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SPECIES DIVERSITY OF WETLAND BIRDS IN DRY ZONE SEASONAL RESERVOIRS IN SRI LANKA

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Abstract
The quantification of species diversity is essential in several aspects of ecology, including conservation biology, and as an indicator of the well-being of ecological systems. However, species diversity of the wetland birds in the seasonal reservoirs in the dry zone of Sri Lanka has received very little attention. In the present study, an attempt was made to determine the species diversity of wetland birds of 20 seasonal reservoirs in Anuradhapura and Monaragala Districts during both migratory and non-migratory seasons. A total of 46 species of aquatic birds belonging to 17 families (represent 7 orders) were recorded during the present study in selected seasonal reservoirs in the two districts. Overall, both bird species richness and abundance were higher in Anuradhapura district compared to Monaragala District. However, there were more bird species in both districts during migratory seasons. We have detected significant seasonal differences in species diversity estimated by both the Shannon-Wiener Index ($F=3.926$; $P<0.1$) and Simpson's Index ($F=3.718$; $P<0.1$). This suggests that there was a significantly higher diversity of wetland birds during the migratory season. Species-area relationships suggested that the species richness of wetland birds associated with seasonal reservoirs would increase as the reservoir size increases. However, these relationships represented weak correlations (R^2 range = 0.331–0.645). Overall our study indicates that seasonal reservoirs in Sri Lanka support a diverse community of wetland birds and provide a strong example for a case of enhancement of biological diversity through human activities by creating artificial habitats.

***Keywords*:** Anuradhapura, aquatic birds, avifaunal diversity, Monaragala, species-area relationship

Introduction

Birds are an integral part of most freshwater ecosystems (lakes, rivers, marshes, etc.). Freshwater ecosystems support various species of birds in varying numbers. Although the birds associated with aquatic habitats are called *Wetland Birds*, there is no clear-cut definition of them. They interact with aquatic habitats for feeding, breeding and roosting. Certain bird

species live in areas close to the water, but others breed and feed in aquatic habitats (Mendis & Fernando, 1962; Weller, 1999). Sri Lanka supports a rich avifauna compared to its small size of landmass. There are nearly 440 bird species recorded from Sri Lanka (Warakagoda & Sirivardana, 2009), more than one third of which are wetland birds that are associated with wetland ecosystems (Legge, 1983; Kotagama & Fernando, 1995; Henry, 1998; Harrison & Worfolk, 1999; Kotagama & Ranavira, 2010). These wetland birds are mainly represented by 22 families and more than 160 species (Harrison &Worfolk, 1999; Appendix I).

Species diversity is a fundamental concept of biodiversity at the local and regional scale (Magurran, 1988; Krebs, 1999). The measurement of species diversity is essential in several aspects of ecology, including conservation biology and as an indicator of the well-being of ecological systems (Magurran, 1988; Krebs, 1999; Osborne, 2000). Investigation of bird species diversity in wetland ecosystems is timely in many ways including the bird impacts on fisheries, bird contributions to biological cycles, the influences of birds on the trophic status of ecosystems, and the status of bird populations for regional conservation efforts (Weller, 1999).

In Sri Lanka, there are over 10,000 small village irrigation reservoirs (<300 ha) in addition to large and medium sized (>300 ha) perennial reservoirs. The total extent of these inland reservoirs is about 175,000 ha, which gives a value of about 2.7 ha for every km^2 of the island (Fernando, 1993). Most village reservoirs are seasonal as they collect rainwater during the inter-monsoonal rainy season from November–January every year and dry off during August–October. These seasonal reservoirs in the dry zone of Sri Lanka are very productive (De Silva, 1988), supporting rich bird communities by providing them both feeding and breeding grounds. However, the species diversity of the aquatic birds of these seasonal reservoirs has received very little attention.

In the present study, we investigated the species diversity of wetland birds during migratory and non-migratory seasons in 20 seasonal reservoirs in Anuradhapura and Monaragala Districts, the two largest districts in the dry zone of Sri Lanka. Additionally we attempted to test the species-area relationships between wetland bird species richness and reservoir area (McArthur & Wilson, 1967).

Materials and Methods

***Study area*:** The study was carried out in 20 seasonal reservoirs in Anuradhapura and Monaragala Districts of the dry zone of Sri Lanka (Table 1). Mean annual temperature in the dry zone of the country is 30°C and the annual rainfall in the study area is below 195 cm, which falls mainly in the two inter-monsoonal periods from November to January and from May to July (Source: Meteorological Dept., Colombo, Sri Lanka).

Table 1: Area of the selected seasonal reservoirs for the present study (Source: DAS, 2000a, b).

District	Reservoir	Abbreviation	Area (ha)
Anuradhapura	Bulankulama	A1	8.16
	Buruthawewa	A2	2.04
	Gambirigaswewa	A3	4.89
	Hinguruwelpitiya	A4	2.44
	Karambegama	A5	10.40
	Katugampolagama	A6	4.89
	Lolugaswewa	A7	4.48
	Mahawewa	A8	10.61
	Meegahawewa	A9	4.89
	Meegassegama	A10	8.47
	Sandanankulama	A11	28.00
Monaragala	Akkarawissa	M1	8.16
	Dosarawewa	M2	18.36
	Bodagama	M3	12.24
	Galwalewewa	M4	2.85
	Meegaswewa	M5	17.95
	Batala-ara	M6	6.53
	Senasumawewa	M7	37.55
	Walaskema-ara	M8	12.24
	Watagala-ara	M9	4.89

***Field observations*:** The studies were conducted between January and October, 2003. Birds were counted in each reservoir once in the migratory season (mid-August–April) and once in the non-migratory season (May–August) (Legge, 1983). The counts were made by point transect method (Sutherland, 1997) with multiple point counts at 100 m intervals along a transect. A pair of binoculars (12 x 24) was used for the counts. Only the birds flying left to right were only counted to avoid multiple counting of the same

bird. Birds which were found within about a five-meter belt of the shoreline of the reservoir were counted. These counts included the birds, which roosted on the trees and bushes within the defined limit and those which flew over the water surface within a vertical distance of about 10 meters (*i.e.*, terns, kingfishers, cormorants etc.). In Akkarawissa Reservoir (M1) and Batala-ara Reservoir (M6) in Monaragala District however, counting of aquatic birds during the migratory season could not be made due to unavoidable circumstances.

***Determination of species diversity indices*:** The species diversity of aquatic birds in the non-perennial reservoirs studied was determined using several species diversity indices. Margalef's Diversity Index (D_{Mg}) (Clifford & Stephenson, 1975) was determined for aquatic birds in individual reservoirs for the migratory and non-migratory seasons separately.

$D_{Mg} = (S - 1) / \ln N$ ……...…… (1)
where, S is the number of species recorded and N is the number of individuals summed over all S species.

The heterogeneity of aquatic birds was measured by the Shannon-Weiner Index (H') of species diversity (Krebs, 1999) for individual reservoirs during the two seasons separately.

$H' = -\sum P_i \ln P_i$ ……..…… (2)
where, P_i is the proportion of individuals found in the i^{th} sample.

Evenness was determined by Simpson's Index (D) (Magurran, 1988) for the migratory and non-migratory seasons separately.

$D = \sum [(n_i(n_i - 1) / N(N - 1)]$ ……..…… (3)
where, n_i is the number of individuals in the i^{th} sample and N is the total number of individuals.

Spatial (*i.e.* Anuradhapura and Monaragala Districts) and temporal (*i.e.* migratory and non-migratory seasons) differences of diversity were tested using two-way ANOVA considering an alpha level of 0.1.

***Determination of species-area relationship*:** Species-area relationships were determined according to MacArthur & Wilson (1967). Species richness was defined as the total number of bird species observed throughout the sampling period and the data on reservoir area were obtained from the Agrarian Development Department (Anon, 2000 a, b). The relationships were obtained by linear regression analysis for log-transformed data of species richness and reservoir area for two districts and for two seasons separately.

Results

***Species Diversity*:** A total of 46 species of wetland birds was recorded in 20 seasonal reservoirs in Anuradhapura and Monaragala Districts. They belong to 17 families under 7 orders (Appendix II). A total of 1917 individuals of wetland birds belonging to 40 species were recorded from Anuradhapura District during migratory and non-migratory seasons. This included 113 (5.9%) individuals of 8 (20%) species of migratory birds. In Monaragala District, 727 individuals, belonging to 34 species were recorded in both seasons, including 155 (21.3%) individuals of 7 (20.6%) species of migratory birds. The composition of resident and migratory birds in migratory and non-migratory seasons in both districts is given in Table 2. Overall, both bird species richness and abundance were higher in Anuradhapura District compared to Monaragala District. However, there were more bird species in both districts during the migratory season (Fig. 1: pl. 5).

Table 2: Species composition of resident and migratory birds in two seasons in two districts.

District	Migratory	Non-migratory
Anuradhapura		
Resident	24 (75.0%)	26 (96.3%)
Migratory	8 (25.0%)	1 (3.7%)
Total	32	27
Monaragala		
Resident	22 (78.6%)	24 (85.7%)
Migratory	6 (21.4%)	4 (14.3%)
Total	28	28

The majority of wetland birds in both Anuradhapura and Monaragala Districts belong to order Ciconiformes (herons, egrets, storks, and bitterns) and order Charadriiformes (jacana, plovers, sandpipers, and terns). In Anuradhapura District, 34.4% of birds belong to order Ciconiiformes in the migratory season and 37% in the non-migratory season. Order Charadriiformes was represented in Anuradhapura District by 43.8% during the migratory season and only 18.5% during the non-migratory season. In Monaragala District, 35.7% of birds of order Ciconiiformes were recorded both during migratory and non-

migratory seasons. Order Charadriiformes was also represented by the same proportion of birds *i.e.* 35.7%, during both seasons in Monaragala District. The minority of the wetland birds was represented by the families of Podicipediformes, Pelecaniformes, Anseriformes, Gruiformes and Coraciformes (Fig. 2: pl. 5). There were no significant differences in bird species richness estimated by Margalef's Index between districts (F=0.002; P=0.961) or seasons (F=0.486; P=0.491) with non-significant interactions (F=1.421; P=0.241). However, we have detected significant seasonal differences of species diversity estimated by both the Shannon-Wiener Index (F=3.926; P <0.1) and Simpson's Index (F=3.718; P <0.1). This suggests that there was a significantly higher diversity of wetland birds during the migratory season (Table 3; Fig. 3: pl. 6).

***Species-Area relationships*:** Generally, four species-area relationships calculated (2 seasons and 2 districts separately) showed positive correlations as expected (Table 4; Fig. 4: pl. 6). This suggests that the species richness of wetland birds associated with seasonal reservoirs would increase as the reservoir size increases. However, these relationships represent weak correlations (R^2 range = 0.331–0.645). The strongest correlation was found for the migratory season in Monaragala district (R^2=0.645). Furthermore, lumping of data between two districts for migratory and non-migratory seasons generated much weaker positive correlations for species-area relationships (migratory season: R^2=0.377; non-migratory season: R^2=0.136). It should be noted that some reservoirs represented outliers. In Anuradhapura District during the migratory season, two data points corresponding to Lolugaswewa Reservoir (A7) and Meegahawewa Reservoir (A9) had exceptionally high and exceptionally low species richness respectively. Similarly in Monaragala District, Galwalewewa Reservoir (M4) during both seasons and Watagala-ara Reservoir (M9) during the non-migratory season were outliers.

Table 3: A two-way ANOVA summary table comparing spatial (*i.e.* districts) and temporal (*i.e.* seasons) differences of wetland bird diversity; d.f., degrees of freedom; Sum Sq., sum of squares; Mean sq., mean squares.

Source of variance	d.f.	Sum Sq.	Mean Sq.	F value	*p* value
Margalef's Index (D_{Mg})					
District	1	0.001	0.001	0.002	0.961
Season	1	0.289	0.289	0.486	0.491
District x Season	1	0.845	0.845	1.421	0.241
Error	34	20.220	0.595		
Shannon-Wiener Index (H')					
District	1	0.120	0.120	0.272	0.605
Season	1	1.725	1.725	3.926	0.056
District x Season	1	0.413	0.413	0.941	0.339
Error	34	14.937	0.439		
Simposon's Index (1-D)					
District	1	0.000	0.000	0.017	0.895
Season	1	0.069	0.069	3.718	0.062
District x Season	1	0.000	0.000	0.002	0.968
Error	34	0.631	0.019		

Table 4: Species-area relationships of wetland birds during two seasons in two districts; S, species richness; A, reservoir area; R^2, coefficient of determination; r, correlation coefficient; ns, non-significant.

District / Season	Relationship	R^2	r	Significance
Anuradhapura				
Migratory	ln S = 0.6787 + 0.3243 ln A	0.323	0.477	ns
Non-migratory	ln S = 0.8079 + 0.3256 ln A	0.331	0.575	ns
Monaragala				
Migratory	ln S = 0.8796 + 0.1537 ln A	0.645	0.803	ns
Non-migratory	ln S = 0.8222 + 0.1363 ln A	0.382	0.618	ns

Discussion

During the present survey 46 species of wetland birds were encountered from sampled seasonal reservoirs in Anuradhapura and Monaragala Districts. They represented about 25% of wetland birds recorded in Sri Lanka (see Appendix I). Of the 46 species, the spot-billed pelican *Pelecanus philippensis*, the greater painted-snipe *Rostratula benghalensis* and the yellow-wattled lapwing *Vanellus malabaricus* are regarded as nationally threatened. According to their global status, the spot-billed pelican is a globally Near threatened species and the Oriental darter *Anhinga melanogaster*, the black-headed ibis *Threshkiornis melanocephalus* and the painted stork *Mycteria leucocephala* are considered to be at lower risk or near threatened species (Ekaratne *et al*., 2003). In addition to wetland birds, we also observed a few other species utilizing wetland associated habitats such as the spotted dove *Strepto peliachinensis*, the rose-ringed parakeet *Psittacula krameri*, the chestnut-headed bee-eater *Merops apiaster*, and the Indian roller *Coracias benghalensis*). Furthermore, we have observed a single non-breeding adult of the white wagtail *Motacilla alba*, which is a rare migratory species in Sri Lanka, at Senasuma Wewa (Monaragala District) in January 2003 (Maduranga, 2004).

Although it is very difficult to measure the species diversity of a given community, mathematical models which consider both number of species and their relative abundance are safer to be employed in the determination of species diversity than employing models based only on the number of species (Magurran, 1988; Krebs, 1999). Therefore we assume that both the Shannon-Weiner index and Simpson's index show a true trend. Our study showed that bird diversity was significantly higher during the migratory season than in the non-migratory season presumably due to the influx of migratory bird species.

In general, the wetland bird populations tend to increase during the migratory season due to the arrival of winter migrants. However the trends in the two districts are apparently different from each other. The dry season of both Anuradhapura and Monaragala Districts coincides with the migratory season, when water levels of most seasonal reservoirs are low. Therefore, there is a restricted availability of usable habitats, which can support wetland birds in seasonal reservoirs during the migratory season. It is also known that most of the migrants (mainly weak flyers) that enter from the Jaffna Peninsula and those arriving along the Andaman route, travel along the eastern coast or fly directly inland following river systems (Kotagama & Ratnavira, 2010). These may be the reasons for the drop off in species diversity of in seasonal reservoirs in Anuradhapura District during the migratory season, and for the differences in species diversity in the two districts.

Restricted availability of suitable habitats leads to increase competition for limited resources, mainly for food (Osborne, 2000). The wetland birds (mostly resident species) in the seasonal reservoirs subjected to periodic drought migrate to adjacent reservoirs, which can support them. These short distance internal migrations of resident birds usually terminate at small reservoirs with sufficient water levels and vegetation or at marginal areas of the larger reservoirs of the surrounding area (S.M.H. pers. obs.). Legge (1983) stated that aquatic birds such as whistling teal *Dendrocygna javanica* and cormorants *Phalacrocorax* spp. have been observed to move from one irrigation reservoir or lagoon to another in search of food. This dispersal (Mackenzie *et al*., 1999) of resident wetland birds during periods of limited availability of food might relax the competition for food among wetland birds in seasonal reservoirs. In such situations, large aggregations of resident birds can be observed in small reservoirs with enough food resources, as reported in the present study in Lolugaswewa (A7), Anuradhapura District in October 2003. A total of 22 species of aquatic birds including 5 migratory species were observed in Lolugaswewa. The majority of the community was represented by resident species (98%). There was an exceptionally higher proportion of the lesser whistling teal *Dendrocygna javanica* (86.1%) population in Lolugas Wewa, where sufficient water level and vegetation cover occurred, compared with the seasonal reservoirs of the surrounding area during the same period.

On the other hand, mostly dried up reservoirs can still support some species of aquatic birds. Weak flyers such as the little grebe *Tachybaptus ruficollis* still remained in those reservoirs with low water level. Some other species, which are capable of tolerating low water levels such as

the Indian pond heron *Ardeola greyii*, egret species and the white-throated kingfisher *Halcyon smyrnensis* thrive on small muddy pools in reservoir beds. Also the resulting muddy beds of the reservoirs provide better feeding grounds for most migratory waders such as sandpipers *Tringa spp*. and plovers *Charadrius* spp. including two resident species, the little-ringed plover *Charadrius dubius* and the Kentish plover *C. alexandrinus*. These small migratory wading birds are well adapted to feed on small insects, worms, and mollusks etc., which are found in the mud flats (Henry, 1998; Harrison & Worfolk, 1999).

Newly arrived migratory wading birds were observed to actively feed on wet mud flats and shallow waters which were not occupied by most of the resident species. Some specialist-resident species cannot further remain in dried reservoirs probably due to the contraction of their feeding area due to low water levels. One good example is the pheasant-tailed jacana *Hydrophasianus chirurgus*, which is always found in those reservoirs where there is comparatively higher coverage of aquatic vegetation with broad floating leaves (Gunaratne, 2013).

The species diversity of aquatic birds in Monaragala District did not significantly changed between seasons. The pattern of drying-off of seasonal reservoirs in Monaragala District was similar to that of Anuradhapura District. Also, the internal short-distance migration of resident wetland birds to suitable aquatic habitats was observed to occur in both areas. There were comparatively higher populations of several species of migratory birds during the migratory season in Monaragala District than in Anuradhapura District. This is probably due to the mass aggregation of most migratory birds in the farther Southern region of Sri Lanka as a result of the termination of almost all of the major migratory flight routes in that region. The wet mud flats and shallow areas of the dried reservoirs provided them better feeding grounds. There was a clear increase in abundance of sandpipers *Tringa* spp. and the whiskered tern *Chlidonias hybridus* during the migratory season in Monaragala District. The muddy beds of the dried seasonal reservoirs provide them better feeding grounds. As a result, resource partitioning between migratory waders and resident aquatic birds may occur during migratory season in Monaragala District as well.

Reservoir size explained 38–64% of the variation in species richness of aquatic birds in the seasonal reservoirs of Monaragala District but only 23–33% of variation in Anuradhapura District. The slopes of the species-area relationships (SAR) for the seasonal reservoirs of Anuradhapura district ranged between 0.324 and 0.327, and between 0.136 and 0.154 for Monaragala District. This indicates that although they are not significantly different ($p>0.05$), the slopes of SAR in Anuradhapura District are appreciably higher than those of Monaragala District. The values of the slopes of Anuradhapura District are much higher than those recorded by previous studies (Nilsson & Nilsson, 1978; Suter, 1994) and the values of Monaragala District closely fit the values reported by Nilsson & Nilssson (1978) for water fowl species in South Swedish lakes (0.12–0.21). The greater slopes of SAR in seasonal reservoirs of Anuradhapura District may be attributed to the fact that many inland water bodies in the North Central and North Western Provinces of the island are frequently occupied by migratory birds coming to Sri Lanka through the Indian sub-continent along two major routes – Eastern and Western routes (Kotagama & Ratnavira, 2010).

Our study indicates that seasonal reservoirs in Sri Lanka support a diverse community of wetland birds. Therefore, Sri Lanka sets a good example as a case of the enhancement of biological diversity through human activities *i.e.* creation of artificial habitats in the form of reservoirs. As Fernando & De Silva (1984) stated, the reservoirs of Sri Lanka are an ancient heritage that can be treated as a modern biological resources.

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Appendix 1: The list of wetland bird families of Sri Lanka (Source: Harrison & Worfolk, 1999) associated with freshwater ecosystems. * Mainly found in seas & coastal areas, but several species are often found in freshwater ecosystems.

Family (representative groups)	No. of species	Family (representative groups)	No. of species
Podicipedidae (grebes)	1	Jacanidae (jacanas)	1
Pelecanidae (pelicans)	2	Rostratulidae (painted snipes)	1
Phalacrocoracidae (cormorants)	3	Dromadidae (crab plovers)	1
Anhingidae (darters)	1	Haematopodidae (oystercatcher)	1
Ardeidae (herons, egrets, bitterns)	17	Recurvirostridae (avocets & stilts)	2
Ciconiidae (storks)	7	Burhinidae (thick-knees)	2
Threshkiornithidae (ibises, spoonbills)	3	Glareolidae (courser, pratincoles)	4
Phoenicopteridae (flamingos)	2	Charadriidae (plovers)	13
Anatidae (ducks, gees)	18	Scolopacidae (curlew, sandpipers, snipes)	39
Pandionidae (ospreys)	1	Laridae * (gulls & turns)	26
Rallidae (rails, crakes, coots)	11	Alcedinidae (kingfishers)	7
		Total	**163**

Appendix 2: List of wetland birds recorded during the present study and their local status (Harrison & Worfolk, 1999); * The resident population is supplemented by migrant birds in winter; ** The resident population is supplemented by winter visitors of race *C. dubius curonicus*; *** A loiterer is a bird, that resists the urge to migrate, staying in the wintering areas; **** Possible breeder on sandy islets of Adam's bridge.

Order & family	Common name (scientific name)	Status
Podicipediformes		
Podicipedidae	little grebe (*Tachybaptus ruficollis*)	resident
Pelecaniformes		
Pelecanidae	spot-billed pelican (*Pelecanus philippensis*)	resident
Phalacrocoracidae	Indian cormorant (*Phalacrocorax fuscicollis*)	resident
	little cormorant (*Phalacrocorax niger*)	very common resident
Anhingidae	oriental darter (*Anhinga melanogaster*)	resident
Ciconiiformes		
Ardeidae	grey heron (*Ardea cinerea*)	resident

	purple heron (*Ardea purpurea*)	resident
	great egret (*Casmerodius albus*)	resident
	intermediate egret (*Mesophoyx intermedia*)	resident
	little egret (*Egretta garzetta*)	resident
	cattle egret (*Bubulcus ibis*)	common resident
	Indian pond-heron (*Ardeola grayii*)	very common resident
	black bittern (*Ixobrychus flavicollis*)	resident *
Ciciniidae	painted stork (*Mycteria leucocephala*)	resident
	Asian openbill (*Anastomus oscitans*)	common resident
	wooly-necked stork (*Ciconia episcopus*)	resident
Threskiornithidae	black-headed ibis (*Threskiornis melanocephalus*)	fairly common resident
	Eurasian spoonbill (*Platalea leucorodia*)	fairly common resident
Anseriformes		
Anatidae	lesser whistling-duck (*Dendrocygna javanica*)	resident
	cotton pygmy-goose (*Nettapus coromandelianus*)	resident
Gruiformes		
Rallidae	white-breasted water-hen (*Amaurornis phoenicurus*)	common resident
	purple swamp-hen (*Porphyrio porphyrio*)	common resident
Charadriiformes		
Jacanidae	pheasant-tailed jacana (*Hydrophasianus chirurgus*)	common resident
Rostratulidae	greater painted-snipe (*Rostratula benghalensis*)	resident
Recurvirostridae	black-winged stilt (*Himantopus himantopus*)	resident
Burhinidae	Eurasian thick-knee (*Burhinus oedicnemus*)	resident
Charadriidae	yellow-wattled lapwing (*Vanellus malabaricus*)	common resident
	red-wattled Lapwing (*Vanellus indicus*)	common resident
	Pacific golden-plover (*Pluvialis fulva*)	common winter visitor
	little ringed-plover (*Charadrius dubius*)	resident **
	Kentish plover (*Charadrius alexandrinus*)	endemic race
	Mongolian plover (*Charadrius mongolus*)	common winter visitor
Scolopacidae	marsh sandpiper (*Tringa stagnatilis*)	regular winter visitor
	common greenshank (*Tringa nebularia*)	regular winter visitor
	green sandpiper (*Tringa ochropus*)	regular, but uncommon winter visitor
	wood sandpiper (*Tringa glareola*)	winter visitor, scarce summer loiterer ***
	common sandpiper (*Actitis hypoleucos*)	winter visitor, scarce summer loiterer
	common snipe (*Gallingo gallingo*)	winter visitor
	little stint (*Calidris minuta*)	winter visitor
Laridae	whiskered tern (*Chlidonias hybridus*)	winter visitor, summer loiterer
	gull-billed tern (*Gelochelidon nilotica*)	winter visitor, summer loiterer ****
	little turn (*Sterna albifrons*)	resident
Coraciiformes		
Alcedinidae	pied kingfisher (*Ceryle rudis*)	resident
	common kingfisher (*Alcedo atthis*)	common resident
	stork-billed kingfisher (*Halcyon capensis*)	resident
	white-throated kingfisher (*Halcyon smyrnensis*)	common resident

PLATE 5

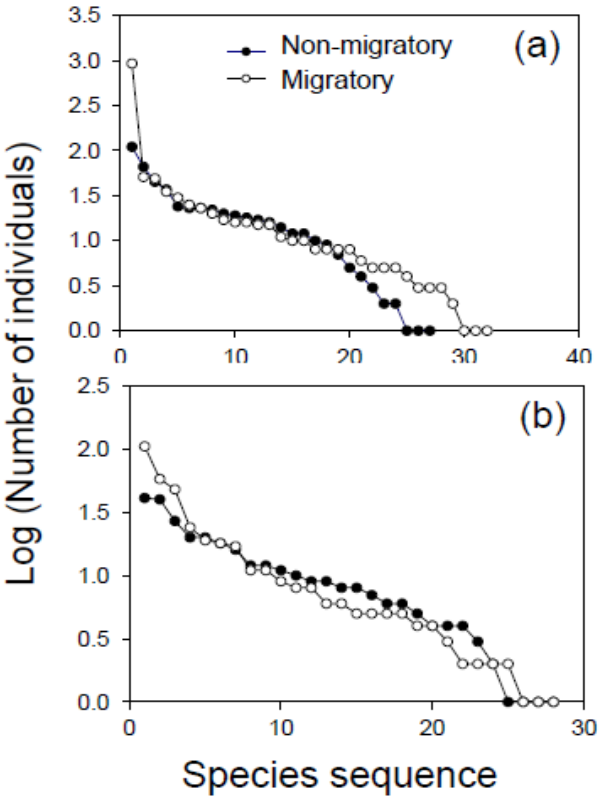

Figure 1: Rank abundance curves for wetland birds in (A) Anuradhapura and (B) Monaragala Districts for migratory and non-migratory seasons.

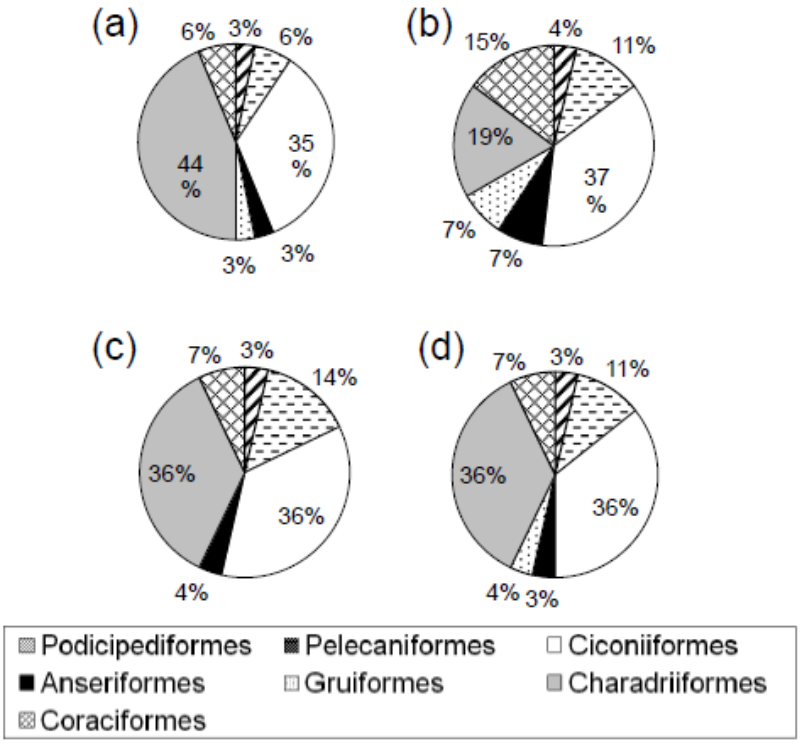

Figure 2: Relative abundance of various orders of wetland birds in Anuradhapura (top) and Monaragala (bottom) Districts during migratory (left) and non-migratory (right) seasons; Anuradhapura District (A) migratory (B) non-migratory; Monaragala District (C) migratory and (D) non-migratory season.

PLATE 6

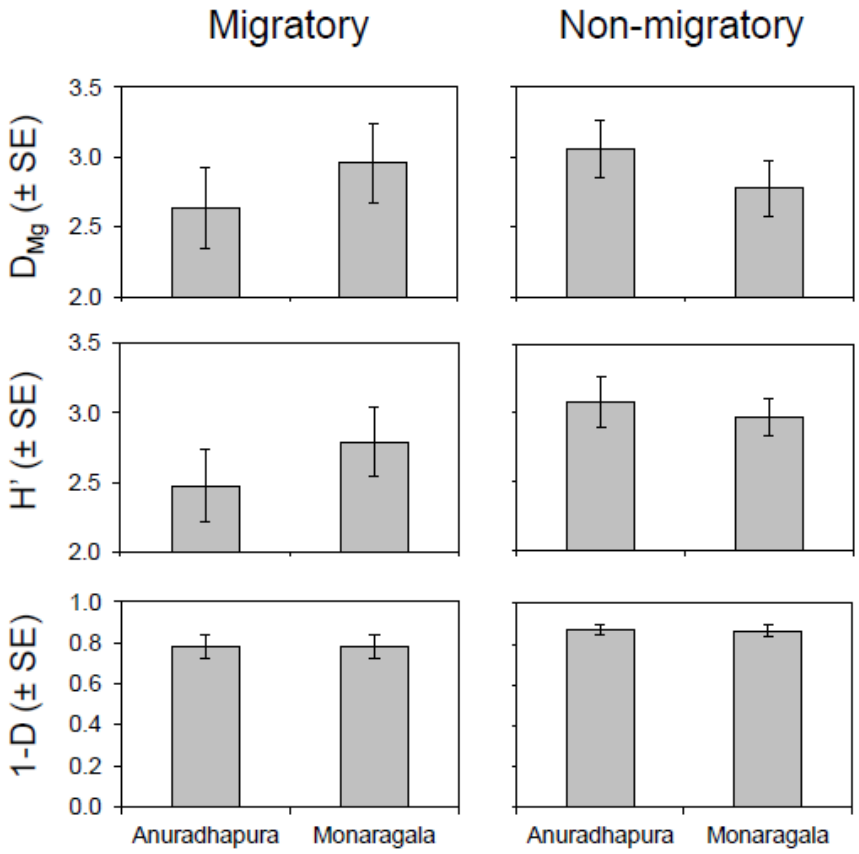

Figure 3: A comparison of wetland bird species diversity of seasonal reservoirs in Anuradhapura and Monaragala Districts between migratory and non-migratory seasons; Margalef's Diversity Index (D_{Mg}) (top); Shannon-Weiner Index (H') (middle); and Simpson's Index (D) (bottom), error bars indicate the standard error (SE).

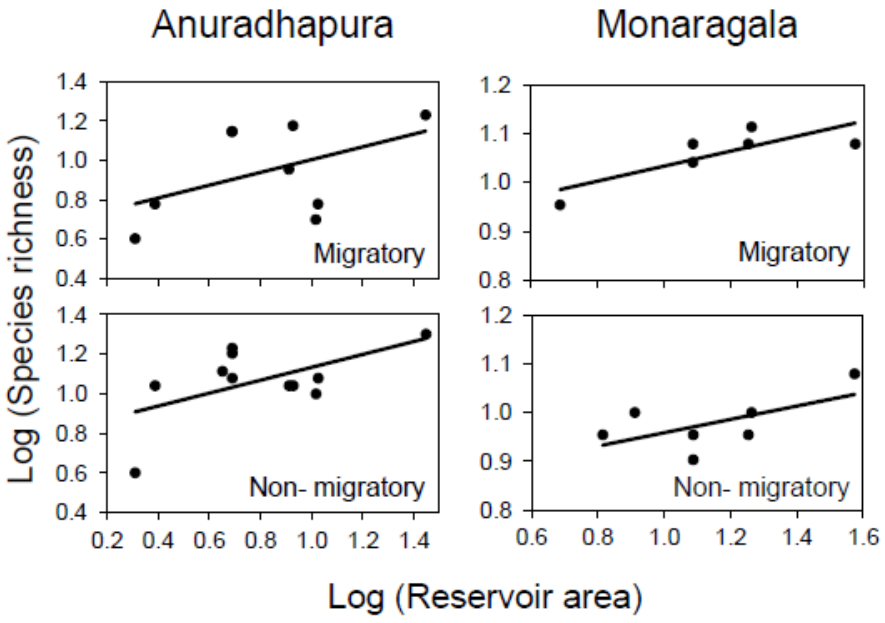

Figure 4: The Species-Area relationships between wetland bird species richness and reservoir area for eleven seasonal reservoirs in Anuradhapura (left; 2.04–28.0 ha) and nine seasonal reservoirs in Monaragala (right; 2.85–37.55 ha) Districts (see Table 4 for more information).