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PATTERNS OF SEASONAL ABUNDANCE AND DIVERSITY IN THE WATERBIRD COMMUNITY OF ANAVILUNDAWA SANCTUARY

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ABSTRACT - Diurnal species richness and diversity of aquatic avifauna at three reservoirs of the Anavilundawa Ramsar site of Northwestern Sri Lanka was recorded using line transect method from October 2009 to March 2010. Populations of the water birds were recorded from 7:00 hrs to 10:00 hrs, three times each month. Twenty eight species of water birds belonging to six orders and twelve families were recorded from Anavilundawa, Suruwila and Maiyawa reservoirs. These included two nationally threatened species, Spot-billed Pelican (*Pelecanus philippensis*) and Great Cormorant (*Phalacrocorax carbo*) and one winter visitor, Garganey (*Anas querquedula*). Relative abundance and rank correlation indicated that Lesser Whistling-Duck was the most common water bird species followed by the Purple Coot and Garganey. Common Moorhen was the least common bird followed by, Little Ringed Plover and Black Bittern. Birds belonging to Anatidae, Ardeidae, Phalacrocoracidae, Rallidae and Jacanidae families were recorded in high numbers. Among the families recorded, Anatidae family had the highest number of birds. Three waterfowl species belonging family Anatidae were recorded. They were, Lesser Whistling Duck (*Dendrocygna javanica*), Cotton Pygmy Goose (*Nettapus coromandelianus*) and migratory waterfowl Garganey (*Anas querquedula*). Suruwila reservoir had the highest Shannon diversity (H') index of 2.345 while Anavilundawa had the lowest diversity index of 2.104. Water birds diversity of the Anavilundawa reservoir differed significantly from the Maiyawa reservoir ($t = 0.140$, $df = 2133$). However it did not differ significantly from the Suruwila reservoir ($t = 3.022$, $df = 3047$). The diversity of water birds between Suruwila reservoir and Maiyawa reservoir did not differ significantly ($t = 2.644$, $df = 1840$). Evenness was high in the Maiyawa reservoir (0.747) and low in the Anavilundawa reservoir (0.638). Present study revealed that the three reservoirs of the Anavilundawa Ramsar wetland provide an important habitat for twenty eight water bird species, and thus warrant protection.

KEY WORDS : Aquatic avifauna, Diversity, Abundance, Anavilundawa Ramsar wetland

INTRODUCTION

Wetlands are the most productive and biologically diverse ecosystems in the world (Gibbs, 1993). Wetlands and aquatic avifauna are inseparable elements and they support a rich array of aquatic communities (Grimmett and Inskipp, 2007). Aquatic avifauna are an important component of most wetland systems as they occupy several tropic levels in the food web of wetlands and nutrient cycles and form the terminal links in many aquatic food chains (Custer and Osborne, 1977). Activities of aquatic avifauna are considered as indicators of quality

of the wetland ecosystem and they reflect changes. Therefore, the estimation of local densities of avifauna helps to understand the abundances of various species of other organisms (Turner, 2003).

Anavilundawa Ramsar Site (ARS) is the 2nd Ramsar wetland of Sri Lanka and is located in Puttalam District of the North Western Province. It is a manmade cascade of reservoirs. ARS consists of freshwater wetland habitats as well as saltwater wetland habitats (Perera et al, 2005). This wetland harbors a rich aquatic faunal and floral diversity (Perera et al, 2005). It has been

recognized as one of the most important habitats for residential as well as migratory aquatic avifauna in Sri Lanka. Many research findings reveal composition of aquatic avifauna in ARS, although data related to the Species Richness, Abundance and Diversity of aquatic avifauna have not been thoroughly studied. Hence, present study concentrated on Species Richness, Abundance and Diversity of aquatic avifauna at ARS.

MATERIALS AND METHODS

The study was conducted in three lakes (Anawilundawa, Suruwila and Maiyawa lakes) and adjacent paddy fields. These three lakes were selected on their accessibility, representative nature and spatial distribution. Survey was carried out on three days per month between October 2009 to March 2010. Populations of the water birds were recorded from 7:00 hrs to 10:00 hrs, while traveling along one kilometer transects. One kilometer transects that provided maximum visibility of reservoirs was marked in each reservoir, with a global positioning system device (GPS) (Garmin eTrex). Individual aquatic avifauna were counted when the numbers present were small. When this number exceeded 200, an estimation of the population size was achieved by dividing the flock into small equal parts and through extrapolation (Baaziz and Samraoui 2008). Nikon 15~60x25 spotting scope and a Nikon Monarch 12x42 ATB binocular were used to detect and count species and identification was done using Harrison and Worfolk (1999) and Kotagama and Fernando. (1995).

The vegetation of the each tank was mapped once a month by drawing the shape and location of patches of vegetation on an enlarged 1:50,000 topographical maps (Mahaulpatha, *et al.* 2008) obtained from the survey department of Sri Lanka. Four habitat types were identified as Open water, Invasive Plants covered [percentage of the lake area covered by Water hyacinth (*Eichhornia crassipes*) and Salvinia (*Salvinia molesta*)], native Floating vegetation covered macrophytes [percentage of the lake area covered by *Nelumbo nucifera* and *Nelum*

(*Nymphaea pubescens*)] and Grass covered. Percentage cover of each habitat type in each month was calculated by cut and weight method (Mahaulpatha *et al.*, 2008).

DATA ANALYSIS

Species richness (S) was calculated as the number of species in the community (Krebs, 1992). The Shannon–Wiener index (H) of diversity was calculated using the equation $H = -\sum p_i \ln p_i$, where, H is index of species diversity and p_i is the proportion of the total sample belonging to the i^{th} species. Evenness values (E1) were calculated from the equation $E1 = H/\ln S$, where H is the Shannon–Wiener index and $\ln S$ is the natural logarithm of the number of species.

RESULTS

During the study period 38 Species of Aquatic avifauna belonging to 13 families representing 6 orders (indicate theme here and remove from the table) were recorded from Anawilundawa, Suruwila and Maiyawa reservoirs (Table 01). These included two nationally threatened species, Spot-Billed Pelican (*Pelecanus philippensis*) and Great Cormorant (*Phalacrocorax carbo*) and seven winter visitors, Black-Tailed Godwit (*Limosa limosa limosa*), Common Greenshank (*Tringa Nebularia*), Common Redshank (*Tringa tetanus*), Common Ringed Plover (*Charadrius hiaticula*), Garganey (*Anas querquedula*), Little Stint (*Calidris minuta*) and Malayan Night Heron (*Gorsachius melanolophus*).

TABLE 1: List of Aquatic avifauna recorded at Annavilundawa Ramsar site from October 2009 to March 2010.

Order	Family	Scientific Name	Common Name	
Podicipediformes	Podicipedidae	<i>Tachybaptus ruficollis</i>	Little Grebe	
Pelecaniformes	Pelecanidae	<i>Pelecanus philippensis</i> ^T	Spot-billed Pelican	
	Phalacrocoracidae	<i>Phalacrocorax carbo</i> ^T	Great cormorant	
		<i>Phalacrocorax fuscicollis</i>	Indian cormorant	
		<i>Phalacrocorax niger</i>	Little cormorant	
	Anhingidae	<i>Anhinga melanogaster</i>	Oriental Darter	
Ciconiiformes	Ardeidae	<i>Ardea cinerea</i>	Grey Heron	
		<i>Ardea purpurea</i>	Purple Heron	
		<i>Casmerodius albus</i>	Great Egret	
		<i>Mesophoyx intermedia</i>	Intermediate Egret	
		<i>Egretta garzetta</i>	Little Egret	
		<i>Bubulcus ibis</i>	Cattle Egret	
		<i>Ardeola grayii</i>	Indian pond heron	
		<i>Gorsuchius melanolophus</i> ^{WV}	Malayan night Heron	
		<i>Ixobrychus sinensis</i>	Yellow Bittern	
		<i>Ixobrychus cinnamomeus</i>	Cinnamon Bittern	
	<i>Ixobrychus flavicollis</i>	Black Bittern		
		Ciconiidae	<i>Anastomus oscitans</i>	Asian Openbill
		Threskiornithidae	<i>Threskiornis melanocephalus</i>	Black-headed Ibis
			<i>Plegadis falcinellus</i> ^{WV}	Glossy Ibis
	<i>Platalea leucorodia</i>		Eurasian Spoonbill	
Anseriformes	Anatidae	<i>Dendrocygna javanica</i>	Lesser Whistling-Duck	
		<i>Nettapus coromandelianus</i>	Cotton Pygmy-goose	
		<i>Anas querquedula</i> ^{WV}	Garganey	
Gruiformes	Rallidae	<i>Amaurornis phoenicurus</i>	White-breasted Waterhen	
		<i>Gallinula chloropus</i>	Waterhen	
		<i>Porphyrio porphyrio</i>	Common Moorhen	
		<i>Fulica atra</i>	Purple Coot	
			Common Coot	
Charadriiformes	Jacaniidae	<i>Hydrophasianus chirurgus</i>	Pheasant-tailed Jacana	
	Recurvirostridae	<i>Himantopus himantopus</i>	Black-winged Stilt	
	Charadriidae	<i>Vanellus indicus</i>	Red wattled lapwing	
		<i>Charadrius hiaticula</i> ^{WV}	Common Ringed Plover	
		<i>Charadrius dubius jerdoni</i>	Little Ringed Plover	
	Scolopacidae	<i>Limosa limosa limosa</i> ^{WV}	Black-tailed Godwit	
		<i>Tringa totanus</i> ^{WV}	Common Redshank	
		<i>Tringa nebularia</i> ^{WV}	Common Greenshank	
		<i>Tringa hypoleucos</i>	Common Sandpiper	
		<i>Calidris minuta</i> ^{WV}	Little Stint	

T: Nationally threatened, WV: Winter Visitor

The number of species recorded at each reservoir varied from 18 species at Maiyawa to the 27 species at Anavilundawa (Table 02). The highest number of aquatic avifauna was recorded at Suruwila and the lowest at Maiyawa. Also Suruwila reservoir had the highest Shannon diversity (H') index of 2.345 while Anavilundawa had the lowest diversity index of 2.104. But water birds diversities in three reservoirs were not significantly difference (t). Evenness value was highest in Maiyawa and lowest in Anavilundawa.

TABLE 2: Recorded species richness, Abundance, Diversity and Evenness Values of Aquatic avifauna Community in Annawilundawa Ramsar site from October 2009 to March 2010

	Annawilundawa	Suruwila	Maiyawa
Species Richness	27	26	18
Abundance	1447	2734	932
Shannon Diversity	2.104	2.345	2.117
Evenness	0.638	0.72	0.747

Lesser Whistling duck was the most common aquatic avifauna in the ARS followed by migratory waterfowl Garganey (Fig 01).

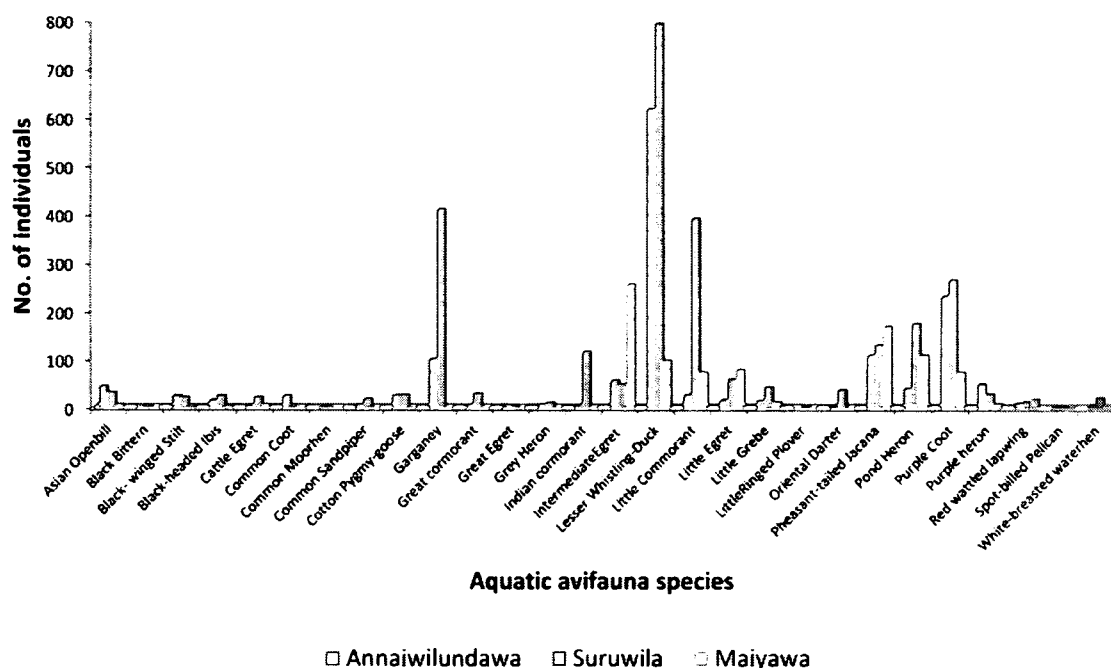


FIGURE 1: Distribution of Aquatic avifauna species in the three reservoirs

Lesser Whistling duck had the highest relative abundance value of 29% and ranked one in terms of abundance followed by (Table 03). Great Egret, Spot-billed Pelican, Black Bittern, Common Moorhen and Little Ringed Plover relative abundance values were lower than 1%.

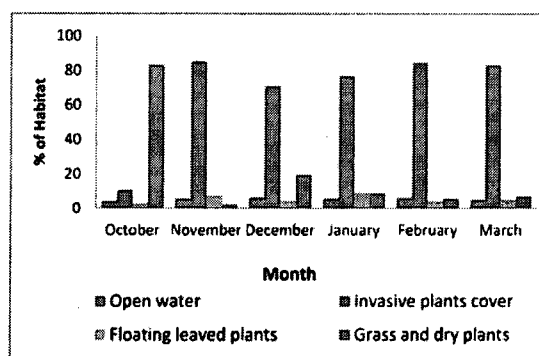
Available habitat type varied within the three reservoirs during the study period. Invasive plant water hyacinth was the most prominent habitat type in the Anavilundawa reservoir from November 2009 to March 2010. But in October, reservoir was heavily covered with grass (Fig 02a). Availability of open water and native plant cover did not vary significantly within months (for open water, $\chi^2 = 0.5416$, $df = 6$, $P < 0.05$ and for native plants $\chi^2 = 5.91$, $df = 6$, $P < 0.05$) in the Anavilundawa reservoir. But invasive plant cover ($\chi^2 = 60.67$, $df = 6$, $P < 0.05$) and Grass cover ($\chi^2 = 228.74$, $df = 6$, $P < 0.05$) had significant monthly variation. Grass (68.72%) is the most prominent habitat type in the Suruwila reservoir followed by Open water (22.16%), Invasive plants (6.83%) and Native plants (2.27%) during the study period (Fig 02b). There

TABLE 3: Relative abundance of the recorded Aquatic avifauna species and relative abundance status given by IUCN; VC: Very Common, C: common, UC: Uncommon, R: Rare, VR: Very rare

Species	Relative Abundance %	Rank	R/ A status given by IUCN
Lesser Whistling-Duck	29.49	1	VC
Purple Coot	11.15	2	VC
Garganey	9.99	3	VC
Little Cormorant	9.62	4	VC
Pheasant-tailed Jacana	8.00	5	VC
Intermediate Egret	7.08	6	C
Pond Heron	6.38	7	VC
Little Egret	3.05	8	VC
Indian cormorant	2.44	9	C
Purple heron	1.72	10	C
Asian Openbill	1.64	11	C
Little Grebe	1.39	12	C
Cotton Pygmy-goose	1.06	13	C
Black-winged Stilt	0.94	14	C
Black-headed Ibis	0.86	15	C
Oriental Darter	0.82	16	C
Red wattled lapwing	0.82	17	VC
White-breasted waterhen	0.72	18	C
Cattle Egret	0.65	19	C
Great cormorant	0.61	20	R
Common Coot	0.49	21	UC
Common Sandpiper	0.49	22	UC
Grey Heron	0.35	23	C
Great Egret	0.08	24	C
Spot-billed Pelican	0.06	25	VR
Black Bittern	0.04	26	R
Little Ringed Plover	0.04	27	C
Common Moorhen	0.02	28	UC

is no significant monthly variation in four habitat type of studied (for Open water $\chi^2=7.7067$, $df=6$, $P<0.05$, for Invasive plants $\chi^2=5.6585$, $df=6$, $P<0.05$, for Native plants $\chi^2=4.8943$, $df=6$, $P<0.05$ and for Grass $\chi^2=4.884$, $df=6$, $P<0.05$). Grass is the most prominent habitat type in the Maiyawa reservoir from October to January. But in February and March reservoir was prominently covered by Native plants (Fig 02c). Availability of open water ($\chi^2=43.4477$, $df=6$, $P<0.05$), native plants ($\chi^2=239.3017$, $df=6$, $P<0.05$) and grass cover ($\chi^2=97.2758$, $df=6$, $P<0.05$) is significant varies with in monthly. But invasive plant cover ($\chi^2=5.4448$, $df=6$, $P<0.05$) did not

have significant monthly Variation.



(a)

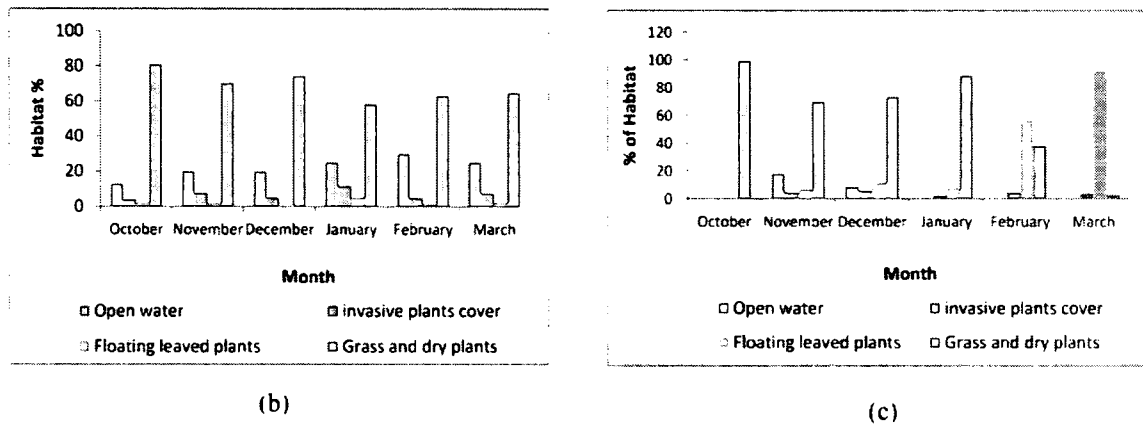


FIGURE 2: Monthly variation in percentage coverage of each habitat in three Reservoirs during October – December 2009 and January – March 2010. (a) Annavilundawa (b) Suruwila (C) Maiyawa

DISCUSSION

Wetlands function as wildlife habitats by providing breeding, nesting, feeding grounds and cover for many species of aquatic avifauna, including migratory waterfowl (Akbar, et al., 2009). Therefore, it is possible that Anavilundawa Ramsar wet land provides a good habitat to thirty one native and seven migratory aquatic avifauna species observed during the study.

Family Anatidae is the most abundant family in Anavilundawa Ramsar Site. According to Perera *et al* (2005) observed five members of family Anatidae at the Anavilundawa Ramsar site. Lesser Whistling-Duck was the most wide spread waterfowl species and they occurred in all three reservoirs and accounted for 29.49% of the total avifauna recorded. This could be attributed to the known fact that Lesser Whistling-Ducks are able to utilize a wide variety of resources (Raeside, *et al.* 2007) and their resistance to differences in the three reservoirs (Gunaratne, *et al* 2009). Highest diversity of aquatic avifauna was recorded in the Suruwila reservoir. This could be attributed to availability of large tracts of open water which provided suitable habitat to waterfowl. Anavilundawa reservoir had little water cover and Maiyawa reservoir had no open water available in the months of October, February and March. Aquatic avifauna used open water for variety of their activities, such as feeding, bathing, and resting. This could be the reason for low densities of aquatic avifauna

observed in these reservoirs.

The importance of having constant water levels in waterfowl habitat is well known (Markham 1982). However the water levels changed drastically with the dry season and the release of water for agriculture from the reservoirs leading the Maiyawa reservoir to dry up. Better management of the water in these reservoirs will make the Anavilundawa Ramsar Site more attractive to the water fowls. Previous studies have recorded large number of different bird species such as Cotton Pygmy Goose (Gunaratne *et al* 2009). In the present study only 13 Cotton Pygmy Goose were recorded. They were restricted mainly to Suruwila and Anavilundawa reservoirs. The non observance of Cotton Pygmy Goose in the Maiyawa reservoir was probably due to the lack of open water in this reservoir. Therefore, having a constant water level would help attract many waterfowl species to this important Ramsar site.

Water hyacinth was the dominant habitat type in Anavilundawa reservoir. But according to past records (Gunaratne, *et al* (2009) open water (45%) was dominant habitat type in Anavilundawa reservoir and dominant floral species was water lily (23%). Present study results indicate that water hyacinth has invaded open water and water lily vigorously in last four years in Anavilundawa reservoir. Further studies are needed to find out the effects of invasive plant on the habitat use of aquatic avifauna.

The present study also demonstrated that

even today the Anavilundawa Ramsar site has a high bird species richness of thirty eight avian species. Hence the management should carefully evaluate the adverse impacts of uncontrolled water releasing and the spread of invasive water plants on the avifauna as these factors will be detrimental to the avifauna and will contribute towards decreasing the value of this important Ramsar site. Therefore, the relevant authorities should take necessary steps to minimize these impacts and improve this important wetland habitat.

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