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Seasonal Abundance and Diversity of Waterbirds of Rapti river from Sauraha to Kasara of Chitwan National Park, Nepal

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Abstract
Wetlands are the most productive areas for biodiversity and local livelihood support. Waterbirds are important components of most wetland environments. These asonal abundance and diversity of waterbirds of the Rapti River was studied to assess the species composition and richness along with their seasonal variation in August 2017 and January 2018. The fixed-line transect method in a wooden dugout canoe was used for bird sampling between the winter and summer seasons. Total of 51 species of birds belonging to 9 orders and 18 families were recorded. Species richness was high in winter season than in summer. The study revealed that the study site harbors many residents and a few migratory water bird species. According to the IUCN Red List status, 43 species were in the Least Concern, 5species were in the Near Threatened, 2 species were invulnerable, and 1 species was in the Endangered category. The order Anseriformes and Charadriiformes were recorded the much in number that was 11 species each. The dominant family was Anatidae represented by 11 species, followed by the Ardeidae with nine species and the lowest representations of one species were in the other nine families. The Shannon wiener diversity index was found to be higher in the winter season (H'= 3.47) than in the summer season (H'= 3.30). High altitude winter migratory bird Bar-headed Goose (*Anser indicus*) was also recorded. The major threats to wetland birds included habitat destruction, human disturbances, and fishing. The study concludes that study area contains a diverse and rich avifauna, especially the population of winter migrants that needs to be monitored regularly.
Keywords: Chitwan National Park, diversity, Rapti river, waterbirds, wetlands

1. Introduction
Wetland birds are significant in monitoring environmental issues since they are key indicators of wetland ecosystems (Urfi et al., 2005). Waterfowls, both migratory and non-migratory, are significant species in wetlands (Wei & Mundkur, 2004). But wetlands are facing tremendous anthropogenic pressure caused by an increase in human disturbances. Thus, these disturbances threaten these ecosystems and greatly influence the bird community's population structure and diversity (Bird Life International, 2003). Water birds or wetland birds are birds that live in wetlands and are reliant on them for food, breeding, nesting, or roosting, either directly or indirectly (Kumar & Gupta 2013). The primary habitat for Nepal's birds consists of forest, wetland, and grassland. Forest provides the major habitat for the birds (77%) and other major habitats include grassland and wetlands (Grimmett et al., 2000). Moreover, it has been found that

forest provides home for about 53% of nationally threatened birds and it is followed by wetland (27%), grassland (15%), open canopy (9%), cultivated land (8%), shrub (5%), near human settlement areas (3%), and the least is the semi desert area with 1% (Inskipp et al., 2013). Wetlands are considered virgin area for the bio-diversity conservation which encompasses several aquatic plants, animals along with several endemic and migratory birds. Regarding the wetland birds, Nepal has recorded a total of 195 species and this number has been possible supporting 187 species only from wetlands of Terai (Jha, 2018). Almost half of the total species of birds recorded from Nepal are migratory which migrates from the colder parts of different countries like China, Russia, central Asia as well as from the cold mountainous regions of Nepal too (Jha & Sharma, 2018). Nepal is known for its great diversity of birds with 886 species known globally (BCN & DNPWC, 2018), among them 43 are listed in the IUCN Red List of globally threatened birds (Bird Life International, 2020), 19 near-threatened species, and 15 restricted-rangespecies (Grimeettetal., 2016; Inskipp et al., 2016). Among Nepal's total bird species, 168 species are classified in nationally threatened groups of which 68 species are critically endangered, 38 species are endangered and 62 species are categorized as vulnerable (Inskipp et al., 2016). Sixty-two species are now classified as near endangered (Inskipp et.al., 2017). As per the National Parks and Wildlife Conservation Act-NPWC Act 1973, nine species of birds are nationally protected (DNPWC, 1973) and 113 species of birds are listed in the CITES category (DNPWC, 2018). It has been reported a total of 120 wetland-dependent species of birds from 625 species of birds belonging to 64 families from Chitwan National Park and its surrounding localities (BES & DNPWC, 2013) has reported. Of the total 120 wetland dependent species of birds, winter visitors are 80, summer visitors are 6, resident 28 and vagrant included 6 species (Baral & Upadhaya, 2008). Due to the increasing trend in the degradation of wetland in Chitwan National Park, wetland birds are also decreasing from the wetland areas like rivers, lakes, ponds, streams (Baral, 2009).

Hunting and netting of the birds have also been reported as significant threats to the Chitwan rivers (Tyabji, 2002). Food shortage due to over-fishing as well as the use of chemicals in water was the main reason for the decreasing number of water birds in the Rapti River of CNP (Jha & Sharma, 2018).

Since the numbers of wetland birds are decreasing year by year,this research aims to study these asonal diversity of water birds intheRapti River (Sauraha to Kasara), Chitwan National Park.

2. Method and Materials

Chitwan National Park (27016’56”–27042’14”N & 83050’23”–84046’25”E) was established in 1973. With the beginning of conservation of biodiversity in Nepal. Chitwan National Park covers an area of 952.63 km^2 and is located in Southern Central Terai of Nepal (Fig. 1). In 1973, the National Parks and Wildlife Conservation Act was enacted and Chitwan National Park was declared the first national park of Nepal (Jha, 2016). United Nations Educational Scientific and Cultural Organization (UNESCO) declared the park a World Heritage Site in 1984 and is also identified as an important bird area (IBA) by Bird Life International (OCNP, 2012). The CNP has a unique mosaic of habitats that include wetlands, woodlands, dense forests, and grasslands that support an amazing diversity of both plant and animal species (CNP, 2018). CNP has been classified into three main vegetation types. Sal (*Shorea robusta*) forest occupies 70 percent of the park. The riverine forest occupies an area of about 7 percent along the Rapti, Narayani, and Reu rivers and their island (CNP, 2020). It is mainly dominated

by Simal (*Bombax ceiba*) and grassland.Grassland occurs in alluvial flood plains that cover 20 percent of the parking area that supports luxuriant growth of grasses interspersed with patches of riverine forest (Dinerstein, 2003). The CNP harbors 50 species of mammals, 526 species of birds, 49 species of reptiles and amphibians, and 120 species of fish (CNP, 2018). The park is especially renowned for its protection of one-horned Rhinoceros (*Rhinoceros unicornis*), Royal Bengal Tiger(*Panthera tigris tigris*), and Gharial Crocodile (*Gavialis gangeticus*) (OCNP, 2012). The park has many river sandlakes. Riversincludethreemajorrivers:the Narayani, Rapti, and Reu. Major lakes areeeshazari Lake, Tamor Lake, Lami Lake, Garud Lake, and Devi Lake (DNPWC, 2018). The current study area is the mainstream of Rapti River that is from Sauraha to Kasara. The distance between Sauraha to Kasara is 20 Km. The study area has a tropical monsoon climate with high humidity all through the year. The temperature reaches up to 38^{o}C in summer (June–July) and October through February with average temperatures of 25^{0}C. The area receives an average annual rainfall of 2600 mm (CNP, 2020).

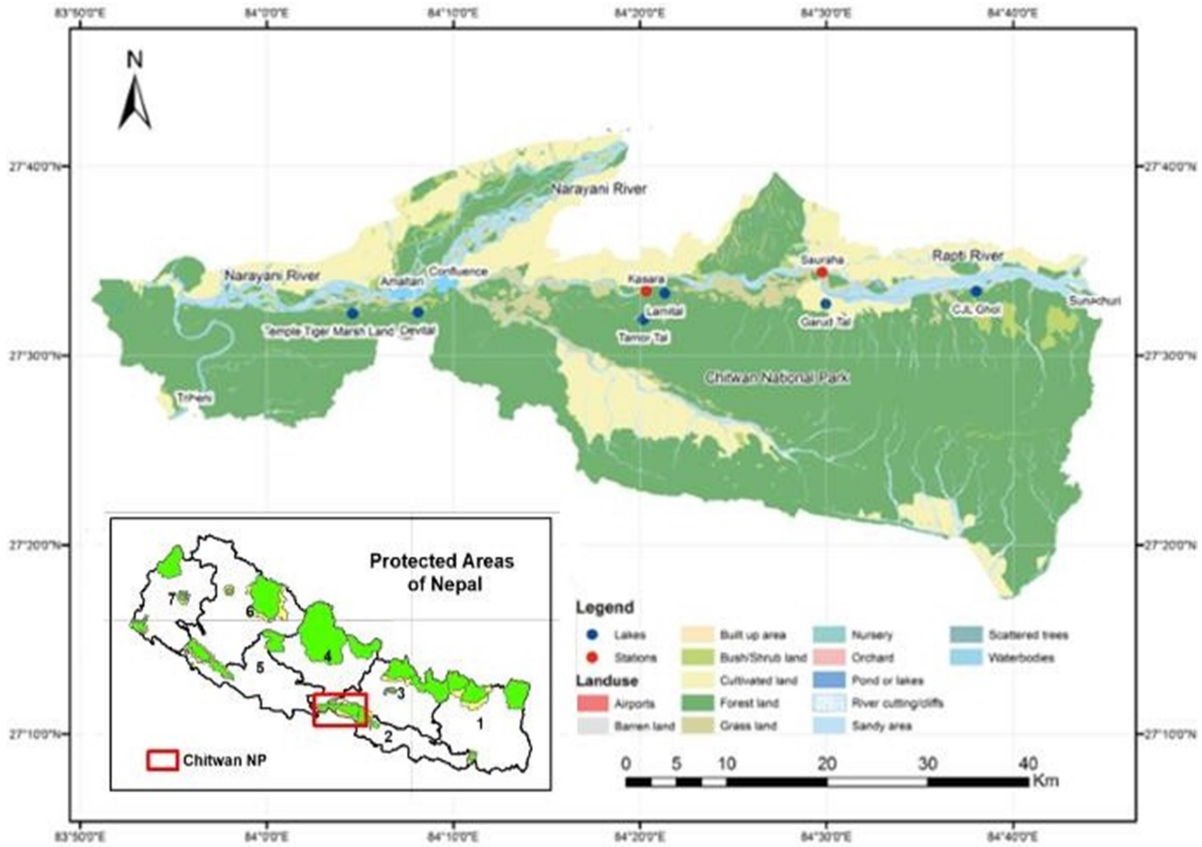

Figure1: *Map showing the location of study area*

2.1 Field Method

The current study was conducted from Sauraha to Kasara of Chitwan National Park. The distance between Sauraha to Kasara is 20 km. This study was conducted in the month of August (2017) and January (2018). A wooden dugout canoe was used to make the populations counts of waterfowls in the study area (Sauraha to Kasara). A survey was conducted in the mainstream of Rapti River with two experienced bird guides focused on both sides of the boat by transect count. The research team spent 6 days on a survey in a range of 4-5 hours. The speed of the travel was

in a range of 3km/hr to 4km/hr. The survey was carried out between 6:30 a.m. to 11:30 a.m. but during the periods of foggy weather, surveys were delayed until visibility was good. The birds were observed during the peak hours of their activity with the help of 10x42 Bushnell waterproof binocular and photographs were taken and videos were recorded by using a Canon Digital SLR camera to facilitate identification ofsome bird species.Afield guide "Birds of Nepal" (Grimmett et al., 2016) and Birds of the Indian subcontinent (Grimmett etal.,2011) were used to identify the birds in the field. All recorded birds species were categorized into different statuses based on IUCN Red List (Grimmettet al., 2003) as per their migratory status such as resident, winter migrants, summer migrants. Each species was classified into categories of national status as well as global status based on the National Red List of Nepal's Birds (Inskipp e tal., 2017) and the current IUCN Red List status 2021.

3. Data Collection

This study was conducted in August 2017 and` January 2018. This study was based on both primary and secondary data.

3.1 Primary Data Collection

The data were collected by transect method using wooden dugout canoe. The birds were recorded on the basis of birds observed, heard and in flight.

3.2 Secondary Data Collection

All the relevant journal papers, books, published and unpublished reports were consulted as secondary data.

4. Data Analysis

Shannon-Weiner diversity index(Shannon and Weaver, 1949) was used to calculate bird diversity.

Shannon-Weiner diversity index 'H' was calculated using the formula:

$H = -\sum(Pi*\ln Pi)$

5. Results

5.1 Avifauna in the Study Area

This study recorded 578 individuals of water birds belonging to 51 species, 9 orders, and 18 families in the study area. Among them, 219 individuals of birds were recorded during October and 359 individuals during January. The present study also revealed that the Anatidae family (11 species) dominated the avifauna in this area, followed by Ardeidae (9 species), Rallidae, Ciconiidae, Scolopacidae (4 species each), Accipitridae, Charadriidae (3 species each), Phalacrocoracidae, Alcedinidae (2 species each). Moreover, 9 families-Gruidae, Glareolidae, Anhingidae, Turdidae, Motacillidae, Rostratulidae, Laridae, Jacanidae, and Threskiornthidae-were poorly represented in the study area with a single species each (Table2).

The highest number of species were found in orders Anseriformes and Charadriiformes (11 species each) followed by Pelecaniformes (10 species), Gruiformes (5 species), Ciconiiformes (4 species),

Suliformes and Accipitriformes (3 species each) and least number 2 in orders Coraciiformes and Passeriformes (Table 2).

Among 51 species, 34 (66.66%) bird species were recorded during the summer season and 45 (88.23%) recorded during the winter season of which 26 (50.98%) species were common to both seasons (Table 2).

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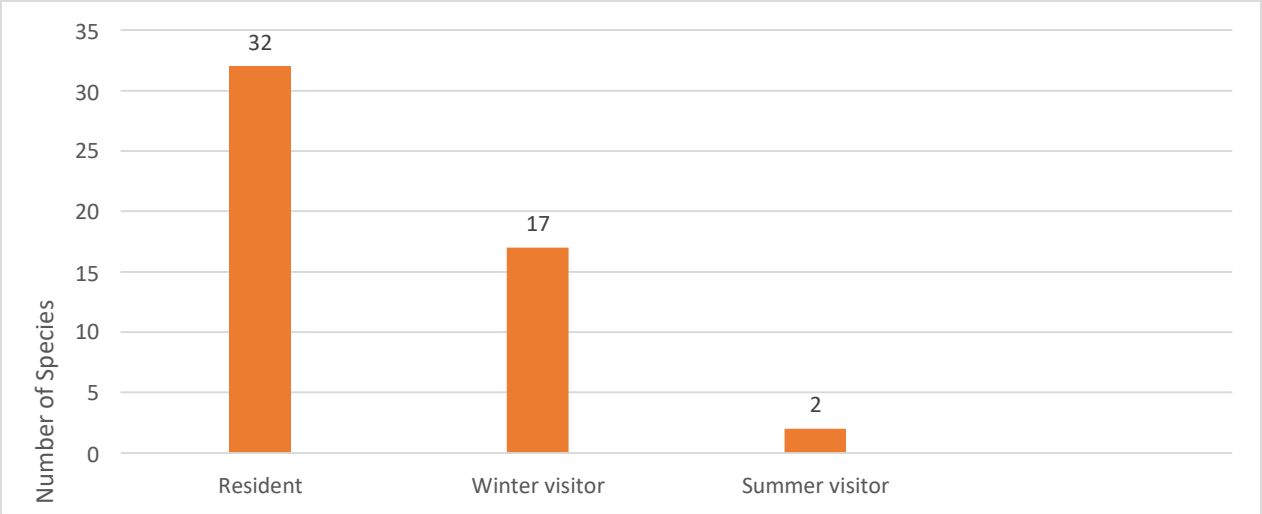

Figure 2: *Population of resident and migratory birds*

Analysis of data on residential status revealed that out of 51 species, 32 (62.74%) constitute residents, 17 (33.33%) were identified as winter visitors, and 2 (3.92%) as summer visitors. Thus, the winter season was found dominant for water birds than summer (Fig.2).

5.2 Population Status

Total of 191 individuals of Goose and ducks were recorded in the study area, of which 186 individual were recorded during the winter season. This figure accounts for 33.04% of the total count of this species. Egrets and herons accounted for 21.10% of a total count of 122. Darter and water hens were similar accounting for 0.86% of the total count of 5 and 5 respectively. However, raptors were observed with very low in the number with a total of 8 (1.38%) individuals (Table 2).

5.3 Species Diversity

Over all the species diversity of winter season was higher than that of summer season. The Shannon-Weiner diversity index showed high diversity in winter season (**H'**= 3.47) than in summer (**H'**=3.30) (Table 1).

Seasons	Number of species	Number of Individual	Shannon-Weiner Index (H)
Summer	34	219	3.30
Winter	45	359	3.47

Table1: *Species diversity in two seasons*

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5.4 Conservation Status of Birds

Of the 51 bird species a total of 43 species of birds were Least Concern, 5 species were Near Threatened, 2 species were Vulnerable, and 1 species as Endangered under the categories of Global IUCN Status. Likewise, 33 species were Least Concern (LC), 10 species were Near Threatened (NT), 4 species were Vulnerable (VU), 3 species were Critically Endangered (CR) and1 species as Endangered (EN) under the categories of National Red List of Nepal's Birds (Fig.3).

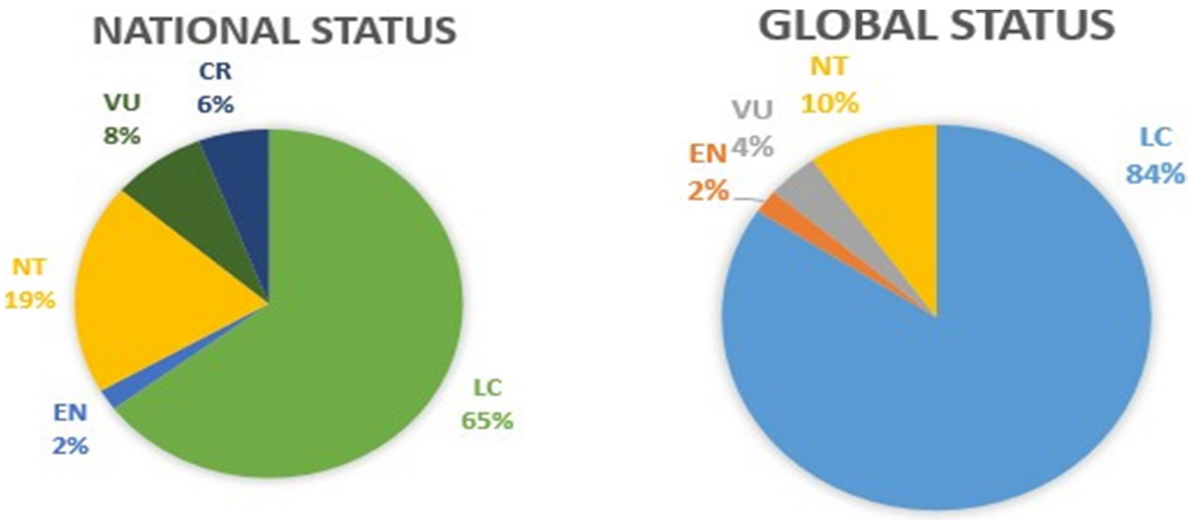

Figure 3: *Conservation status of recorded birds.*

6. Discussion

Although various researchers have collected the data about birds of Nepal and Chitwan, this study has been carried out to determine seasonal diversity, migratory status and common threats to birds. During the mid-winter water bird count, it has been found that 9 species of waterfowl with a total of 6072 individuals in 2010, 12 species of waterfowl with a total of 7550 individuals in 2011, 12 species of waterfowl with a total of 6884 individuals in 2012, 11 species of waterfowl with a total of 7797 individuals in 2013 in Chitwan National Park (Khadka, 2017). A trend of overall increase in the waterfowl number has been recorded with 9146 individuals compared to the previous years (Khadka, 2014). This trend of increase in the number of waterfowl species might be due to the adequate amount of food in the wetland (Khadka, 2014).The result of the present study showed 578 individuals of birds with 51 birds species belonging to 9 orders and 18 families. A total of 191 individuals of geese and ducks were recorded in the study area. In the present study, the number of water bird species are found to be lower in compared to the previous studies. This might be due to the limited time and small study area.

Total of 34 bird species were recorded during our first visit (August) whereas a total of 45 bird species were recorded during the second visit (January). Easy availability of food, suitable climate and temperature, and migration of birds might be the reason for high species richness in the winter season. Birds are unable to tolerate the high temperature in the summer season so that low species were recorded in the first visit. However, during the winter season,

the assemblage of water bird species was high because most of the winter migratory birds are dependent on the wetland. This might be because Chitwan National Parks being located in warmer region, the winter migratory birds feel more comfortable in warmer region due to the harsh cold climatic conditions of the cold mountainous regions and colder parts of the world during winter (Jha, 2019). The birds which come to Nepal as winter migrants comprise mostly Duck species and Raptors, the other species are Thrushes, Flycatchers, Leaf Warblers, and Wagtails (Jha, 2018). Different anthropogenic disturbances such as land mining, livestock grazing, water pollution, fish poisoning, fishing through electric shock, and random movement of people are prevalent in the study area. This has resulted in the loss of habitats and disturbances to waterfowl. Therefore, very low numbers of waterfowls were recorded. Holistic solutions of the Rapti River is essential to protect the water fowl in CNP.

7. Conclusion

The species richness of water birds in the Rapti River of CNP during two different months (January and August) showed that there were altogether 51 species of birds belonging to 9ordersand18 families.

The highest number of bird species was recorded during January (45) than in August (34) showing the seasonal variation in species richness of avifauna. Different factors such as climate, temperature, and availability of food influence the distribution of species in the area. The family Anatidae was found the most abundant with 11 species. The diversity index and species richness were higher in winter season as compared to summer. The present study revealed that, though the habitat destruction, human interferences, and fishing were major threats to the water birds in the study area, it still provides some potential habitats for winter migratory water birds as well as residents.

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Table 2: *Systematic list and status of Birds in the study area.*

S.N.	Order	Family	CommonName	ScientificName	No. in Summer	No. in Winter	sidentialStatus	NationalStatus	IUCN Status
1	Anseriformes	Anatidae	Red-crested Pochard	*Nettarufina*(Pallas,1773)		20	WV	LC	LC
2	Anseriformes	Anatidae	CommonPochard	*Aythyaferina* (Linnaeus,1758)		14	WV	NT	VU
3	Anseriformes	Anatidae	CommonTeal	*Anas*creccaLinnaeus,1758		12	WV	LC	LC
4	Anseriformes	Anatidae	NorthernPintail	*Anasacuta*Linnaeus,1758		15	WV	EN	LC
5	Anseriformes	Anatidae	Mallard	*Anasplatyrhynchos*Linnaeus,1758		13	WV	LC	LC
6	Anseriformes	Anatidae	Gadwall	*Marecastrepera*(Linnaeus, 1758)		15	WV	LC	LC
7	Anseriformes	Anatidae	CommonShelduck	*Todornatodorna*(Linnaeus,1758)		8	WV	LC	LC
8	Anseriformes	Anatidae	RuddyShelduck	*Todornaferruginea*(Pallas,1764)		53	WV	NT	LC
9	Anseriformes	Anatidae	Bar-headed Goose	*Anserindicus*(Latham,1790)		23	WV	NT	LC
10	Anseriformes	Anatidae	Lesserwhistling Duck	*DendrocygnaJavanica* (Horsfield,1821)	5	13	R	LC	LC
11	Anseriformes	Anatidae	EurasianWigeon	*Anaspenelope* (Linnaeus,1758)		16	WV	LC	LC
12	Ciconiiformes	Ciconiidae	Black Stork	*Ciconianigra*(Linnaeus,1758)	6	7	R	VU	LC
13	Ciconiiformes	Ciconiidae	AsianWollyneck	*Ciconia episcopus* (Boddaert,1783)	5	3	R	NT	NT
14	Ciconiiformes	Ciconiidae	AsainOpenbill	*Anastomus oscitans* (Boddaert,1783)	7	3	R	VU	LC
15	Ciconiiformes	Ciconiidae	LesserAdjutant	*LeptoptilosJavanicus* (Horsfield,1821)	3	4	R	VU	VU
16	Suliformes	Phalacrocoracidae	Great Cormorant	*Phalacrocoraxcarbo*(Linnaeus,1758)	3	7	R	NT	LC

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17	Suliformes	Phalacrocoracidae	LittleCormorant	*Microcarboniger*(Vieillot, 1817)	4	5	R	LC	LC
18	Suliformes	Anhingidae	OrientalDarter	*Anhinga melanogaster*Pennant, 1769	4	1	R	NT	NT
19	Accipitriformes	Accipitridae	HenHarrier	*Circuscyaneus* (Linnaeus,1766)		4	WV	VU	LC
20	Accipitriformes	Accipitridae	Grey-headed Fish-eagle	*Icthyophagaichthyaetus*(Horsfield,1821)	4	1	R	CR	NT
21	Accipitriformes	Accipitridae	Pallas'sFish-eagle	*Haliaeetus leucoryphus* (Pallas,1771)	2	1	R	CR	EN
22	Gruiformes	Rallidae	CommonCoot	*Fulicaatra* Linnaeus,1758		3	WV	LC	LC
23	Gruiformes	Rallidae	Watercock	*Gallicrexcinerea*(Gmelin,1789)	8		SV	NT	LC
24	Gruiformes	Rallidae	CommonMoorhen	*Gallinulachloropus*(Linnaeus,1758)		9	WV	LC	LC
25	Gruiformes	Rallidae	White-breastedWaterhen	*Amaurornisphoenicurus* (Pennant, 1769)	5		R	LC	LC
26	Gruiformes	Gruidae	CommonCrane	*Grusgrus*(Linnaeus,1758)		13	WV	NT	LC
27	Pelecaniformes	Threskiornithidae	Red-napedIbis	*Pseudibispapillosa*(Temminck,1824)	5		R	LC	LC
28	Pelecaniformes	Ardeidae	Black-crowned NightHeron	*Nycticoraxnycticorax* (Linnaeus,1758)	5		SV	LC	LC
29	Pelecaniformes	Ardeidae	GreatWhiteEgret	*Ardeaalba* Linnaeus,1758	9	7	R	LC	LC
30	Pelecaniformes	Ardeidae	IntermediateEgret	*Ardeaintermedia*Wagler,1829	7	6	R	LC	LC
31	Pelecaniformes	Ardeidae	LittleEgret	*Egrettagarzetta*(Linnaeus,1766)	19	11	R	LC	LC
32	Pelecaniformes	Ardeidae	CattleEgret	*Bubulcusibis* (Linnaeus,1758)	6	3	R	LC	LC
33	Pelecaniformes	Ardeidae	Green-backedHeron	*Butoridesstriata* (Linnaeus,1758)	8	5	R	LC	LC
34	Pelecaniformes	Ardeidae	IndianPond Heron	*Ardeolagrayii* (Sykes,1832)	12	3	R	LC	LC
35	Pelecaniformes	Ardeidae	Purple Heron	*Ardeapurpurea*Linnaeus,1766	6	3	R	LC	LC
36	Pelecaniformes	Ardeidae	GreyHeron	*Ardeacinerea* Linnaeus,1758	7	5	R	LC	LC

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37	Charadriiformes	Charadriidae	RiverLapwing	*Vanellusduvaucelii*(Lesson,1826)	16	3	R	NT	NT
38	Charadriiformes	Charadriidae	Red-wattled Lapwing	*Vanellusindicus* (Boddaert,1783)	8	2	R	LC	LC
39	Charadriiformes	Charadriidae	Grey-headedLapwing	*Vanelluscinereus* (Blyth,1842)		8	WV	LC	LC
40	Charadriiformes	Scolopacidae	EurasianCurlew	*Numeniusarquata*(Linnaeus,1758)		6	WV	CR	NT
41	Charadriiformes	Scolopacidae	GreenSandpiper	*Tringaochropus*Linnaeus,1758	9	3	R	LC	LC
42	Charadriiformes	Scolopacidae	CommonSandpiper	*Actitishypoleucos*Linnaeus,1758	9	7	R	LC	LC
43	Charadriiformes	Scolopacidae	Common Greenshank	*Tringanebuleria*(Gunnerus,1767)	7		R	LC	LC
44	Charadriiformes	Glareolidae	LittlePratincole	*Glareolalactea*Temminck,1820	9	9	R	NT	LC
45	Charadriiformes	Rostratulidae	GreaterPainted Snipe	*Rostratulabenghalensis* (Linnaeus,1758)		5	WV	LC	LC
46	Charadriiformes	Laridae	CommonGull-billed Tern	*Gelochelidonnilotica*(Gmelin, 1789)	3		R	LC	LC
47	Charadriiformes	Jacanidae	Bronze-winged Jacana	*Metopidiusindicus*(Latham,1790)	12	9	R	LC	LC
48	Coraciiformes	Alcedinidae	PiedKingfisher	*Cerylerudis*(Linnaeus,1758)	9	6	R	LC	LC
49	Coraciiformes	Alcedinidae	CommonKingfisher	*Alcedoatthis*(Linnaeus,1758)	10	3	R	LC	LC
50	Passeriformes	Turdidae	Black-throated Thrush	*Turdusatrogularis*Jarocki,1819	9	12	R	LC	LC
51	Passeriformes	Motacillidae	WhiteWagtail	*Motacillaalba*Linnaeus,1758	21	13	R	LC	LC

SV=Summer Visitor; WV=Winter Visitor; R=Resident; LC=Least Concern; VU=Vulnerable; EN=Endangered, CR=Critically Endangered; NT=Near Threatened.