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Population and Occupancy Estimates of Avian Species in Payaindah and Putrajaya Wetlands, Peninsular Malaysia

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Abstract

Knowledge on the population of avian community in the wetland is important to the conservation of wetlands. This study aimed to understand the population and occupancy estimate of birds in Malaysian wetlands and results showed that both wetlands were very diverse in bird population. We make recommendations to wildlife managers on how to use this information to enrich their wetlands.

Context: In Malaysia, multiple land uses by humans have opened the way to substantial loss of wetland ecosystem, and shrinkage of the populations, habitat and food bases of avian species. However, the study of the avian population and occupancy estimate becomes eminent to understand the complexity of wetlands ecosystem structure, and also develop appropriate management with robust monitoring tools to ensure their ecological sustainability.

Aim: We aimed to determine and compare the population and occupancy estimates of water and terrestrial dependent avian species in Paya Indah and Putrajaya wetlands, Peninsular Malaysia.

Method: We employed the distance sampling point count technique to survey the avian species from November 2016 to July 2018. We systematically placed 82 count stations at 300 m interval apart with each point count station surveyed for 10 min. Using the Distance and Presence software, we computed the avian species ' population and occupancy estimates respectively.

Key results: A total of 124,032 and 125,643 bird's individuals were identified in Paya Indah and Putrajaya wetlands from November 2016 to December 2018. The result showed that the terrestrial birds in Paya Indah had higher observed individuals (n=04,872), species diversity (N=7.25), richness (R1=132.50), evenness (E=0.92) as compared to the terrestrial birds in Putrajaya wetland (n=97340) (N=7.84; R1=239.60, E=0.93). All the observed birds' individual and estimated indices were significantly different except for the Pielou's J evenness index. However, Putrajaya had the highest observed individual (n=28303) species diversity (N=7.60), richness (R1=132.50), evenness (E=267.3) as compared to the terrestrial birds in Putrajaya wetland (n=19160) (N=7.10; R1=156.00, E=0.79).

Conclusion: Our study revealed the potentials of the Paya Indah and Putrajaya wetlands to harbour diverse avian species.

Implications: We recommend the need to conserve this enclave in order to increase the population, perpetuity and sustainability of the avian species.

Keywords: Population; Diversity; Avian species; Wetlands; Occupancy

Introduction

Protecting birds beyond that present in nature reserve is still a new conservation strategy, especially in developing countries [1]. The study of the avian population is important for the understanding of the complexity of wetlands ecosystem structure and for providing updated information on each type of wetlands in the ecosystem. In Malaysia, demand for food, raw materials and residential areas have opened the way to substantial loss of natural vegetation. Buildings and monocultures crop system, such as oil palm plantations have largely replaced large swath of wetlands vegetation areas [2].

Wetlands are periphery environments amongst earthly and oceanic biological systems [3]. They are exceedingly essential territory for various fauna including warm-blooded creatures, birds, reptiles, terrestrial and water animals, and sea-going spineless creatures [3]. Their significance relies upon numerous elements-wetland estimate, network to encompassing regions, and variety of vegetation, water quality, sustenance assets and geography. Wetlands are evaluated to possess almost 6.4% of the world's surface, 30% of which is comprised of lowlands, 26% fens, 20% marshes, around 15% surge fields, and so forth [4]. The measure of crisp water on earth is little contrasted with seawater, of which 69.6% is secured away in the mainland ice, 30.1% in underground aquifers, and 0.26% in streams and lakes. Lakes specifically possess under 0.007% of the world's new water. Wetlands are among the most intensely affected natural surroundings of every environmental framework [5,6]. Half of the wetland regions of the world have been obliterated in the past century [3,6]. The remaining half is under serious dangers and is declining locally and territorially due to redirection and damping of stream streams, change of bogs, swamps, lakes and floodplains into farming fields and aquaculture lakes, eutrophication, defilement of water from agrarian fields and ventures [7].

Good management practices should be implemented to strike balance between both wetlands ecosystem sustainability and human demand. However, the management efforts embedded in the surrounding landscape can also affect the composition and diversity of birds in that area. For example, birds were particularly high in the structurally rich landscape that contains large area of natural wetlands [8]. Therefore, the distance to the nearest wetland habitat is too important for maintaining bird populations in managed landscape wetlands [8]. Some wetlands composed more forest birds than those located further away from natural wetlands. High bird diversity has not only been associated with the complexity of landscapes, but also the structure of the vegetation within wetland types. Several studies highlight the importance of tree cover in the tropical wetlands for the conservation of wetland bird communities [9]. Although homogeneous plantation trees with a dense canopy can still support some wetland species vegetation heterogeneity has been shown to increase the number of niches and consequently the richness of species of birds [8].

Human activities such as farming, settlement, charcoal making, pole cutting and firewood collection have contributed in degradation which has extensively damaged the natural habitat of birds, affecting their variety and variability. The threats to bird populations are immeasurable including habitat loss, fragmentation and severe anthropogenic pressures. This has generated considerable disturbance to birds, especially when they are perched above the high tide, forcing them to fly from one place to another and increase their energy expenditure. Increase in marine traffic volume and recreation activities along the coast had also proven to be highly detrimental to the water bird assemblage. Together, these developments and natural threats such as coastal erosion and drought alter the coast in a way that degrades extensive bird habitat areas. Apart from mangroves, oil palm plantation is a major driver of the current bird diversity crisis in tropical Southeast Asia. Malaysia is honored with 5.19 million ha wetland assets which cover 15.65% of an aggregate land zone of the nation. This aggregate territory is separated into mangroves (0.63 m. ha), mudflats (0.05 m. ha), freshwater swamps (0.54 m. ha), peat swamps (1.54 m. ha), swamps (0.74 m. ha), nipa overwhelm (1.65 m. ha) and melaleuca overwhelm (0.03 m. ha) [5]. Numerous birds' species rely upon these wetland territories to fulfil their necessities and perform different exercises. They select wetland natural surroundings in light of vegetation structure and arrangement, nourishment assets and microclimatic conditions that give ideal assets to their survival. Birds are bio indicators of wetland biological system, show an assortment of methods to use the wetland zone and demonstrate environmental conditions and wetland efficiency [3,5,10].

Hence, determining the accurate population size of different bird species that inhabit the wetland habitats is highly important to understand the bird community structures and population status of existing bird species. It is also essential to evaluate the factors that cause population fluctuations of different bird species in their habitats. This understanding will allow comparison of different habitats in consequent studies to determine the most preferable habitat for wetland birds towards their conservation and management actions. There is little or no information on the avian density among different habitats such as marshes, swamps, open water bodies and adjacent areas in Peninsular Malaysia. Thus, this study aimed to determine and compare the population and occupancy estimate of terrestrial and water avian species in two Malaysian prestige wetlands.

Methodology

Geographical description

The study was undertaken at the Payaindah wetland and Putrajaya wetlands. Putrajaya wetlands are geographically situated within 2° 57' 43" latitude and 101° 41' 47" longitude. It is located at 26 km south to Kuala Lumpur (Figure 1A) and covers a land cover mass of 200 ha (77.70 ha planted zone, 76.80 ha vast water bodies, 9.60 ha islands, 23.70 ha immersion region and 9.40 ha tracks) (Seymour and Simmons 2008) [11]. The wetland comprises of five arms (upper west, upper north, upper east, bring down east, upper bisa) and central swamp. It is highly diverse in plant species which provide a distinctive microhabitat to the avian species. Payaindah which in Malay is translated "beautiful swamp". The wetland reserve is made up of about 3050 ha of lands out of which 450 ha are under the management of the Department of Wildlife and National Parks, Peninsular Malaysia (Figure 1B). Payaindah wetland reserve is a part of Kuala Langat north permanent Forest Reserve (a peat swamp forest) and it comprises of degraded tin-mining lakes, logged peat swamp forest and large open lakes [3]. The area is a 'green lung' or super corridor due to its strategic location 30 km south of Kuala Lumpur, 12 km west of Putrajaya, 15 km north of Kuala Lumpur International Airport and the nearest town Dengkil (4 km away). There are 14 lakes in PayaIndah wetland. They are Belibis, Seroja, Telipok, Drift wood, Tunira, Senduduk, Sendayan, Grebe, Resam, Teratai, Kemoning, Rusiga, Typha1 and Typha2 lakes. They are made up of lotus swamp, marsh swamp or open water body. The dryland is made up of grasses and shrubs [12].

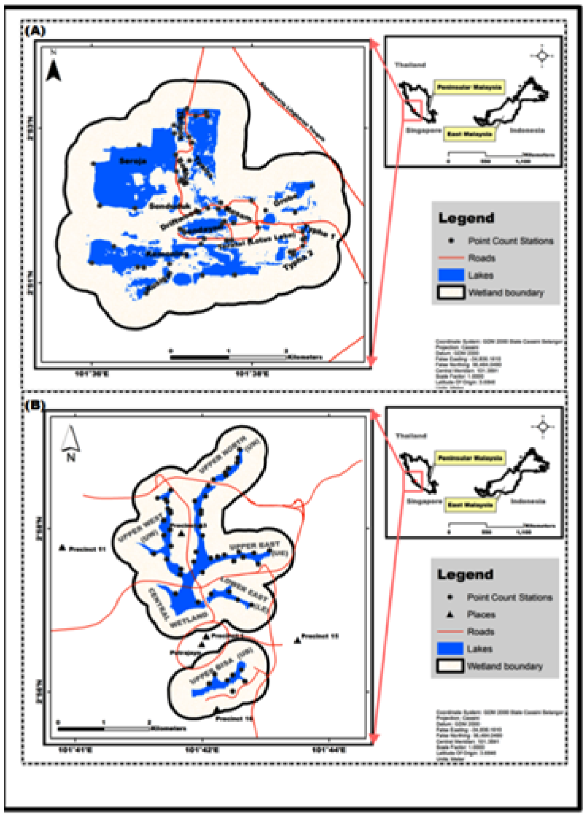

Figure 1: Map of Payaindah (A) and Putrajaya (B) Wetlands Malaysia.

Bird surveys

The distance sampling point count technique was employed to survey the avian species of man-made Putrajaya wetlands from November 2016 to July 2018. This technique is a less demanding and more proficient approach to determine the population status of avian species [3,5,12]. It involves the visual and sound-related identification of winged animals with settled or variable radius plots, and this gives critical data on species abundance, diversity and density among various natural surroundings [13-15]. It enhances deductibility, which permits the estimation of density and abundance of wild creatures, including birds [16]. Information was collected for 19 consecutive months. 82 count stations were systematically placed at 300 m interval apart, to avoid the double count of the same avian species at more than one station. Each point count station was surveyed for 10 min. The survey was taken from 0730 h–1100 h. The method was followed as delineated by Martins et al. 2017; Rajpar and Zakaria 2010; Nadeau et al. 2008; Mohamed and Anjana 2017[3,12,16,17].

Data analysis

The distance software Version 7.2 was used to determine the avian density and diversity [16,18]. The key to distance sampling is to use the distribution of the observed distances to estimate the "detection function," g(y), the probability of detecting a bird at distance y. This function can then be used to estimate the average probability of detecting a bird given that it is within w of the point, denoted Pa. Given an estimate of Pa, bird density can be estimated as (Where a=size of the covered region, n=number of birds seen, and Pˆa (zi)=the estimated probability) of detecting the bird given that it is within w=mean perpendicular distance of sighted birds at point and has the covariate values zi.

Results

Bird diversity indices of the terrestrial and water birds in Payaindah and Putrajaya wetland are presented in Table 1. The result showed that the terrestrial birds in Payaindah had higher observed individuals (n=104,872), species diversity (N=7.25), richness (R1=132.50), evenness (E=0.92) as compared to the terrestrial birds in Putrajaya wetland (n=97340) (N=7.84; R1=239.60, E=0.93). All the observed birds individual and estimated indices were significantly different except for the Pielou's J evenness index. However, Putrajaya had the highest observed individual (n=28303) species diversity (N=7.60), richness (R1=132.50), evenness (E=267.3) as compared to the terrestrial birds in Putrajaya wetland (n=19160) (N=7.10; R1=156.00, E=0.79). Also, the observed birds individual and estimated indices were significantly different except for the Pielou's J evenness index. Table 2 showed the list of the individual birds in Payaindah and Putrajaya wetlands. Some common species in Putrajaya were *Nycticorax nycticorax, Ardea cinerea, Casmero diusalbus, Dendrocygna javanica, Dupetor flavicollis* and *Ixobrychus cinnamomeus*. Payaindah also had some common species like *Elanus caeruleus, Aegithina virdissima, Lalage nigra, Corvus macrorhynchos*.

Estimate	Terrestrial Birds				Water Birds			
Species	**Payaindah**	**Putrajaya**	**t-value**	**P**	**Payaindah**	**Putrajaya**	**t-value**	**p**
Observed birds individuals	104,872	97,340	7.44	0.00*	19,160	28,303	25.01	0.00*
Shannon's diversity index(N)	7.25	7.84	162.22	0.00*	7.1	7.6	37.64	0.00*
Margalefs richness index(R)	132.5	239.6	283.24	0.00*	156	267.3	172.36	0.00*
Pielou's J evenness index(E)	0.92	0.93	1.55	0.12	0.79	0.73	6.5	0.00*
Dominance	0	0	81.14	0.00*	0	0	13.02	0.00*

Table 1: Bird diversity indices comparisons of the terrestrial and water birds in Payaindah and Putrajaya wetland.

Putrajaya Wetlands		PayaIndah Wetlands	
Family	**Scientific name**	**Family**	**Scientific name**
Ardeidae	*Nycticorax nycticorax*	Accipitridae	*Elanus caeruleus*
Ardeidae	*Ardea purpurea*		*Aviceda leuphotes*
Ardeidae	*Ardea cinerea*		*Haliastur indus*
Ardeidae	*Bubulcus ibis*		*Circus aeruginosus*
Ciconiidae	*Mycterial eucocephala*		*Haliaeetus leucogaster*
Ardeidae	*Ixobrychus sinensis*	Aegithinidae	*Aegithina virdissima*
Charadriidae	*Vanellus indicus*		*Aegithina tiphia*
Ardeidae	*Egretta garzetta*	Campephagidae	*Lalage nigra*
Ardeidae	*Mesophoyz intermedia*		*Pericrocotus divaricatus*
Rallidae	*Amaurornis phoenicurus*	Caprimulgidae	*Caprimulgus macrurus*
Ardeidae	*Butori desstriata*	Cisticolidae	*Prinia flaviventris*
Ardeidae	*Ardeola speciosa*		*Cisticola juncidis*

Alcedinidae	*Alcedo atthis*		*Prinia rufescens*
Rallidae	*Porphyrio porphyrio*	Columbidae	*Treron vernans*
Alcedinidae	*Halcyon smyrnensis*		*Geopelia striata*
Rallidae	*Gallinule chloropus*		*Streptopelia chinensis*
Scolopacidae	*Tringa hypoleucos*		*Treron bicincta*
Scolopacidae	*Gallina gostenura*		*Treron olax*
Ardeidae	*Egretta eulophotes*		*Treron curvirostra*
Ardeidae	*Casmero diusalbus*	Coraciidae	*Eurystomus orientalis*
Anatidae	*Dendrocygna javanica*	Corvidae	*Corvus macrorhynchos*
Ardeidae	*Dupetor flavicollis*		*Corvus splendens*
Ardeidae	*Ixobrychus cinnamomeus*	Cuculidae	*Centropus bengalensis*
Columbidae	*Columba livia*		*Cacomantis merulinus*
Passeridae	*Passer montanus*		*Chrysococcyx minutillus*
Corvidae	*Corvus splendens*		*Centropus sinensis*
Sturnidae	*Aplonis panayensis*		*Clamator coromandus*
Sturnidae	*Sturnus sturninus*		*Eudynamys scolopacea*
Estrildidae	*Lonchura punctulata*	Dicruridae	*Dicrurus leucophaeus*
Pycnonotidae	*Pycnonotus goiavier*	Emberizidae	*Emberiza aureola*
Sturnidae	*Acridotheres fuscus*	Estrildidae	*Lonchura punctulata*
Estrildidae	*Lonchura malacca*		*Lonchura malacca*
Sturnidae	*Sturnus contra*		*Lonchura maja*
Megalaimidae	*Megalaima haemacephala*	Hirundinidae	*Hirundo tahitica*
Nectariniidae	*Anthreptes malacensis*	Laniidae	*Lanius cristatus*
Sturnidae	*Acridotheres tristis*		*Lanius schach*
Sturnidae	*Acridotheres javanicus*	Meropidae	*Merops philippinus*
Hirundinidae	*Hirundo tahitica*		*Merops viridis*
Estrildidae	*Lonchura maja*	Motacillidae	*Anthus richardi*
Columbidae	*Treron vernans*	Muscicapidae	*Muscicapa dauurica*
Phasianidae	*Turnix suscitator*	Nectariniidae	*Anthreptes malacensis*
Ploceidae	*Ploceus philippinus*		*Nectarinia jugularis*
Nectariniidae	*Nectarinia jugularis*		*Anthreptes simplex*
Columbidae	*Chalcophaps indica*		*Aethopyga saturata*
Dicaeidae	*Dicaeum cruentatum*		*Arachnothera longirostra*
Rhipiduridae	*Rhipidura javanica*		*Nectarinia calcostetha*
Chloropseidae	*Aegithina tiphia*		*Nectarinia sperata*
Sylviidae	*Acrocephalus orientalis*		*Anthreptes rhodolaema*

Nectariniidae	*Anthreptes simplex*	Oriolidae	*Oriolus chinensis*
Cisticolidae	*Prinia flaviventris*	Pachycephalidae	*Pachycephala grisola*
Pycnonotidae	*Pycnonotus plumosus*	Passeridae	*Passer montanus*
Zosteropidae	*Zosterops palpebrosus*	Phasianidae	*Gallus gallus*
Sylviidae	*Orthotomus sutorius*		*Coturnix chinensis*
Picidae	*Picumnus innominatus*	Picidae	*Dinopium javanense*
Cuculidae	*Centropus sinensis*		*Celeus brachyurus*
Muscicapidae	*Muscicapadauurica*		*Chrysocolaptes lucidus*
Columbidae	*Streptopeliachinensis*		*Picumnus innominatus*
Turdidae	*Copsychussaularis*	Ploceidae	*Ploceus philippinus*
Columbidae	*Geopeliastriata*	Pycnonotidae	*Pycnonotus goiavier*
Cisticolidae	*Cisticolajuncidis*		*Pycnonotus plumosus*
Sylviidae	*Orthotomusruficeps*	Rhipiduridae	*Rhipidura javanica*
Motacillidae	*Anthusnovaeseelandiae*	Sturnidae	*Acridotheres fuscus*
Cuculidae	*Eudynamysscolopacea*		*Acridotheres tristis*
Phasianidae	*Gallus gallus*	Sturnidae	*Aplonis panayensis*
Chloropseidae	*Aegithinaviridissima*		*Acridotheres grandis*
Meropidae	*Meropsviridis*		*Gracula religosa*
Oriolidae	*Orioluschinensis*	Sylviidae	*Acrocephalus orientalis*
Laniidae	*Laniuscristatus*		*Orthotormus sutorius*
Meropidae	*Meropsphilippinus*		*Orthotomus ruficeps*
Nectariniidae	*Arachnotheralongirostra*		*Orthotomus sericeus*
Picidae	*Celeusbrachyurus*		*Phylloscopus borealis*
Campephagidae	*Lalage nigra*		*Locustella certhiola*
Cuculidae	*Cacomantismerulinus*	Turdidae	*Copsychus saularis*
Corvidae	*Corvusmacrohynchos*	Turnicidae	*Turnix suscitator*
Picidae	*Dinopiumjavanense*	Alcidinidae	*Halcyon smyrnensis*
Nectariniidae	*Anthreptesrhodolaema*		*Alcedo atthis*
Cuculidae	*Centropusbengalensis*	Anatidae	*Dendrocygna javanica*
Picidae	*Picoidesmoluccensis*		*Nettapus coromandelianus*
Cuculidae	*Cacomantissolleratii*	Ardeidae	*Ardea purpurea*
Passeridae	*Passer domesticus*		*Ixobrychus sinensis*
	Pycnonotusjocosus		*Ixobrychus cinnamoneus*
	Macrnousgulais		*Butorides striatus*
	Dicrurusmacrocercus		*Nycticorax nycticorax*
	Elanuscaeruleus		*Ardea cinerea*

	Arachnotheraflavigaster		*Ixobrychus eurhythmus*
	Avicedaleuphotes		*Chasmerodius albus*
	Cuculusmicropterus		*Egretta garzetta*
	Accipiter gularis		*Vanellus indicus*
	Lonchuraleucogastroides		*Hydrophasianus chirurgus*
	Caprimulgusmacrurus		*Tachybaptus ruficollis*
	Laniusschach		*Porphyrio porphyrio*
	Treroncurvirostra		*Amaurornis phoenicurus*
	Chrysococcyxxanthorhynchus		*Gallinula chloropus*
	Arachnotherachrysogenys		*Porzana cinerea*
	Phylloscopus borealis		*Porzana pusilla*
	Ketupaketupu		*Gallicerx cinerea*
	Eurystomusorientalis		*Gallirallus striatus*
	Psittaculalongicauda		*Gallinago stenura*
	Eurostopodustemminckii		*Tringa hypoleucos*
	Spilornischeela		*Milvus migrans*
	Haliaeetusleucogaster		*Spilornis cheela*
	Megalaimahenricl		*Collocalia esculenta*
			Hirundapus giganteus
			Cypsiurus balasiensis
			Bubulcus ibis
			Hirundo rustica
			Lanius tigrinus
			Sterna albifrons
			Aethopyga siparaja
			Gerygone sulphurea
			Orthotomus atrogularis

Table 2: List of individual birds in Paya Indah and Putrajaya wetlands.

Site occupancy estimates of avian species in Payaindah and Putrajaya Wetlands, Peninsular Malaysia is presented in Table 3. Payaindah and Putrajaya wetlands recorded the same naïve occupancy by terrestrial birds (NO=1.00) and occupancy estimate (Ψ=1.00 ± 0.00) with CI (0.00-1.00). Likewise, both sites had the same occupancy estimates by water birds (Ψ=0.98 ± 0.02). But, Putrajaya wetlands recorded a higher naïve occupancy by water birds (NO=98), while Payaindah wetlands had the least recorded a higher naïve occupancy by water birds (NO=0.96). However, Putrajaya wetlands had a higher detection probability of terrestrial birds (P=0.46 ± 0.01) with CI (0.45 -0.48), while Payaindah wetlands had the least detection probability of terrestrial birds (P=0.24 ± 0.01) with CI (0.23-0.26). Also, Putrajaya wetlands recorded a higher detection probability of water birds (P=0.47 ± 0.01) with CI (0.46-0.48), while Payaindah wetlands had the least detection probability of water birds (P=0.25 ± 0.01) with CI (0.24-0.26).

Lakes	Payaindah Wetlands		Putrajaya Wetlands	
	Terrestrial birds	Water birds	Terrestrial birds	Water birds
NO	1	0.96	1	0.98
Ψ ± SE	1.00 ± 0.00	0.98 ± 0.02	1.00 ± 0.00	0.98 ± 0.02
CI	0.00-1.00	0.87-1.00	0.00-1.00	0.88-1.00

P ± SE	0.24 ± 0.01	0.25 ± 0.01	0.46 ± 0.01	0.47 ± 0.01
CI	0.23-0.26	0.24-0.26	0.45-0.48	0.46 -0.48

Table 3: Site occupancy estimates of avian species in Payaindah and Putrajaya Wetlands, Peninsular Malaysia.

NO:naïve occupancy; Ψ:occupancy estimate; SE:standard error; CI: 95% confidence interval (specified by Program PRESENCE output), P:detection probability.

Discussion

Avian species are exceptionally versatile animals that frequently display unmistakable relationship with specific habitat [19,20]. Observing the avian density among various natural surroundings give data about population variety in a specific habitat [13,21,22]. The total sum of avian species recorded in Payaindah and Putrajaya wetlands showed that it is an appropriate habitat suitable for various avian species. Moreover, information on avian study demonstrated that bird's density in both wetlands fluctuated in various environments relying upon vegetation structure and composition, accessibility of nourishment assets, event of reasonable scavenging, settling and chick raising locales and furthermore encompassed scene. Vegetation composition of these wetlands contains trees, bushes, grasses, emergent and submerged vegetation, reeds, sedges, greeneries and herbs.

The heterogeneity of vegetation has made different layers, for example, shade layer, bush layer and ground vegetation layer, i.e. grasses and water vegetation (New and submerged vegetation) that pulled in a wide cluster of avian species. The shelter layer of the wetland hold is inadequately circulated along the edges of water bodies and someplace thick stands of trees and bushes in the dry land. Besides, the bushes possess the vegetation underneath five meters' tallness under trees and along the banks of lakes, while the ground layer comprises of herbaceous plants, for example, grasses, reed beds of sedges and developing vegetation. Assorted variety of vegetation structure and piece gives physical design trademark to wetland living spaces and pull in decent variety of bird's species, in light of the fact that vegetative structure and arrangement is an essential proximate factor that figures out where and how fowls utilize assets, influencing natural surroundings choice, affected the species abundance, distribution, diversity and density [12,23-28].

Above all, this investigation uncovered that Payaindah and Putrajaya wetland marsh swamps of this wetland encourage higher birds' density. This is likely because of lavishness and assorted variety of vegetation of rising vegetation (Water Chestnuts, Marsh Sedges, Water Lilies, Water-Milfoils, and Bulrushes), accessibility of plenteous nourishment sources (spineless creatures, vegetable, fishes, amphibians, reptiles, and mammals), shelter from harsh weather and predators, suitable nesting and chick rearing sites as reported by earlier studies [13,26,29]. Emergent vegetation apparently goes about as an extreme factor, as it gives nourishment, settling locales and cover for swamp hen, crakes, moorhens, songbirds. The grasses along the edges of swamps offer settling reason for ducks, water hens, and water cocks. This showed avian species select living spaces that give an ideal blend of assets to enable them to play out different exercises, for example, scavenging, reproducing, perching and settling.

It has been accounted for that both wetland marsh swamps have the most astounding avian assorted variety than other wetland writes and are the most vital normal instrument for keeping up water quality to help avifaunal decent variety to satisfy their day by day necessities and multiplication [27,28]. The avian density and assorted variety is related with the accessibility of sustenance, natural surroundings condition and safe rearing locales and furthermore abiotic factors, for example, soil, temperature and relative humidity [28,30]. These elements thus influence the wetland subordinate networks and additionally the biological community characteristic, for example, species abundance, diversity and density [29]. Moreover, climate and atmosphere conditions likewise assume a huge part in avian populace influencing their rearing and wintering grounds, accessibility of nourishment assets specifically and in a roundabout way [31]. Besides, the landing and flight of transitory feathered creature species additionally impact avian species wealth and sustenance assets [32-37].

Conclusion

This study showed that Paya Indah and Putrajaya Wetland Reserve incorporates heterogeneous vegetation that offers diverse living spaces and sustenance assets for a wide exhibit of avian species. Besides, this investigation additionally uncovered that marsh swamp man-made surroundings pulled in higher bird's density when contrasted with different marshes, vast water body, dry land and bushes patches. Wetland loss also aggravates climatic disturbances by increasing carbon build up in the atmosphere. As Malaysia is prone to recurrent drought, the consequences of wetland loss could aggravate the situation of resident and migratory bird population. The loss of wetland resources could affect the hydrological cycle which in turn leads to a shortage of water and decline of irrigation development options. In addition, wetlands of Malaysia are major shelters for aquatic and terrestrial biodiversity; endemic fishes, birds and other life forms depend on wetlands. Loss of these wetlands is devastating to several endemic species and particularly to wetland dependent species. There is a wide range of different ways in which land use and wetlands can interact, both spatially and in terms of their characteristics ecological, socio-economic and political that linked to the functional roles of bird communities. Therefore, there are a need to develop awareness on stakeholders to commit in to delivering positive biological outcomes, developing the national, regional ecological network on land to restore health and connectivity of wetlands. There is an increasing realization that the impacts of species loss from ecosystems might be large enough to rival the impacts of other global drivers affecting our environment such as climate change. Wetlands directly and indirectly affect bird population even though it is rarely linked to the development index of avian populations. The degree of threat to the country's wetlands is critical and urgent action in policy development and on the ground implementation is required.

Conflicts of Interest

The authors declare no conflicts of interest.

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