SPATIAL DYNAMICS AND COMPOSITION OF WATERBIRDS IN JAFFNA AND KILINOCHCHI DISTRICTS, SRI LANKA

***G. Kandasamy*[1*], *D.K. Weerakoon*[2], *A. Sivaruban*[1] *H.B. Jayasiri*[3]**

[1] *Department of Zoology, University of Jaffna, Sri Lanka.*

[2] *Department of Zoology, University of Colombo, Sri Lanka.*

[3.] *Ocean University of Sri Lanka*

Species composition, diversity and abundance of waterbirds will vary spatially based on their habitat requirements for foraging, resting, roosting or breeding. Although the northern region of Sri Lanka consists of unique bird species and migrant entry points, the region was inaccessible for three decades due to the armed conflict. Based on the habitat variability, the present study was carried out in eight study sites namely, Mandaitivu, Mankumban, Kayts-Araly Road, Kavutharimunai, Pallai, Thadduvankoddy, Sarasalai and Nagarkovil from December 2016 to November 2018 to document the spatial distribution patterns of waterbird communities. The block count method was carried out for counting of waterbirds. In this method, each site was divided into 500 m blocks along a line transect. Each block was separated at least by 500 m to avoid double counting. Altogether 82 waterbird species belonging to 20 families were recorded. Among them, 44 were migrants while 38 were breeding residents. The most dominant species is Northern Pintail (*Mareca penelope*), followed by Greater Flamingo (*Phoenicopterus roseus*) and Black-tailed Godwit (*Limosa limosa*). Abundance of birds were transformed into densities (number of birds km^{-2}). Kruskal-Wallis test revealed that density of waterbirds varied significantly among eight study sites (Kruskal-Wallis test, H = 40.120, $p < 0.01$). That might be due to habitat heterogeneity and available microhabitats with water level fluctuation and migration of birds. According to the hierarchical agglomerative cluster analysis (SPSS, 14.0), dendrogram on density of waterbirds separated Sarasalai from all other sites. Sarasalai is with the highest species richness (71) and mean species density (2834.33) due to the rich habitat heterogeneity comprising a mosaic of habitats for a wide array of waterbirds. Pallai was separated from all other sites. That might be due to the lowest density of waterbirds (335.17) which may be due to the disturbances caused by the nearby wind farm. The present study revealed that Sarasalai was the richest site in terms of density of waterbirds, followed by Thadduvankoddy, Mankumban and Nagarkovil. Sarasalai showed rich habitat heterogeneity including mangroves, saltmarsh, mudflats and scrublands and had shallow waters throughout the year. Thus, conservation of these wetlands is important for the conservation of waterbirds in the northern region of Sri Lanka.

Keywords: Composition, Jaffna, Kilinochchi, spatial, waterbirds

[*] *Corresponding Author:* [*]*vadhana.gk@univ.jfn.ac.lk*

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INTRODUCTION

Species composition, diversity and abundance of waterbirds will vary spatially based on their habitat requirements for foraging, resting, roosting or breeding. It is important to establish such spatial patterns as wetland ecosystem management should be based on regional specific knowledge about habitat requirements of various species that make up the waterbird community at a given wetland (Zhang *et al.*, 2017).

In a wetland, several species of waterbirds can coexist due to resource partitioning through a combination of foraging habitat, diet and foraging style. Thus, waterbirds can be classified into foraging guilds using these factors (Gatto, *et al.*, 2008). Root (1967) defined guilds as a group of species that exploits the same class of environmental resources in a similar way. Guilds are ecological units of various communities that are useful for understanding the structure of communities. Further, guild structure of a given wetland serves as an ecological indicator of habitat quality and heterogeneity (Chatterjee *et al.*, 2020).

Although the northern region contains a number of significant waterbird habitats, only few studies have been done on the waterbirds as the region was inaccessible nearly for three decades due to the armed conflict. After the culmination of the war several studies have been done (Rajkumar and Wijesundara, 2014; Wijesundara *et al*., 2018), which focused mainly on documenting the baseline conditions with respect to waterbirds such as diversity and abundance rather than interpreting ecological requirements and habitat usage patterns of waterbirds.

METHODOLOGY

Bird counting was carried out once a month at eight study sites. Bird counting was carried out at regular intervals from December 2016 to November 2018. Based on the habitat variability, the study was carried out in eight study sites (Figure 1), namely, Mandaitivu in the Island South Divisional secretariat division (Divisional Secretariat Division (DSD) (9 ^{0} 37’ 28” N, 79 ^{0} 59’ 52” E), Mankumban in the Island South DSD (9 ^{0} 38’ 31” N, 79 ^{0} 56’ 28” E), Kayts in the Island North DSD (9 ^{0} 40’ 17” N, 79 ^{0} 55’ 30” E), Kavutharimunai in the Pooneryn DSD (9 ^{0} 34’ 42” N, 80 ^{0} 06’ 24” E), Pallai wind farm in the Pachchilappalli DSD (9 ^{0} 35’ 59” N, 80 ^{0} 18’ 60” E), Thadduvankoddy in the Kandavalai DSD (9 ^{0} 30’ 0” N, 80 ^{0} 25’ 0” E), Sarasalai in the Vadamaradchi South West DSD (9 ^{0} 44’ 09” N, 80 ^{0} 10’ 48” E), and Nagarkovil in the Vadamaradchi East DSD (9 ^{0} 36’ 00” N, 80 ^{0}17’ 00” E). Thadduvankoddy area is closer to the Chundikulam National Park.

Figure 1: The eight study sites denoted with numbers 1:Mandaitivu, 2:Mankumban, 3:Kayts, 4:Kavutharimunai, 5:Pallai, 6:Thadduvankoddy, 7:Sarasalai and 8:Nagarkovil.

Bird counting

The block count method was carried out for counting of waterbirds. A line transect was established in each site, considering the vegetation variability and availability of water. This method of bird counting was utilized to evaluate windfarm in Mannar, Sri Lanka (SRI Wind power project, 2017). The entire transect belt was divided into three counting blocks in length of 500 m with open width in each study site. Each block was separated at least by 500 m to avoid double counting of birds as most were open areas. Each block was marked to increase the clear visibility. All the waterbirds seen on either side of the transects up to 500 m were counted during dawn, noon or dusk on alternate months from 0600 h – 1800 h to capture temporal variation by walking along the transect line in each block.

RESULTS AND DISCUSSION

Altogether 82 waterbird species belonging to 20 families were recorded at the eight study sites. Among them, 44 were migrants while 38 were breeding residents. Abundance of birds were transformed into densities (number of birds km^{-2}) to compare differences among study sites. The most dominant species is Eurasian wigeon (*Mareca penelope*), which accounted for 20.10 % of the total number of individuals recorded with a mean density of 1433.17 Individuals/km^2, followed by Greater flamingo (*Phoenicopterus roseus*) (19.60 % of relative abundance and a mean density of 1397.34 Individuals/km^2) and Black-tailed Godwits (*Limosa limosa*) (13.05 % of relative abundance and a mean density of 930.83 Individuals/km^2) (Figure 2).

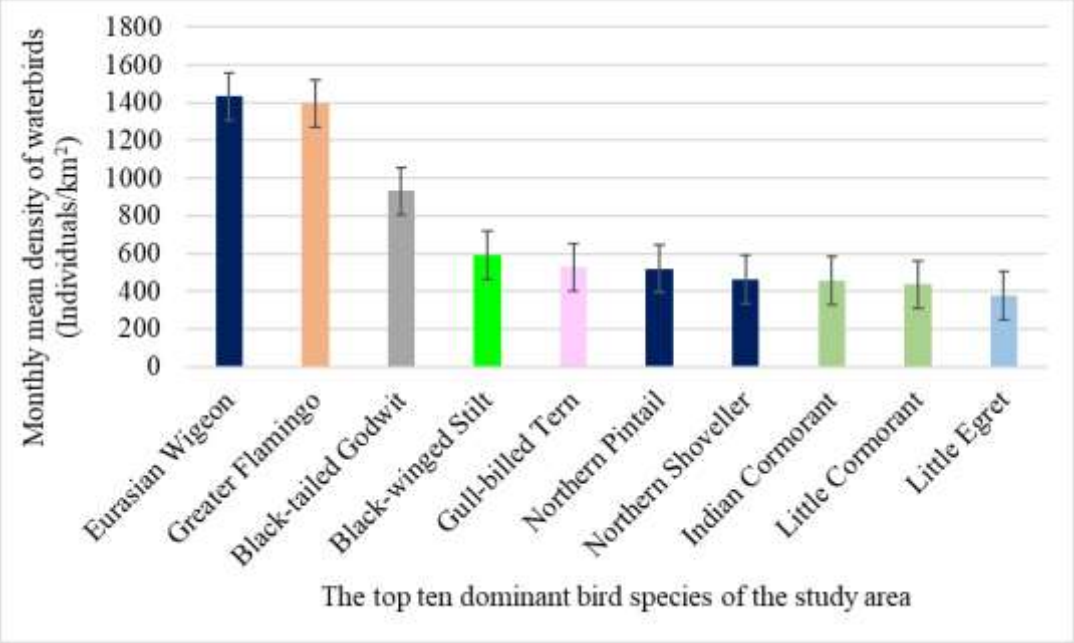

Figure 2: Mean density of the ten most dominant waterbird species in the eight study sites, Mandaitivu, Mankumban, Kayts, Sarasalai and Nagarkovil in the Jaffna district and Kavutharimunai, Pallai and Thadduvankoddy in the Kilinochchi district (Colour codes are given based on their foraging guilds).

The highest species richness (71), mean density of waterbirds (2834.33), and diversity (Margalef's *d*= 7.19) were recorded in Sarasalai (Table 1). The, mosaic of habitats present in Sarasalai, including mangroves, saltmarshes, open shallow water pools, coastal scrublands, coastal shoreline, offshore sandbars, sand flats and mudflats as well as availability of year-round shallow water have contributed as significant waterbird habitats that supports a wide array of waterbird species. The present study revealed that Sarasalai was the richest site in terms of density of waterbirds, followed by Thadduvankoddy, Mankumban and Nagarkovil.

Table 1: Comparison of species richness, monthly mean density of birds (birds km^{-2}) ± standard deviation (SD) and Shannon – Wiener diversity, Pielou's Evenness, Margalef's richness and Berger-Parker dominance Indices among eight study sites.

	Mandaitivu	**Mankumban**	**Kayts**	**Kavutharimunai**	**Pallai**	**Thadduvankoddy**	**Sarasalai**	**Nagarkovil**
Species Richness	62	57	51	35	41	58	71	59
Monthly mean density (birds km^{-2}) ± SD	1193.33 ± 16.42	1989.33 ± 31.47	1372.33 ± 22.23	785.67 ± 29.31	335.17 ± 6.99	2146.33 ± 43.78	2834.33 ± 40.68	1744.67 ± 31.19
Shannon Wiener Diversity Index	3.26	2.98	3.12	2.59	2.49	2.73	3.24	2.26
Simpson Diversity Index	18.83	14.74	14.17	7.98	9.13	9.13	15.74	11.35
Pielou's Evenness Index	0.79	0.74	0.79	0.73	0.67	0.67	0.76	0.55
Margalef's Richness Index	6.87	5.97	5.55	4.02	5.26	6.13	7.19	6.27
Berger Parker Dominance Index	0.11	0.17	0.20	0.29	0.25	0.25	0.14	0.19

Cluster analysis

Cluster analysis was used to detect similarity groups between the sampling sites (Iscen *et al.*, 2008). Dendrogram shows similarity among eight study sites, in terms of density of waterbird species, showing spatial variation of waterbirds of three selected counting blocks. Spatial variation can be interpreted in this way.

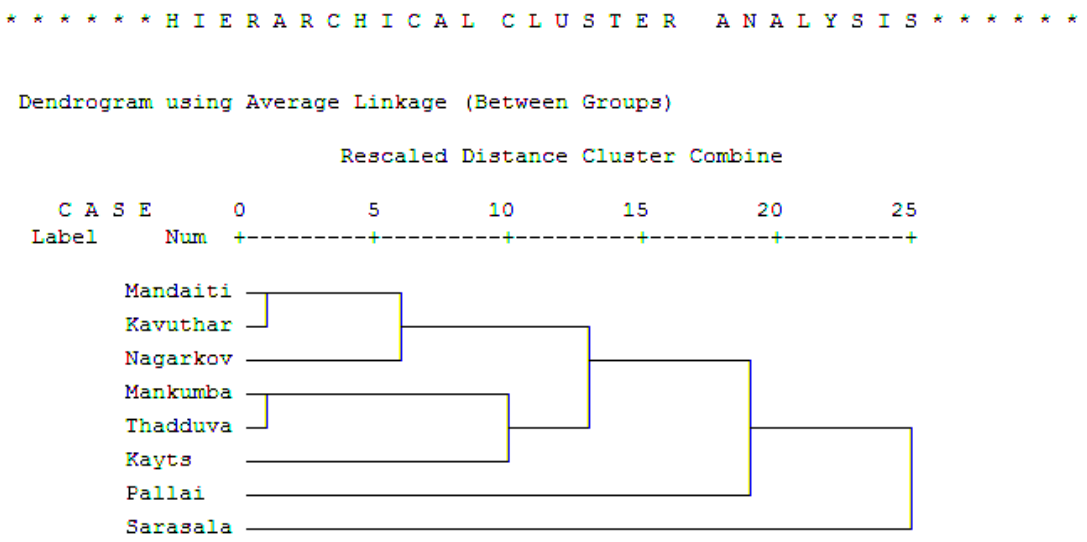

Figure 3: Dendrogram representing the similarity among eight study sites based on square-root transformed density of waterbirds (grouped by sites) among sites. There were four major clusters of similarities: 1) Mandaitivu, Kavutharimunai and Nagarkovil 2) Mankumban, Thadduvankoddy and Kayts 3) Pallai 4) Sarasalai.

In the cluster dendrogram, Sarasalai was separated from all other sites (Figure 3), which can be attributed to Sarasalai having the highest mean species density (2834.33 Individuals/km^2). Sarasalai is rich in habitat heterogeneity comprising a mosaic of habitats such as mangroves, saltmarshes, mudflats, sand flats, scrublands and paddy fields providing a range of microhabitats for a wide array of waterbirds. Further, the site at Sarasalai is covered with shallow water throughout the year and supports a diverse vegetation.

Kruskal-Wallis test

Kruskal-Wallis test (Table 2) revealed that density of Waterbirds varied significantly among eight study sites (Kruskal-Wallis test, H = 40.120, p *<0.01*). This could be attributed to the habitat heterogeneity among the study sites which provided microhabitats for various guilds of waterbird species.

Table 2: Summary of the Kruskal – Wallis test for density of waterbirds among eight study sites [a]: Kruskal-Wallis test, [b]: grouping variable - site.

Test statistics [a,b]	Density of Waterbirds
H value	40.12
p	0.000

CONCLUSIONS/RECOMMENDATIONS

Eurasian Wigeon (*Mareca penelope*) was the dominant species observed in the northern region followed by Greater Flamingo (*Phoenicopterus roseus*) and Black-tailed Godwit (*Limosa limosa*). Greater Flamingos (*Phoenicopterus roseus*) are uncommon in other parts of Sri Lanka, but recorded year-round in the northern region. Mandaitivu, Mankumban, Kayts, Thadduvankoddy, Sarasalai and Nagarkovil are suitable habitats to observe Greater Flamingos in the northern region of Sri Lanka. As they are major tourist attractions, the northern region is an important birding location for avitourists in Sri Lanka where Greater Flamingos (*Phoenicopterus roseus*) can be observed even beyond the migratory season.

Sarasalai was the richest site in terms of density of waterbirds, followed by Thadduvankoddy, Mankumban and Nagarkovil.

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