

## Seasonal Abundance and Diversity of Water Birds in Some Wetlands of Sinnar State, Sudan

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### Abstract

This study aims at filling the gap of knowledge in Sinnar state in which little studies about birds were carried out and the information about birds in general is meagre. Objectives of this study are to: identify bird's species at various wetlands of Sinnar State; and total number of birds, diversity indices should be attained and listing them according to the conservation status.

This study is conducted in Sinnar state, central Sudan (Latitudes 05°-12° to 05°-14° and longitudes 32.9°-35.4°), Figures, covering 12 wetlands (mayas), during the wet and the dry season spanning 2011-2013; the wetlands are Ronga, Allahmaana, Gladeema, Elban, Rahad Kobri 45, Lawni, Kinnaf Tura 5, Rigaba, Shamiya, Wad elgack, Homrani and Sinnar Dam reservoir. Birds are counted twice a day (morning and evening) in all wetlands with the help of telescopes and binoculars. Species utilizing each category of the wetlands are identified. Birds' Diversity indices are calculated in each wetland.

Species richness in wetlands of Sinnar fluctuated widely. Numbers of water birds varied seasonally, presumably due to climatic changes during the wet and dry seasons, the total number counted in the whole study was 62160 individuals, of 71 species. Diversity indices; of birds varied from 1.0 to 0.15. Species richness of water birds varied seasonally among wetlands. This applies also to the total numbers of water birds.

Most species categorized under the least concern while some of them were not listed in the red list.

**Keywords:** Diversity indices; Water birds; Sudan; Wetlands; Conservation; Abundance; Least concern

### Introduction

Birds are often common denizens of the ecosystems and they have been considered as an indicator species of inhabited areas [1].

Population of birds is a sensitive indicator of pollution in both terrestrial and aquatic ecosystem [2,3]. The estimation of local densities of avifauna helps to understand the abundance of various species of other organisms [4]. One of the major priorities in conserving animals is monitoring their populations to find methods for their long term survival [5].

Wetlands are the most productive and biologically diverse in the world but very fragile ecosystems [6]. Wetlands and water birds are inseparable elements and thus form a rich array of water bird communities [7].

Water birds are an important component of most of the wetland ecosystems as they occupy several trophic levels in the food web of wetland nutrient cycles. Activities of water birds are considered as indicator of quality of the wetland ecosystem and form the terminal links in many aquatic food chains, and as a result they reflect changes originating in several different ecosystem components [8]. A water bird is any species of bird primarily and anatomically adapted to live continuously where aquatic conditions predominate. And, it may be added, a land bird is any species of bird not so adapted.

Water birds include the following groups:

Water fowl - ducks, geese, swans, thus referring only to the family Anatidae.

Water birds or aquatic birds - All species with webbed feet that commonly swim, including the anatidae, also all deep water waders belonging to the order Ciconiformes such as herons and storks.

Sea birds or marine birds - All species directly associated with the open seas and consistently dependent on the seas for food.

Shore birds - Oyster catchers, plovers, snipes, Sandpipers, curlews, phalaropes, and sheathbills. Ornithologist in Britain and the British Commonwealth, speak of shore birds as waders [9].

The avifauna of Sudan is varied between authors, recorded 971 species of birds, 1013 species of which three are endemic, one has been introduced by humans, and 4 are rare or accidental and 10 species are globally threatened. Nikolous [10] listed more than 200 Palearctic species frequenting a variety of ecological zone in Sudan of which 23 species were raptors and 75 passerines. Large rivers are often an important, although relatively neglected, component of water bird habitat range [11]. The Nile valley is associated with vast and numerous wetlands. These wetlands are very different in nature and ecosystem and potentially support largely unknown water bird concentration [10,12,13]. Working in partnership, Wildlife Conservation General Administration, University of Sinnar, Sudanese wildlife Society and the French Game and Wildlife Agency (ONCFS) conducted a water bird project in order to fill gaps in knowledge about their population size and distribution and to reinforce IWC (International water bird's census) programme in the Nile basin [14]. Mohammed [15] studied

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the abundance and distribution of storks in the Dinder National Park. Eldigair [16] studied bird's species in Elssuki locality and found that their numbers during the wet season were correlated with the numbers of trees that increased southwards, and the birds' richness was correlated with some factors such as birds' migration, number of small mammals on which some of them feed on and the herbs cover. Elhassan [17] studied eleven mayas (wetlands) in Dinder National Park (DNP) and found that numbers and diversity of water birds fluctuated widely between years and seasons, the largest assemblage being in winter in which time Palaearctic migrants comprised most of the species richness recorded, Ibrahim [18] estimated numbers and biomass of Guinea fowl (*Numidia meleagris*) in the Dinder National Park

Wetland habitats make up 20% of the total area of the Sudan. They include the River Nile and its tributaries (a drainage network of 9000 km), 750 km of coastline along the Red Sea, a number of inland lakes, 2000 "haffirs" and 10,000 km of canals in the Gezira irrigation scheme in addition to innumerable seasonal swamps [19]. Censuses in 2003 indicated the presence of 170,000 water birds of 50 species [20]. Robertson [11] mentioned 12 Important Bird Areas (IBA) in Sudan, supporting 937 species of birds of which 616 are resident and 312 regular seasonal migrants, including 214 from the Palearctic, and 17 species of global conservation concern. In addition, the islands of the Sudanese Red Sea support important breeding populations of a number of seabirds. Based on the Ramsar definition, there are about 13 wetland types in the country [21], include the following:

Seasonal Streams (eg. Gash, Baraka, Dinder and Rahad); The Nile and its tributaries; Mountain Streams (Khor arba'at, River Gilo and Ingassana Hills); Lakes; Man-made lake system; Dams; Hot springs; Haffirs; Mayas; Coral reef; Mangrove Swamps (Red Sea coast); and Riparian forest [19].

Wetlands are among the most productive and biologically rich ecosystems on earth. Since time immemorial wetlands have served as cradles of civilization, the focal points around which great cultures took roots and flourished. Human beings, living in the flood plains of major rivers used the annual cycles of the floods and the nutrients deposited on the plains for their advantage [22].

Wetlands are also amongst the most endangered ecosystems. In the recent past, the feverish pace of urbanization and industrialization has resulted in worldwide destruction of the wetlands.

Wetlands refer to a landscape saturated with water or covered by water either perennially or for a major part of the year; there are numerous definitions of wetlands but all essentially agree to the above criterion [23,24]. Under the Convention on Wetlands, wetlands are defined as areas of marsh, fen, peat land or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six meters; this may incorporate riparian and coastal zones adjacent to the wetlands, and islands or bodies of marine water deeper than six meters at low tide lying within the wetlands [25].

Many definitions for wetlands have been proposed and utilized over the years; among the most widely accepted definitions is that of Cowardin et al. [26] which was adopted by the U.S. Fish and Wildlife Service: "Land where an excess of water is the dominant factor determining the nature of soil development and the types of animals and plant communities living at the soil surface. It spans a continuum of environments where terrestrial and aquatic systems intergraded". This definition comprises three aspects-water, soil, and organisms,

which are accepted by wetland scientists as the basis for recognizing and describing wetland environments. The term "wetland" was not commonly used in the American vernacular until quite recently. It appears to have been adopted as a euphemistic substitute for the term "swamp" [27]. Nineteenth-century scientists used terms such as mire, bog, and fen to describe the lands that are now called wetlands, and these terms are still used by the scientists to describe specific kinds of wetland [28].

The term 'wetland' has come gradually into common scientific usage only in the second half of the twentieth century. A reference definition of wetlands is "an ecosystem that depends on constant or recurrent, shallow inundation or saturation at or near the surface of the substrate. The minimum essential characteristics of a wetland are recurrent, sustained inundation or saturation at or near the surface and the presence of physical, chemical, and biological features reflective of recurrent, sustained inundation or saturation. Common diagnostic features of wetlands are hydric soils and hydrophytic vegetation. These features will be present except where specific physicochemical, biotic, or anthropogenic factors have removed them or prevented their development [29].

Hussien [30], studies the water birds of Sinnar dam reservoir, counted 39 species. He stated that the number of birds and species richness affected seasonally by the water level.

This study is the first scientific study ever done in Sudan and Sinnar state to estimate the water birds covering many sites in Sinnar state.

Objectives of this study are to: identify bird's species at various wetlands of Sinnar State; and total number of birds, diversity indices should be attained and listing them according to the conservation status (Table 1).

## Materials and Method

Twelve wetlands or locally called (Maya)s, according to classification)) were studied during the dry season and the wet season; these were Ronga, Allahmaana, Gladeema, Elban, Rahad Kobri 45, Lawni, Kinnaf Tura 5, Rigaba, Shamiya, Wad elggack, Homrani and Sinnar Dam reservoir. Distributed all over the localities of the states (Figures 1 and 2). Locations and detailed descriptions of these wetlands (Table 1 and Figure 3).

Sinnar Dam on the Blue Nile was constructed in 1925, the dam reservoir extends up to Singa town about 80 km to south. The average length of the reservoir at the flood time is about 50 km. It is constructional storage capacity is 930 million m<sup>3</sup>.

Name	Coordination
Gladeema	N 13.341833 E33.742517
Ronga	N13.288818 E 33.89012
Allah maana	N13.259289 E33.0926969
Kinaf Tura 5	N 12.617379 E34.03792
Shamiyia	N 12.62132 E34.14017
Rigaba	N 12.60163 E34.16600
Rahad Kobri 45	N 12.61711 E34.04314
Elban	N 13.08110 E33.58585
Wad elggack	N 13.02699 E33.95849
Lawni	N124922.1 E 34 0121.7
Homrani	N 13.304017 E33.8746
Sinnar Dam reservoir	N33.68661 E13.465216

Table 1: Name of wetlands and location.

## Methodology

### Bird abundance

Basic bird counts are a good way to estimate population size, detect changes in population size or species diversity, and determine the cause of the changes if environmental or habitat data is collected as well. Basic bird counts can be completed fairly easily and inexpensively, and



Figure 1: Location of Sinnar state (Source: NSDDRC.SC/UNDP 2010).

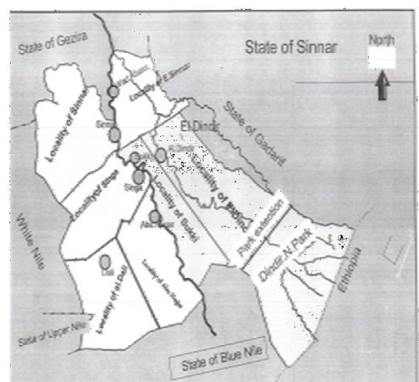


Figure 2: Sinnar state localities (Source: (NSDDRC.SC/UNDP 2010)).

they provide general information about the status of a bird population. Birds can be directly counted on breeding colonies, and at roosts, flocks, or Leks. Large diurnal migrants, like many raptors, can be counted as they pass through migration bottlenecks. Small nocturnal migrants are harder to count, but many advances have been made in the use of radar and microphone arrays to identify and count them [31-33].

Direct observation technique (Direct count) was used for estimating the number of birds which is used by Elhussien [17] to assess the abundant and distribution of birds in Dindir National Paak and Elahassan [17] to assess water birds in meadows of Dindir National Park [34]. Du Rou and Mondain [14] used the same method for International Water Bird Census in Sudan from 2011 to 2013.

The study included two seasons: Wet season from January to March, and the dry season from March to June.

Total count of birds was conducted twice a day (morning and evening) in all wetlands with the help of telescopes and binoculars, and bird species utilizing each wetland were identified, their frequency of occurrence determined.

Number of individuals of different species indicates only relative abundance, because relative counts are easier to make and are quite adequate for most management decisions, and in the case of Sinnar state relative cunt are quite useful, since there is no existing information for relative abundance [35-37].

Indices of diversity ( $H'$ ) was calculated according to the information theory as:

$$H' = -\sum_{j=1}^s (p_j \log p_j),$$

Where  $p_j = N_j/N$ .

$P_i$  = proportion of  $j$  made up of the  $i$ th species.

## Result and Discussion

### Abundance and richness of birds

Seasonal abundance of birds is summarized in Table 2, Species richness and the total number of birds counted during the wet and dry seasons are presented in Table 2 and Figure 3. More population numbers of birds were distributed along the riverine ecosystem in 2011-2012 compared with 2012-2013 (Figure 1). There was a decrease in the number of birds (-12.7%) during the wet seasons, an increase (+34.4%) during the dry seasons across the 12 wetlands (Table 1).

Wetlands	Richness	Wet season		Dry season		Total (%)
		2011-2012	2012-2013	2011-2012	2012-2013	
Gladeema	37	553	728	385	4723	6389 (10.3)
Ronga	30	924	3	405	1533	2865 (4.6)
Allaa maana	30	184	73	72	36	365 (0.6)
Kinnaf turaa 5	30	2595	22	1319	0	3936 (6.3)
Shamiya Khalil	32	307	197	138	166	808 (1.3)
Rigaba	32	1052	17	461	202	1732 (2.8)
Rahad 45	40	12786	17992	2745	2173	35696 (57.4)
Elban	29	1167	436	585	327	2515 (4.0)
Wad elggack	30	2243	110	0	138	2491(4.0)
Lawni	32	338	228	808	654	2028 (3.3)
Homrani	33	235	28	383	222	865 (1.4)
Sinnar Dam	39	684	312	784	687	2467 (4.0)
Total		23068	20146	8085	10861	62160
			-12.7%		+34.4%	

Table 2: Richness and total number of birds in wetlands of Sinnar state during the wet and dry seasons 2011-2013.

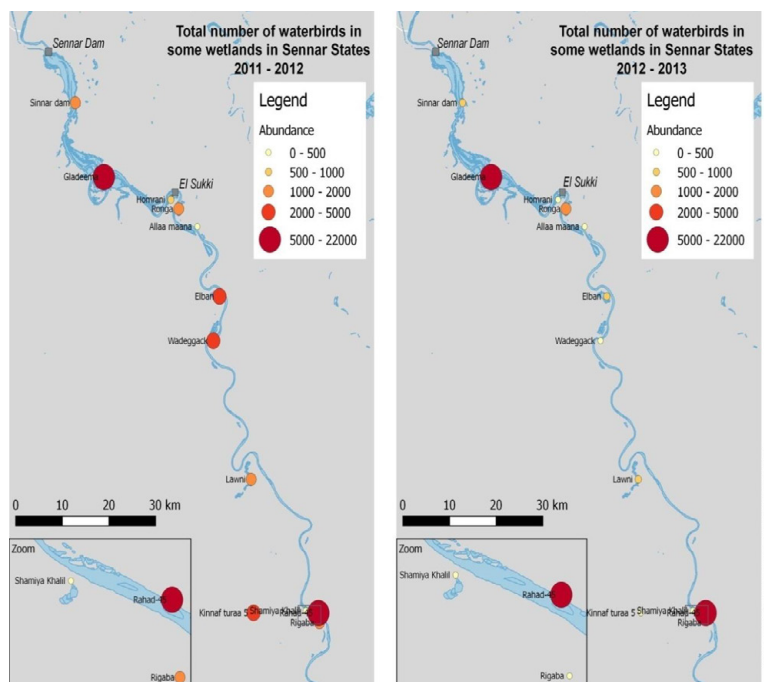


Figure 3: Total number of water birds in some wetlands in Sinnar state (2011-2013).

Richness in Rahad 45 was highest (40 species) followed by Sinnar dam (39 species) and Gladeema (37 species). The remain wetlands supported species richness varied between 33 and 29. Both species richness and the proportion of birds utilizing the wetland were used to judge the importance of the wetlands. In this context, Rahad 45 was the most important wetland; it supported the highest species richness and the highest proportion (57.4%) of birds utilizing it, followed by Gladeema (10.3%).

In ecology, species richness refers to number of species [38]. Species richness in wetlands of Sinnar fluctuates widely. This fluctuation is more or less may related to seasonal changes in the abundance of plant and bird's species. Which may have affected by the amount of rain fall and hence the size of wetlands Table 3 stated that the size of wetland directly affected on species richness which is accepted here in a large extent in some big size wetlands such as Rahad 45, Gladeema and Sinnar dam reservoir [39].

Numbers of water birds varied seasonally, presumably due to climatic changes during the wet and dry seasons. The variation of species richness among wetlands is more or less related to wetlands productivity; the most productive wetlands support more water birds Gladeema, Rahad, Kinnaf, Elban, Homrani and Sinnar dam reservoir [40]. There is little doubt that the species richness and the total number of birds may have affected by the human activities, since most wetlands studied were closed to residential areas where many activities practices around considering more disturbance for birds.

Species richness can be affected widely by latitude; it is also varying significantly among bird's community in single latitude. Generally, such variation can be explained by both productivity and complexity of the local environment [9].

Because they are not adequately explored, this study is a cornerstone for future wetlands conservation in Sinnar state provided that more

Month \ Year	Rainfall, mm			
	2011	2012	2013	2014
May	7.9	16.1	0	11.5
June	20.2	52.7	51.9	27.2
July	58	182.4	42.1	176.9
August	235.9	222.6	274.3	171.2
September	38.6	68.4	38.2	0
October	52.3	2.8	13.5	0
Average	63.28	90.83	84	96.7
Maximum	235.9	222.6	274.3	171.2
Minimum	7.9	2.8	13.5	11.5

Source: Metrological station of Crop protection (Dindir, Sinnar state)

Table 3: Rain fall during the study period in Sinnar state.

wetlands are to be proclaimed as Ramsar sites or important bird areas (IBAs).

### Bird's diversity indices

Bird species encountered in and surrounding Sinnar wetlands are water birds and non-water birds. Diversity indices,  $H'$ , of Water bird for each wetland are presented. Data was missing from Kinaf Tura 5 and Ronga in 2012-2013 dry seasons so their diversity indices, were incomparable (Table 4).  $H'$  was low in Rahad, high in Lawni and Homrani. Ronga indicated the lowest  $H'$  value (0), hosting one species in 2012/2013 wet season and it was highest (1.0) in wet and dry seasons 2011/2012. In 2011/2012 wet season Sinnar Dam had low  $H'$  (0.44), but high values (0.97-1.0) during the respective 2011/2012 wet and 2012/2013 dry seasons. Allah maana indicated higher  $H'$  during the wet seasons 2011/2012 compared with the dry season.

The highest values (1.0) was found in 7 wetlands with their corresponding seasons, these were Ronga, Allah Maana, Kinaf Tura 5, Shamiya Khaliel, Rigaba, Wad elggak, Homrani, and Sinnar Dam (Table 4).

Wetland	Diversity index H'			
	Wet season		Dry season	
	2011/2012	2012/2013	2011/2012	2012/2013
Gladeema	0.97	0.76	0.69	0.67
Ronga	1.0	0	1.0	0.61
Allah maana	1.0	0.90	0.86	0.47
Kinaf Tura 5	0.58	0.66	1.0	-
Shamiya Khaliel	0.89	0.66	0.16	1.0
Rigaba	1.0	0.51	0.96	0.93
Rahad	0.15	0.64	0.66	0.55
Elban	0.86	0.45	0.93	0.68
Wad elggak	1.0	0.90	-	1.0
Lawni	0.94	0.78	0.96	0.99
Hammrani	0.70	0.87	1.0	0.89
Sinnar Dam	0.97	0.44	0.68	1.0

Table 4: Diversity indices of bird's species in wetlands of Sinnar State 2011-2013.

The lowest H' values (0.44) were recorded in Sinnar dam during the wet season 2012/2013, and 0.16, 0.15 at Shamiya and Rahad during the dry season 2011/2012, and wet season 2011/2012, respectively.

Different levels of disturbance have different effects on diversity [37]. The reason why some wetlands have lower diversity indices than others can be attributed to the water level, where most water bird's species preferred lower level and avoid the high level of water such as in Sinnar dam in the first dry season, the size and how far the wetlands from the villages (local community) in relation with the type of their activities. Rigaba as example. The last reason the dominant of some species such as Demossel crane (*Numenius arquata*) in Rahad 45.

### Conservation status

The conservation status of water birds, according to IUCN [41] fall into six categories: Not in red list yet, least concern (LC) (Unknown), LC (Stable), LC (Increasing), LC (decreasing), Near threatened (decreasing) and threatened (Table 5).

Twenty-six water birds (36.62%) were listed in the first category (Not in red list yet) (Table 5). The second category (LC ((Unknown)) constituted 9 birds (2.50%). The LC (Stable) category comprised 7.04% of the water birds. Those of the LC (Increasing) category constituted 16.67%, the LC (Decreasing) 23.94%. A small proportion (2.82%) was in the Near Threatened (Decreasing) category and Threatened 1.41 category.

For conservation purpose, species of birds found in wetlands are categorized according to IUCN Red List (IUCN 2018) [41]. This category provides an easily and widely understood method for highlighting those species under high extinction risk, so as to focus on conservation measure designed to protect them [42]. Listing in the category "Not in red list yet" indicates that no assessment of the extinction risk has been made, though for different reasons. Until such time an assessment is made, species listed in these categories should not be treated as if they were not threatened, and it may be appropriate to give them the same degree of protection as the threatened taxa, at least until the status is evaluated [43-45]. "The Least Concern" category somewhat lies between "Conservation Dependent" and "Near Threatened categories: Conservation Dependent are taxa which are the focus of a continuing taxa-specific conservation programme targeted the taxon in question, whereas Near Threatened are taxa which do not qualify for conservation dependent [41].

The Least concern taxa (unknown) mean that their trends recently

globally known, (stable) mean neither decreasing nor increasing [46].

In country like Sudan where wetlands ecosystem is neglected and no conservation measures applied make the species under (LC decreasing and NT) categories were more exposure to risk and creeping in high speed to extinction [47-49].

### Conclusion

The conclusions to be drawn from this study are the following:

1. Birds' diversity indices in most wetlands are fairly high indicating that the wetlands of Sinnar State are rich with biodiversity.
2. Most of the birds are distributed in the wetlands along the riverine ecosystem. Rahad 45 is the most important wetland as it supports the highest population numbers of birds, followed by Gladeema.
3. Most bird's species categorized under least concern and only two species under near threatened species.

### Recommendations

The following recommendations should be considered:

1. Training and public awareness through communication, education and capacity building, especially amongst conservation managers, site managers, non- governmental organizations, research institutions and local communities.
2. Training on wetlands evaluation and management, using modern techniques and programs.
3. More studies on wetlands are needed to identify, evaluate bird's species and the ecological status of their habitat, through national and regional programs.
4. Economic and cultural valuations of migratory water birds are needed as well as developing a sensitivity map of power lines along the flyways to help minimize their impact on the birds.
5. Ensure full legal protection for the important wetlands like Rahad 45, Gladeema, Lawni and Sinnar dam reservoir and promote their ecological importance.
6. Collate up-to-date information about water birds' poaching, review the impacts of poaching and identify gaps in law

Conservation status	Serial no.	Common name		
Not in red list	1	African Spoon bill	Palaearctic migrant	
	2	Marabou Stork	Intra migrant	
	3	Open bill Stork	Intra migrant	
	4	Striated Green-backed heron	Intra migrant	
	5	Black-crown night heron	Intra migrant	
	6	White faced whistling Duck	Intra migrant	
	7	Fulvous whistling Duck	Intra migrant	
	8	Northern Shovellor	Palaearctic migrant	
	9	Pied kingfisher	Palaearctic migrant	
	10	Demoselle Crane	Palaearctic migrant	
	11	Common Sandpiper	Palaearctic migrant	
	12	Wood sand piper	Palaearctic migrant	
	13	Temink's stint	Palaearctic migrant	
	14	Greater Snipe	Palaearctic migrant	
	15	Spotted Red shank	Palaearctic migrant	
	16	Common red Shank	Palaearctic migrant	
	17	Kitlittiz's Plover	Palaearctic migrant	
	18	Gull bill Tern	Palaearctic migrant	
	19	Collard Pratincol	Palaearctic migrant	
	20	Senegal Thicknee	Palaearctic migrant	
	21	Giant Kingfisher	Palaearctic migrant	
	22	Malachite Kingfisher	Palaearctic migrant	
		Total 23 (32.39%)		
LC(Un known)	24	Great white Pelican	Palaearctic migrant	
	25	Great white Egret	Intra migrant	
	26	Black Kite	Palaearctic migrant	
	27	Squacco Heron	Intra migrant	
	28	Grey Heron	Intra migrant	
	29	Pied Avocet	Palaearctic migrant	
	30	Black-headed Lapwing	Intra migrant	
	31	White-tailed Lapwing	Palaearctic migrant/Visitor	
	32	Black Stork	Palaearctic migrant	
	Total 9 (12.67%)			
LC (Stable)	33	Little ringed plover	Palaearctic migrant	
	34	Common Moorhen	Palaearctic migrant	
	35	African jacana	Palaearctic migrant	
	36	White winged tern	Palaearctic migrant	
	37	whiskered Tern	Palaearctic migrant	
	38	Pied wagtail	Palaearctic migrant	
		Total 6 (8.45%)		
	39	Eurasian marsh Harrier	Palaearctic migrant	
	40	Black-headed Heron	Intra migrant	
	41	Cattle Egret	Intra migrant	
	42	Little Egret	Intra migrant	
	43	Greater Flamingo	Palaearctic migrant	
	44	Spur-winged Goose	Palaearctic migrant	
	45	Green Sand piper	Palaearctic migrant	
	46	Little Stint	Palaearctic migrant	
47	Black winged Stilt	Palaearctic migrant		
48	Spur-winged Plover	Intra migrant/ resident		
49	White stork	Palaearctic migrant		
	Total 11 (15.49%)			
LC (decreasing)	50	Sacred Ibis	Palaearctic migrant	
	51	Ruff	Palaearctic migrant	
	52	Abdim's Stork	Intra migrant	
	53	Little Grebe	Palaearctic migrant	
	54	Glossy Ibis	Palaearctic migrant	
	55	Yellow billed Stork	Intra migrant	
56	Yellow billed Egret	Intra migrant		

	57	Northern Pintail	Palaearctic migrant/ Visitor
	58	Garganey	Palaearctic migrant/ Visitor
	59	Comb(Knob-billed) duck	Palaearctic migrant/ Visitor
	60	Eurasian Wigeon	Palaearctic migrant/Visitor
	61	Red knobbed Coot	Palaearctic migrant
	62	Marsh Sandpiper	Palaearctic migrant
	63	Common ringed Plover	Palaearctic migrant
	64	Egyptian Plover	Palaearctic migrant/visitor
	65	Kentish Plover	Palaearctic migrant
	66	Yellow Wagtail	Palaearctic migrant
	67	Common Snipe	Palaearctic migrant
	68	Long-tailed Cormorant	Palaearctic migrant/Resident
	69	Purple Heron	Intra migrant
	Total 20 (28.17%)		
NT (decreasing)	70	Curlew Sand piper	Palaearctic migrant
	71	Black-tailed Godwit	Palaearctic migrant
	Total 2 (2.81%)		

IUCN (2018); LC: Least concern; NT: Near Threatened; Stable: Number is stable globally, neither increase nor decrease; Decreasing: Number of individuals Decreases globally; Increasing: Number of individuals increases globally

**Table 5:** Conservation status and global population trend of water birds encountered in Sinnar wetlands 2011-2013.

enforcement and legislation relative to specific areas and/or species where this is a real priority.

- Encourage coordinated international agreement and seek for national and international partnership.
- Support the development of flyway-scale site networks, especially where they are least developed, to include the widest possible range of available habitat for migratory birds.
- Make information on site networks and the sites within networks easily available, further developing initiatives modeled on the AEWA critical site network tool.
- Encourage research, collate and disseminate information on climate change and effects on migratory birds and observed responses, identifying the most sensitive and vulnerable species and populations.
- The need for wetland policy and establishment of department authorize for wetland conservation, management and development.

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