0	1	1.298
Pycnonotidae	2	2.631	1	1.315	2	2.597
Rallidae	3	3.947	1	1.315	3	3.896
Rhipoduridae	1	1.315	1	1.315	1	1.298
Scolopacidae	2	2.631	0	0	2	2.597
Sturnidae	5	6.578	4	5.263	5	6.493

Sylviidae	4	5.263	1	1.315	4	5.194
Turdidae	1	1.315	1	1.315	1	1.298
Turnicidae	1	1.315	0	0	1	1.298
Total	**76**		**32**		**77**	

To determine whether artificial wetland or lake habitats support high species diversity, richness and evenness, I compared the results using Species Diversity Indices method (Henderson and Seaby, 2007). The results indicated that higher bird species diversity i.e. Shannon's diversity index (N1= 27.97) and higher richness i.e. Margalef's richness index (R1= 8.783) occurred in wetland as compared to lake habitats. However, higher species evenness index (Pielou J = 9.00) was observed in lake area as compared to wetland area (Pielou J = 8.683). Overall, results show that wetland is highly attractive to diverse bird species as compared to lake (Table 5).

Table 5. Diversity indices of bird species observed in Putrajaya Wetland and Lake habitats

Indices	**Wetland**	**Lake**	**Over all**
Diversity Indices			
➢ Shannon's Index	27.97	19.82	30
➢ Simpson's index	18.37	15.77	21.08
Richness Indices			
➢ Margalef's Index	8.783	5.011	8.823
➢ Menhinik's Index	1.063	1.452	1.084
Evenness Indices			
➢ Pielou J Index	0.766	0.687	0.785
➢ McIntosh's index	0.868	0.900	0.883

The bird feeding guilds were categorized into nine categories based on foraging behaviour observed during surveys. The results clearly indicated that Insectivore which comprised of arboreal foliage and bark gleaners, sallying and terrestrial foragers was the most dominant group of birds (32.467%) and Frugivore was the rarest group of birds (2.597%) (Table 6).

Table 6. Feeding guilds observed in Putrajaya wetland and lake

No	Name of Guild	Observation	No of Species	%
1	Carnivore	8	3	3.896
2	Carnivore/Pisicivore/Insectivore	965	16	20.779
3	Frugivore	12	2	2.597
4	Frugivore/Insectivore	699	3	3.896
5	Granivore	159	4	5.194
6	Granivore/Insectivore	441	5	6.493
7	Insectivore	1178	25	32.467
8	Nectarivore/Insectivore	97	4	5.194
9	Omnivore	2039	15	19.480

The feeding guild was also determined to examine the importance of wetland and lake areas for different bird groups. The results showed that Insectivore was the most dominant group of birds in wetland habitats and Omnivore was the most dominant group of birds in lake habitats. While the Carnivore was the rarest group of birds in wetland and no carnivore was observed in lake area (Table 7).

Table 7. Comparison of feeding guilds in Putrajaya wetland and lake area

S. No	Name of Guild	Wetland		Lake	
		No of Species	%	No of Species	%
1	Carnivore	3	3.896	0	0
2	Carnivore/Pisicivore/Insectivore	16	20.779	1	1.298
3	Frugivore	2	2.597	1	1.298
4	Frugivore/Insectivore	3	3.896	1	1.298
5	Granivore	4	5.194	3	3.896
6	Granivore/Insectivore	5	6.493	3	3.896
7	Insectivore	24	31.168	11	14.285
8	Nectarivore/Insectivore	4	5.194	2	2.597
9	Omnivore	15	19.480	10	12.987

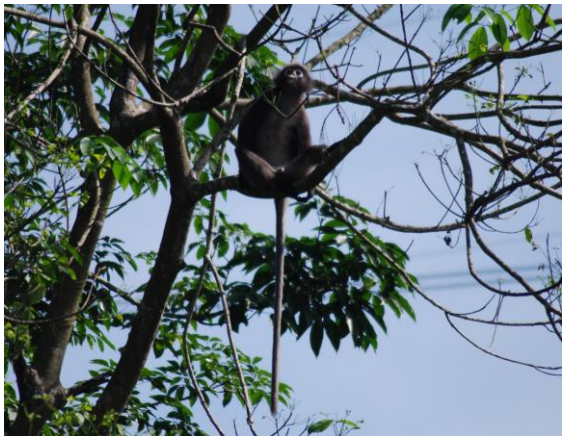
Other Fauna

During four consecutive months of surveys, five mammal species namely Long-tailed Macca (*Macaca fascicularis)*, Dusky Leaf Monkey (*Presbytis obscura*), Ground Squirrel (*Tupaia tana*), Grey-bellied Squirrel (*Callosciurus caniceps)* and Wild Boar (*Sus scrofa*) and four reptile species namely Monitor Lizard (*Varanus salvator),* Gould's Monitor Lizard (*Varanus*

goulgii), Ground Agamid (*Agama acuealta*) and Malaysian Box Turtle (*Cuora amboinensis*), ten Lepidoptra (Butterfly and Moth species) and Odonata (Dragon Fly and May Fly species) were recorded.

Mammal Species









Reptile Species







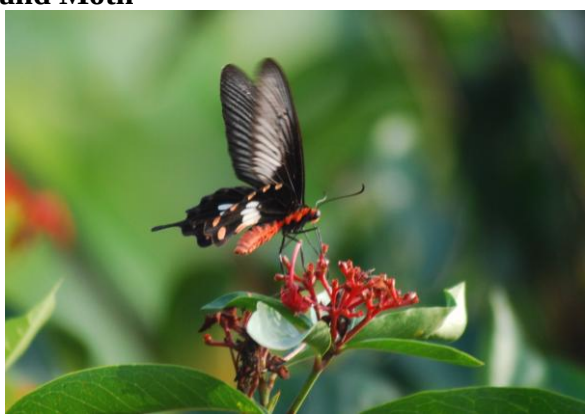






Butterfly and Moth





















Dragon Fly and May Fly














DISCUSSION

Monitoring the population status of existing fauna species and their habitats at national as well as regional level is highly important tool to identify the species that are declined at particular area in the light of growing pressure on wetlands due to anthropogenic activities, climatic and edaphic changes. These changes cause great threats to diversity of fauna species and their habitats (Laurance, 1999; Achard *et al*., 2002).

Putrajaya wetland and lake is important habitat for wide array of fauna species especially for bird species due to heterogeneous vegetation, abundant food resources and safe breeding sites especially for waterbirds. A total of 5598 bird observations were recorded in wetland and lake areas that belong to 77 species and 35 families during four consecutive months using distance sampling point count method from March to June 2009. In addition, five bird species were also recorded as opportunistic observations. The occurrence of 82 species showed that wetland and lake constitute important habitat for bird species.

The relationship between birds and habitats is of many factors namely heterogeneity of flora, water quality, food resources, nesting and roosting sites, shelter from weather and predators. The aquatic vegetation and food resources especially fruiting trees are prominent factors that directly and indirectly influence the occurrence and distribution of bird species. The bird species often select available food resources and microhabitats in different ways for foraging, loafing, roosting and breeding purposes.











The importance of food resources of wetland and lake areas was determined for avian species. I observed that wetland dependent bird species namely swamphen and moorhen used swampy areas to feed on soft shoots, stems, herbs, seed of reeds, rushes, small vertebrates such as tadpoles, fishes and invertebrates such as larvae of insects. Bitterns and herons hide in thick vegetation in shallow water (shallower than the size of their legs) to catch variety of aquatic insects, tadpoles and fishes. Egrets were seen often running with raised wing to chase its prey in shallow water mostly for amphibians, fish and insects. Waterhen and water cock frequently used wet moist soils in shallow water and along the edges of water bodies to probe in mud on variety of food items such as worms, insects and adjacent terrestrial areas especially covered with grasses to forage on seeds and vegetable matter. Kingfishers used variety of habitats to hunt on fishes and insects and often perched on trees along the edge of lakes and adjacent lakes areas. Other species such as plovers, snipes and sandpipers used wet ground (soft soil of muddy shorelines) for probing or picking up food items such as worms and insects.

The terrestrial bird species were more abundant in sparse trees and shrub thickets along the edge of water bodies. Pigeons, orioles, bulbuls, starlings and mynas were gathered on fruiting trees and shrubs to forage on berries of *Ficus* spp., *Syzygium* spp., *Cinnamonum iners, Fragraea fragrans, Melastomea malabathrium* and *Peltophorum pterocarpum*. Doves mainly forage on grounds on seed of grasses. Sparrow forages on ground and in trees mostly eat grains, weeds and grasses seeds. Munias and weavers frequently forage on marshes and reed beds in flocks mostly feeds on seed of *Panicum* spp., *Scleria purpurascens* and insects.

Crows and mynas were versatile in its foraging behaviour mostly feed on wide range of items. Sunbirds and spiderhunters preferred flowering trees such as *Delonix regia*, *Lagerstroemia speciosa*, *Syzygium jambos*, *Cocos nucifera*, *Acacia auriculiformis* and other flowering trees to nip the flower's nectar and hunt insects. Bee-eaters caught flying insects on wing especially bees and wasps by sallying from an open perch. Quails, coucals and junglefowl mostly forage on the ground in grasses and low bushes picking up food items such as insects, worms, grains and seeds. Ioras, pipits, robins, prinias, warblers, fantails, trillers, shrikes, cisticola, woodpeckers and tailorbirds preyed on variety of insects such as flies, wasps, bees, butterflies, moths, termites, beetles and caterpillars on trees, grasses, shrubs and even on flight and concentrated at where insect populations were abundant especially after raining. Raptors like kites, baza, harriers and eagles feed on small birds, fishes, mites, dragons and lizards caught while flying and also consumed while perching on trees.

CONCLUSION

Based on the results, it is concluded that Putrajaya wetland and lake habitats are highly important area not only for water dependent but also for terrestrial fauna due to variation in floristic composition, rich food resources, suitable shelter from weather and predators, safe breeding and roosting sites. Therefore, both wetland and lake areas should be declared as wildlife sanctuary to protect and enhance its populations.

REFERENCES

Achard F., Eva H. D., Stibig H. J., Mayaux P., Richards T. and Malingreau J. P. 2002. Determination of deforestation rates of the World's humid tropical forests. *Science*, 297: 999–1002.

Aik, Y.C., 2002. The effectiveness of the Asian waterbird census and other related programmes as a tool for waterbird and wetland monitoring in Malaysia. Proceedings of Workshop on developing a proposed framework for a wetland inventory, assessment and monitoring system (WIAMS) Kula Lumpur Malaysia 18 and 19 April, 2002. Wetland International Malaysia. Pp 92-101.

Bibby, C.J., N.D. Burgess and D.A. Hill, 1992. *Bird Census Techniques*. London; Academic Press.

Blonde, L., C. Ferry and B. Forchot, 1981. *Point Counts With Unlimited Distance*. In C. J. Ralph and J.M.S. Scott (Eds). *Estimating Numbers of Terrestrial Birds*. *Studies in Avian Biology,* 6: 414–420.

Breen, P.F. 1990. A mass balance method for assessing the potential of artificial wetlands for wastewater treatment. Wat. Res. 24:689-697.

Buckland, S.T., D.R. Anderson, K.P. Burnhan, J.L. Lake, D.L. Borchers and L. Thomas, 2004. *Advance Distance Sampling; Estimating Abundance of Biological Populations*. London; Campman & Hall.

Casado, S. and Montes, C. 1995. Guía de los lagosy humedales de España. J.M. Reyero, Madrid.

Caziani, S. and E.J. Derlindat, 2000. Abundance and habitat of high *Andes flamingos* in northwestern Argentina. *Waterbirds,* 23(1)**:** 121–133.

Dawson, D.K., D.R. Smith and C.S. Robbins, 1995. *Point Count Length and Detection of Forest Neotropical Migrant Birds*. Pp. 35–43, in Ralph, C.J., J.R. Sauer and S. Droege (Eds.). *Monitoring Bird Population by Point Counts*. USDA For. Ser. Gen Tech. Rep. PSW-GTR-149, Pacific Southwest Res. Stn., Albany, California.

Guntensbergen, G.R. and F. Stearns, and J.A. Kadlec. 1989. Wetland vegetation. Pp.73-88. In Constructed wetlands for wastewater treatment. D.A. Hammer, ed. Lewis publishers, Chelsea, Michigan.

Henderson, P.A. and R.M.H. Seaby, 2007. Community Analysis Package 4.0, Pisces Conservation Ltd, Lymington, UK.

Krebs, J.R., J.D. Wilson, R.D. Bradbury and G.M. Siriwardena, 1999. The second silent spring? *Nature,* 400: 611–612.

Kushlan, J. A. 1993. Waterbirds as bioindicators of wetland change: are they a valuable tool? *In:* Moser, M., Prentice, U.C. and J. van Vessem (eds), Waterfowl and Wetland Conservation in the 1990's–A Global Perspective. IWRB Special Publication 26, Slimbridge.

Laurance, W. F. 1999. Reflections on the tropical deforestation crisis. Biological Conservation, 91: 109 –117.

Lee, Y.J., 1999. Sustainable wetland management strategies under uncertainties. The Environmentalist, 19: 67-79.

Mitsch, W.J. and J.G. Gosselink, 1993. Wetlands, Fourth Edition. New Jersey, John Wiley and Sons.

Nadeau, C.P., Conway, C.J., Smith, B.S. and Lewis, T.E. 2008. Maximizing detection probability of wetland dependent bird during point count surveys in North-western Florida. *The Wilson Journal of Ornithology,* 120(3):513–518.

Petit, D.R., L.J. Petit, V.A. Saab and T.E. Martin, 1995. *Fixed Radius Point Counts in Forests: Factors Influencing Effectiveness and Efficiency*. Pp. 49–56, in Ralph, C.J., J.R. Sauer and S. Droege (Eds.). *Monitoring Bird Populations by Point Counts*. USDA For. Ser. Res. Paper SO-274, Southern For. Exp. Stn., New Orleans, Louisiana. Diane Publishing Co.

Rogers, K.H. and P.F. Breen, and A.J. Chick. 1991. Nitrogen removal in experimental wetland treatment systems: evidence for the role of aquatic plants. Res. J. Water Polit.. Control Fed. 63:934-941.

Smith, W.P., D.J. Twedt, D.A. Wiedenfeld, P.B. Hamel, R.P. Ford and R.J. Cooper, 1993. *Point Counts of Birds in Bottomland Hardwood Forests of the Mississippi Alluvial Valley: Duration, Minimum Sample Size, and Points Versus Visits*. USDA For. Ser. Res. Paper SO-274, Southern For. Exp. Stn., New Orleans, Louisiana. Diane Publishing Co.

Wiens, J.A., 1989. *The Ecology of the Bird's Communities*. Cambridge; Cambridge University Press.

Zhijun, M.A., Li, B., Zhao, B., Jing, K., Tang, S. and Chew, J. 2004. Are artificial wetlands good alternatives to natural wetlands for waterbirds?- A case study on Chongming Island, China. Biodiversity and Conservation, 13: 333-350.