

**Status of wading birds in selected wetlands with special reference to threatened
and migratory species**

By Karishma Gurudas Naik

Seat No: 21P044017

Under the Guidance of

Dr. Minal Desai Shirodkar

Zoology Discipline

School of Biological Sciences and Biotechnology

Goa University

2022- 2023

**STATUS OF WADING BIRD IN SELECTED WETLANDS WITH SPECIAL
REFERENCE TO THREATENED AND MIGRATORY SPECIES**

A Dissertation Report for

Course code and Course Title: ZOC 438 Dissertation

Credits: 8

Submitted in partial fulfilment of Masters / Bachelor's Degree

Zoology

by

Karishma Gurudas Naik

Roll Number: 21P044017

Under the Supervision of

Dr Minal Desai Shirodkar

School of Biological Sciences and Biotechnology
Programme Zoology



Goa University

Date:

Examined by:

Seal of the School

DECLARATION BY STUDENT

I hereby declare that the data presented in this Dissertation / Internship report entitled, “Status of wading bird in selected wetlands with special reference to threatened and migratory species” is based on the results of investigations carried out by me in the Master of Zoology at the School of Biological Sciences and Biotechnology, Goa University under the Supervision of Dr Minal Desai Shirodkar and the same has not been submitted elsewhere for the award of a degree or diploma by me. Further, I understand that Goa University or its authorities will be not be responsible for the correctness of observations / experimental or other findings given the dissertation.

I hereby authorize the University authorities to upload this dissertation on the dissertation repository or anywhere else as the UGC regulations demand and make it available to any one as needed.

Karishma Gurudas Naik
21P044017
Programme Zoology
School of Biological Sciences and Biotechnology
Date:

Place: Goa University

COMPLETION CERTIFICATE

This is to certify that the dissertation / internship report “Status of wading bird in selected wetlands with special reference to threatened and migratory species” is a bonafide work carried out by **Ms Karishma Gurudas Naik** under my supervision/mentorship in partial fulfilment of the requirements for the award of the degree of **Master in Zoology** in the Discipline Programme Zoology at the School of Biological Sciences and Biotechnology, Goa University.

Date:

Dr Minal Desai Shirodkar
Assistant Professor
Programme Zoology

Dr Savita Kerkar
Dean of SBSB
Programme Zoology
School of Biological Sciences and Biotechnology
Date:
Place: Goa University

School Stamp

Acknowledgement

In completion of this project successfully, many people have offered me their guidance and supplied pertinent information for which I am grateful. The success and the final outcome of this project required domain expertise, encouragement and constructive criticism which I received from my project guide, Dr Minal Desai Shirodkar, Assistant Professor, Programme Zoology. Her mentoring and critique have enabled me to shape this project report meaningfully and submit the same in time.

I would like to offer my sincere gratitude to my parents for their moral support, encouragement and accompanying me on the field. I would also like to thank my classmates and friends who have helped me in some way or the other in various phases of the completion of the project.

Ms Karishma Naik

Index

Serial No	Content	Page No
1	Chapter 1: Introduction	1- 3
2	Chapter 2: Literature Review	4- 6
3	Chapter 3: Study Area	8- 13
4	Chapter 4: Methodology	14- 16
5	Chapter 5: Observations	17- 50
6	Chapter 6: Discussion	51- 54
7	Chapter 7: Conclusion	55- 56

Chapter 1: Introduction

Introduction

Wetlands are fragile ecosystem with diverse characters including birds (Burger, 1985). They are one of the most important and valuable ecosystems and thus are also referred to as “kidneys of Earth” (Zhang et, 2010). It assists gathering of wide range of migratory and resident bird species as it has high nutritional value as well as productivity (Bahadur *et. al.* 2012). The water birds exploit a variety of habitats and depend upon a mosaic of microhabitats for their survival. Habitats with scattered vegetation cover and stray tree provide suitable shelter and foraging grounds for the wetland birds (Kumar *et. al.* 2009).

Species co-exist through resource partitioning, including the partition of habitat, food and habitat utilization time. This behaviour of resource partitioning is considered to be an evolutionary strategy to partition limited resources and to minimize the competition between different species (Zhou, 2013). Wetland are crucial foraging areas for waterbirds (Gatto *et. al.* 2008) and birds use various foraging techniques to exploit the food resources available in an area (Nudds and Bowlby, 1984). Difference between sizes of bill length and tarsus enable the birds to hunt at different depth and prey items (Rajpar *et. al.* 2010). Energy constraints in obtaining food confines a species in a specific habitat types in terms of its morphology (Liordos, 2010).

Habitats that provide convenient foraging, roosting and breeding grounds influence the integrated value of a given area for supporting a year-round avian community. Each of these functions may require different habitats which might be used independently in different areas (Ashkenazi *et. al.* 1998). Presence and absence of bird is indicative of the health of ecosystem and forms a link between food web and nutrient recycling (Zakaria and Rajpar, 2010).

Classifying the birds into feeding guilds and habitat guilds help understand the bird community structure (Sohil and Sharma, 2020). Birds are predictors of integrity and function of habitat

(Mukhopadhyay and Mazumdar, 2019). Site heterogeneity provide feeding, roosting and nesting opportunities (Sohil and Sharma, 2020; Kumar and Gupta, 2009), which benefits diverse waterbird species (Ashkenazi *et. al.* 1998). Availability of food resources determine the distribution and abundance of an area (Rajpal *et. al.* 2010; Hafner *et. al.* 1986, Evans and Dugan, 1984).

Birds are important indicators of the environment. They are found all around the world, in almost any habitat from artic to the desserts. Changes in bird populations and trends is an indicator of environmental problems. Birds being a remarkable and significant component of freshwater wetland ecosystems; their presence or absence may be indicative of ecological conditions of the particular areas (Rajpar *et. al.* 2010)

Feeding guilds and foraging behavior are important factors that determine the diversity, distribution, abundance and habitat utilization within wetlands (Gatto *et. al.* 2009). Guilds form the building block of a community (Anthal and Sahi, 2017). The term guild basically includes the species which have similar feeding habits in an environment and overlap in their niche utilization (Panda *et. al.* 2021). Feeding guild are related to complex ecosystem structure and functional communities within it (Rathod and Pedate, 2017).

Thus, study of these character is important to understand the community structure of an ecosystem. This study is an attempt to evaluate the status of wading birds in 5 selected sites with reference to threatened and migratory species.

Chapter 2: Literature Review

Literature review

Rathod *et. al.* (2015) worked on birds of coastal Jamnagar and their feeding guilds, where they described the dominant guilds were omnivorous followed by carnivorous and insectivorous. Nectivores and frugivores were less which might be attributed to high industrialisation and low tree cover. A similar study was done on the feeding guild by Panda *et. al.* (2021) who worked on understanding the influence of habitat heterogeneity on feeding guild composition in urban areas. They found out that areas such as agricultural land, parks, small forest patches and gardens support within urban areas support good bird diversity. Therefore, such habitats should be conserved within cityscape while planning developmental projects. Another such study was conducted by Liordos (2009) where he studied foraging habitat type and feeding techniques of 14 species of birds. He observed high degree of specialization in waterbird assemblage.

Waterbird communities are influenced by resources available and their ability to use them. This can be seen through the study carried out by Chatterjee *et. al.* (2020) on foraging guild and niche structure. Most species clustered together were generalist feeders compared to specialist feeders. Species with smaller niche width were more prone to habitat fluctuations.

Water depth, water level fluctuations, vegetation, salinity, topography and accessibility to food are habitat variables that influence the diversity of a wetland (Ma *et. al.* 2010). Chastant *et. al.* (2017) concluded that water level influences prey production and nesting success of wading birds. According to Chowdhury *et. al.* (2008) aquatic macrophytes display a feeding relationship with fishes within the aquatic body and the number of bird species and their diversity is proportional to the richer vegetation covering the water surface.

Availability of an appropriate roost site is an important aspect of a habitat. Birds prefer roost site which reduce thermoregulatory cost so that their energy requirement can be reduced and the conserved energy can be used for other vital processes (Block *et. al.* 2013). The author also concluded that the cost benefit function of roost site changes along with change in environment (reason and temperature). Petlik and Wedinger, (2007) studied the roosting in Little Owl. They found that tree diameter, whether the tree is dead or alive, and entrance size directly affect the temperature of the roosting site. Pearce *et. al.* (2016) in their study of Sandhill Crane roosting site found that birds select roost site based on various factors, requirements and motivation. Ecological and environmental as well as anthropogenic factors influence their roost site.

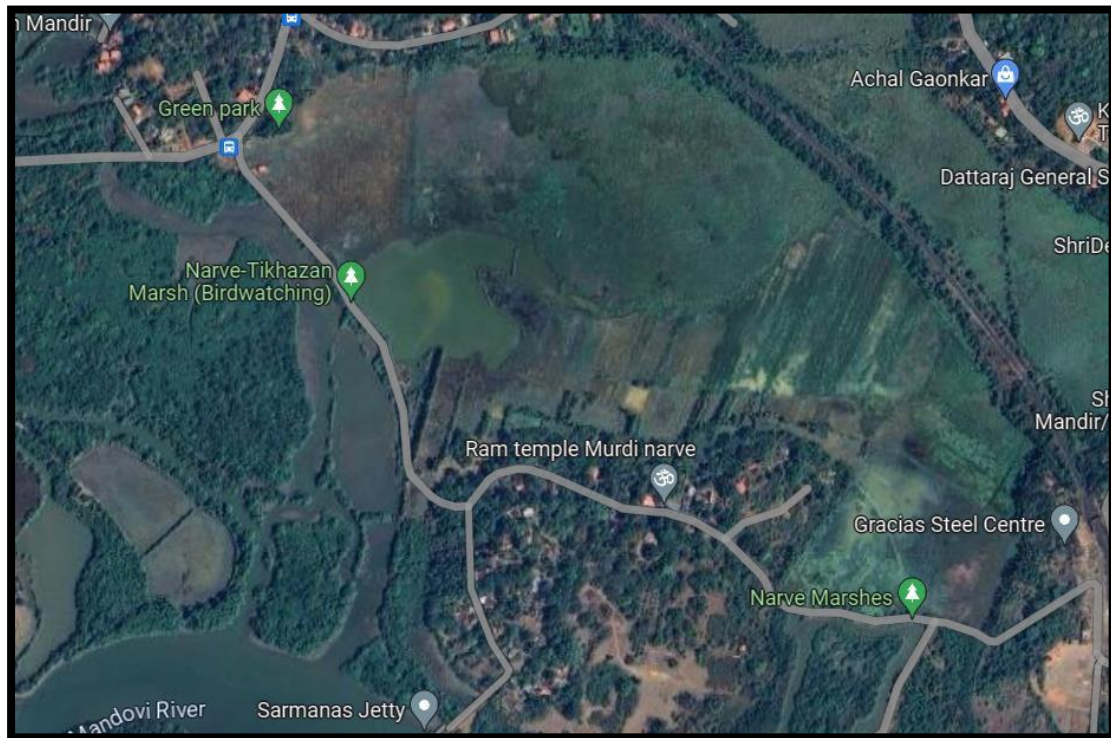
Suryakant (2017) worked on avifaunal diversity and status of threatened species in urban wetland of Kolhapur. He used Shannon diversity index to analyse the diversity of the area. He recorded an amount of diversity and concluded that urban wetlands provide necessary facilities to the birds and can support their diversity. A similar study was done by Ringim and Shafi'u (2019) where they compared two wetlands from different states and said that the two wetlands are almost similar in their species composition (45%). Such wetlands support a wide range of bird diversity and their conservation is of utmost importance. Ringim *et. al.* (2017) through their research analysed the importance of Protected Area and unprotected area as wintering ground for migratory birds.

Objectives

- To assess the diversity of threatened species in selected wetlands.
- To evaluate the diversity of migratory species in selected wetlands.
- To study the community structure based on feeding guilds in selected wetlands.
- To study the bird diversity and roosting at Narva wetland

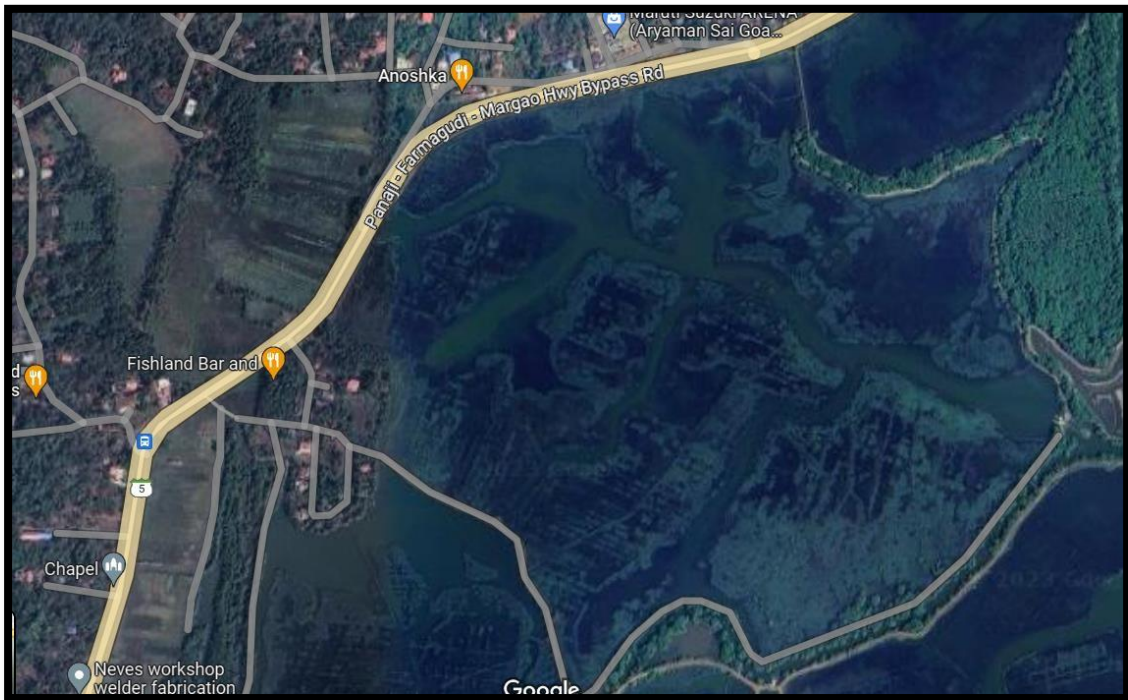
Chapter 3: Study Area

Narva Wetland



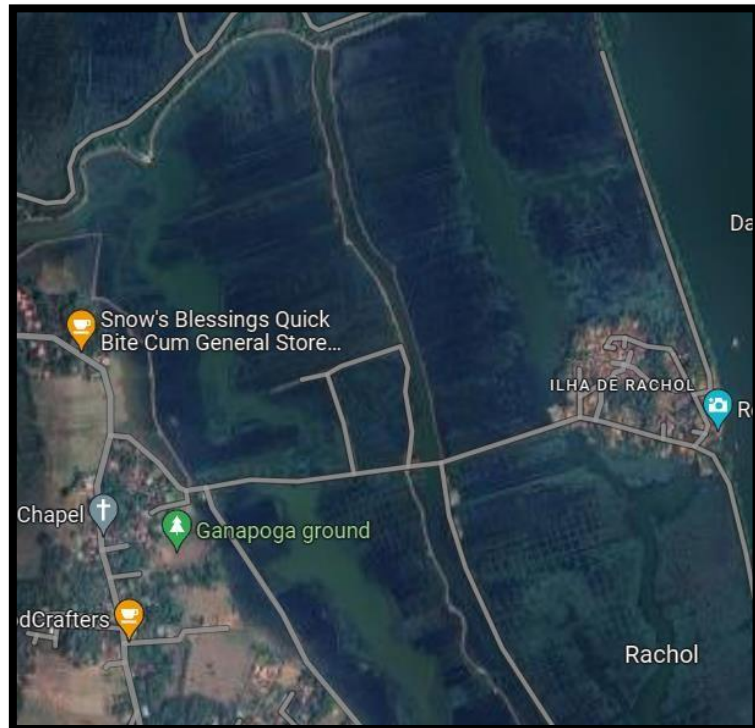
The study was carried out in Bicholim taluka of North Goa at Narva wetland. The wetland lies between $15^{\circ} 55'$ and $15^{\circ} 54'$ N latitude and $73^{\circ} 91'$ and $73^{\circ} 92'$ E longitude. The study area comprises of mixture of terrains such human habitation, fields, freshwater area and estuary. The freshwater wetland is divided by a small forested patch in between which harbours human habitation. The wetland area is usually covered with rainwater for almost half a year. Later, as the water gets drained the ground is covered by reeds and grasses. The freshwater area is usually dominated by reeds throughout the year. Other than reeds, water lilies and mangroves are also present. The area on the western side of the wetland is used for farming purpose and usually paddy is grown. Whereas on the eastern is an estuary, covered with mangroves which is separated from the study by a road passing in between. This area is a part of Mandavi estuary. The dense cover of mangrove is used by the wetland birds as their roosting site. The study was conducted for a period of one year from May 2022 till April 2023.

Loutulim Wetland



The second site is in Salcete taluka of South Goa district. The wetland lies between. The area is divided into 2 parts by a road passing in between. One part of the study site is seasonal wetland (agricultural field) and the other part is a perennial wetland. The seasonal wetland consists of water lilies, reeds and other grasses and is used by shallow water foragers. Whereas almost half part of the perennial wetland is covered by water grasses and reeds. Aquatic swimmers and divers use this area.

Santemol Wetland



Santemol is in Salcete taluka. The area stretches for several square metres. Similar to other two sites, this wetland also has a road passing in between dividing the area into agricultural land and perennial wetland. The agricultural area consists of small pond and a water stream that empties into the perennial wetland. This side lacks primary vegetation like grasses, but has mangroves on the bank of water stream. The perennial wetland area is divided further by bundhs. It consists of reeds and mangroves at the edges.

Maina Curtorim- 1 Wetland



Maina Curtorim is a community conserved area (CCA) located in Salcete taluka. This area is known for rich bird diversity. The vegetation includes water lilies and grasses. Water level rises during the rainy season. Then, as summer approaches, the water gets restricted to a pond. This area is used for grazing by cattle and fishing by local people.

Maina Curtorim 2 Wetland



Few meters away from Maina Curtorim-1, the last site Maina Curtorim-2 is located. A road passing through middle divides the area into two parts; one smaller seasonal wetland and the other bigger perennial wetland. The smaller area is covered with grasses and water lilies; and usually used by shallow water waders. The perennial wetland area is majorly covered by reeds, followed by few mangroves. It is used by aquatic swimmers and divers.

Chapter 4: Methodology

Methodology

A thorough study was undertaken to explore the diversity of birds at Narva wetland for a year from May 2022 to April 2023. Looking at diversity at Narva, four more wetlands were assessed to compare the bird diversity. A total of five readings were taken at each wetland site and five reading of Narva wetland were considered for comparative study. Observations on diversity, abundance, foraging techniques and feeding guilds of the avian fauna were carried out at the study site and adjacent areas. Bird presence and activity was recorded for each habitat.

The methods used included point count and line transect. A total of 5 points were marked along the transect. Each point was approximately 150m away from the other. 20- 30 minutes were spent at each point for observation and to record the diversity. However, observations were also made during other timings according to convenience (Kumar *et. al.*2009).

Direct count of the bird species was carried out by using the binoculars and pictures were taken with the help of cannon EOS 1600D. For identification, the field guide; Birds of Indian Subcontinent was used. After identification, birds classified into three categories based on migratory status; migrant, resident and local migrant. Their IUCN status was also recorded. To study the species diversity of Narva, regular surveys were conducted by visiting the wetland once two weeks.

To examine the nesting and breeding behavior, direct observations were made using a binocular. The bird was considered to be breeding in the study area if they were found nesting, if they showed courtship behavior like mating dance, feeding, chasing etc. and if young ones were found with their parents.

To study the roosting in birds, the study area was visited once a month. Visits were made during the evening hours after 5pm. Roost sites were identified by direct observations on

known roost sites and potential habitats. The count was taken through direct observation and mobile recordings. Count was taken during flight to avoid visibility issue. Photos of the trees were taken for identification.

To study the feeding guilds, direct observations were made on their feeding pattern. Based on their feeding habits, birds were classified into carnivore, omnivore, insectivore, herbivore, granivore, frugivore and nectivore. A total of 25 visits were conducted with five visits per wetland.

Chapter 5: Observations

Observation

A study was conducted from May 2022 to April 2023 on status of wading birds with reference to threatened and migratory species in Narva. Four more sites were selected for comparative study which included Narva, Maina Curtorim-1, Maina Curtorim- 2, Santemol and Loutulim. Narva was assessed for species diversity, feeding guilds, abundance and roosting of birds.

Narva wetland

A total of 93 species of birds were recorded at Narva. Highest abundance was observed in the month of February with 452 individuals of 50 bird species. Lowest abundance was observed in month of July. Bird species diversity and abundance was low during the monsoon season whereas the winter season showed highest diversity and abundance.

Migratory birds

Out of 93 species, 14 were migrants and 76 were residents. The migratory birds were Painted Stork, Glossy Ibis, Ruddy Shelduck, Black winged Stilt, Common Redshank, Common Greenshank, Wood Sandpiper, Marsh Sandpiper, Common Snipe, Blyth's reed Warbler, Pied Crested Cuckoo, Ashy Drongo, Paddy field Pipit and Little ring Plover. The most dominant species was Swamphen.

Roosting

Estuarine part of the wetland was used by birds for roosting. 12 species were observed roosting on mangroves which were Black headed Ibis, Glossy Ibis, Jungle Myna, Darter, Great Egret, Little Egret, Cattle Egret, Pond Heron, Swamphen, Asian Openbill, Little Cormorant and Lesser whistling Duck. Of these birds, Darter has an IUCN status of Near Threatened (NT). Highest abundance was observed in the month of February with 1242 individuals. Least abundance was recorded in July with 383 species.

The mangroves used by the birds for roosting were *Avicennia officinalis*, *Rhizophora mucrona*, *Avicennia alba*, *Acanthus illicifolius* and *caseolaris*. *Avicennia officinalis* were used for roosting as well for basking by Little Cormorants.

Feeding guild

Birds were classified into 7 feeding guilds; carnivorous, omnivorous, insectivorous, frugivorous, granivorous, herbivore and nectivorous. The dominant feeding guild was carnivore with 33 species followed by insectivore comprising of 25 species, followed by omnivore which had 19 bird species. Frugivore had 5 species and granivore, nectivore and herbivore had 4, 4 and 3 species respectively.

Comparative data between five study sites

A comparative study was conducted between Narva, Loutulim, Santemol, Maina Curtorim-1 and Maina Curtorim-2 wetland to survey for the migratory and threatened birds as well as for abundance and feeding guilds.

Feeding guild

Wetland is a highly diverse and productive area and thus support birds of various types of feeding habits. Birds observed during field study were classified into 7 feeding guilds; carnivorous, omnivorous, insectivorous, frugivorous, granivorous, herbivore and nectivorous. Highest species richness and abundance was observed for carnivore (species richness 35 and abundance 6436) followed by omnivore (species richness 21 and abundance 4245). Only three individuals of herbivore were present but the abundance was 3790. Insectivore had 533 individual belonging to 19 species. Whereas frugivore guild had 4 species with 15 individuals. Only two species of granivore and nectivore guilds were recorded with abundance 44 and 4 respectively.

Maina Curtorim- 1 wetland

A total of 2389 individual belonging to 36 species were recorded. The most dominant family was Ardeidae with 6 species.

Out of 36 species, 3 species of waders were migrant, 2 were local migrants and 29 were resident birds. The migrant species included Black winged Stilt, Wood Sandpiper and Marsh Sandpiper. Other than these, Barn Swallow and Paddy field Pipit were migrant bird present on study site. 3 threatened species were observed which were Lesser adjutant Stork, Black headed Ibis and River Tern.

The dominant feeding guild was carnivore with 18 species, followed by omnivore and insectivore with 8 species each and frugivore and granivore were represented by only one specie.

Maina Curtorim- 2 wetland

5518 individuals of 43 species were recorded in study area. Ardeidae was the dominant family with 6 species. Out of 43 bird species, 27 were resident birds, 4 were local migrants and 12 were migrants.

The wader migrant birds included Great Cormorant, Eurasian Spoonbill, Northern Shoveler, Black winged Stilt, Black tailed Godwit, Wood Sandpiper, Marsh Sandpiper, Green Sandpiper and Garganey. Other migrant species observed were Blue tailed Bee-eater, Long tailed Shrike and Paddy field Pipit.

3 species of IUCN red list status were present, which were Darter, Black tailed Godwit and Black headed Ibis. Black tailed Godwit was found significantly more in this site ($p= 0.04$).

As per feeding guild, carnivore was dominant guild, comprising of 20 species followed by omnivore comprising 10 species and insectivore, herbivore, granivore and nectivore had 8, 3,

1 and 1 species respectively.

Santemol wetland

Bird species diversity of Santemol was recorded to be 43 species. 4055 individuals of these 43 species were present. The dominant family was Charadriidae with 8 bird species.

There was a total of 11 wader migrant species including Great Cormorant, Painted Stork, Eurasian Spoonbill, Garganey, Black winged Stilt, Black tailed Godwit, Marsh Sandpiper, Wood Sandpiper, Common Redshank, Green Sandpiper and Common Snipe. Wood Sandpiper and Common Redshank were found significantly more in this wetland compared to other sites ($p= 0.011$ and $p= 0.001$ respectively). 4 spec

ies were local migrants and 28 were resident.

5 threatened species were present namely Painted Stork, Lesser adjutant Stork, Black headed Ibis, Black tailed Godwit and river tern. Black headed Ibis was found more significantly in Santemol ($p= 0.007$).

For feeding guilds, carnivore was the most dominant with 27 species, followed by omnivore comprising of 7 species. Insectivore and herbivore comprised of 4 and 3 species respectively with granivore and frugivore having one species each.

Loutulim wetland

During study, 35 species of birds were recorded with 1563 individuals. Ardeidae was dominant family represented by 6 species.

Out of 35, 24 species were resident, 3 were local migrants and 8 species were migrants. The migrant birds were Painted Stork, Great Cormorant, Garganey, Black winged Stilt, Marsh Sandpiper, Wood Sandpiper, Green Sandpiper and Common Tern. Out of 35 species, 5 were threatened species comprising of Darter, Painted Stork, Woolly necked Stork, Black headed

Ibis and River Tern.

Five feeding guilds were identified in this area of which carnivore was dominant with 24 species followed by omnivore comprising of 7 species and the feeding guild with least species of bird was herbivore, insectivore and frugivore with 2, 1 and 1 species respectively.

Narva wetland

Narva showed highest bird diversity with 67 species with 1533 individuals. The dominant families were Ardeidae and Scolopacidae with 8 species each.

Of 67 species, 51 were resident, 4 were local migrants and 12 were migrants including terrestrial birds. The wader migrant birds were Painted Stork, Garganey, Ruddy shelduck, Black winged Stilt, Wood Sandpiper, Marsh Sandpiper and Common Snipe. Other than waders, Eurasian marsh Harrier, Paddy field Pipit, Blue tailed Bee-eater, Barn Swallow and Long tailed Shrike were also found. Ruddy Shelduck was significantly found only in Narva

4 threatened species were present in Narva represented by Darter, Painted Stork, Woolly necked Stork and Lesser adjutant Stork.

Narva showed presence of 7 feeding guilds. Carnivore was the dominant guild with 24 species followed by omnivore and insectivore with 15 species each. Frugivore and herbivore comprised of 4 and 3 species respectively and feeding guilds with least species were granivore and nectivore with 2 species each.

Fig 1: Pie chart showing feeding guild composition of Narva wetland

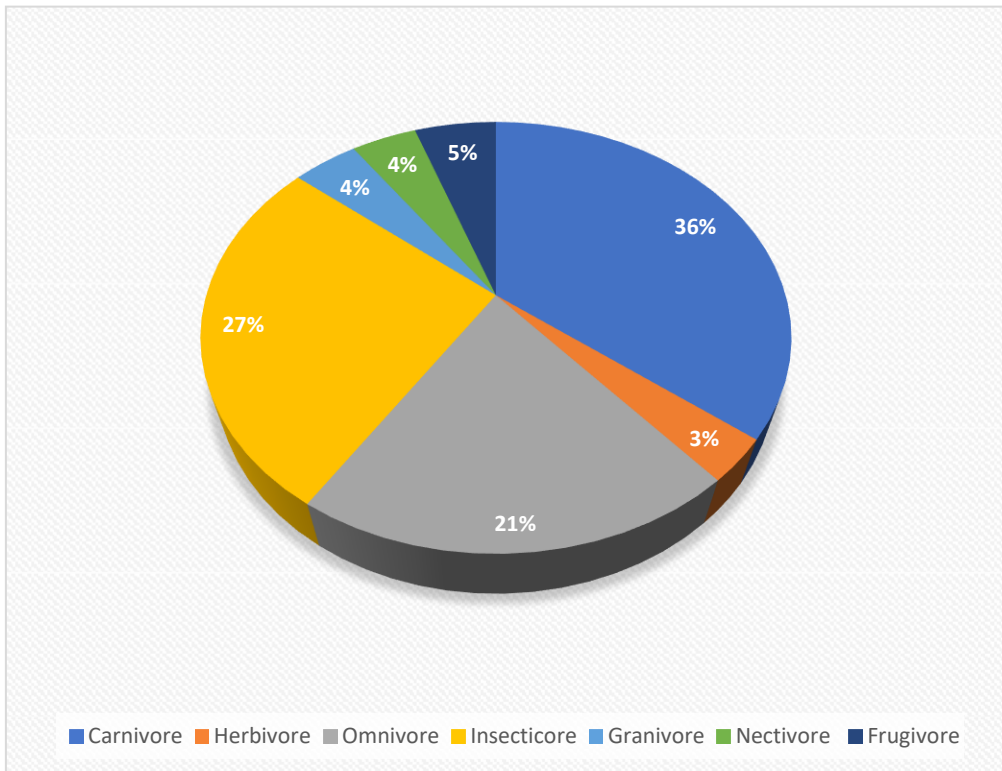


Fig 2: Bar graph showing roosting in Narva wetland

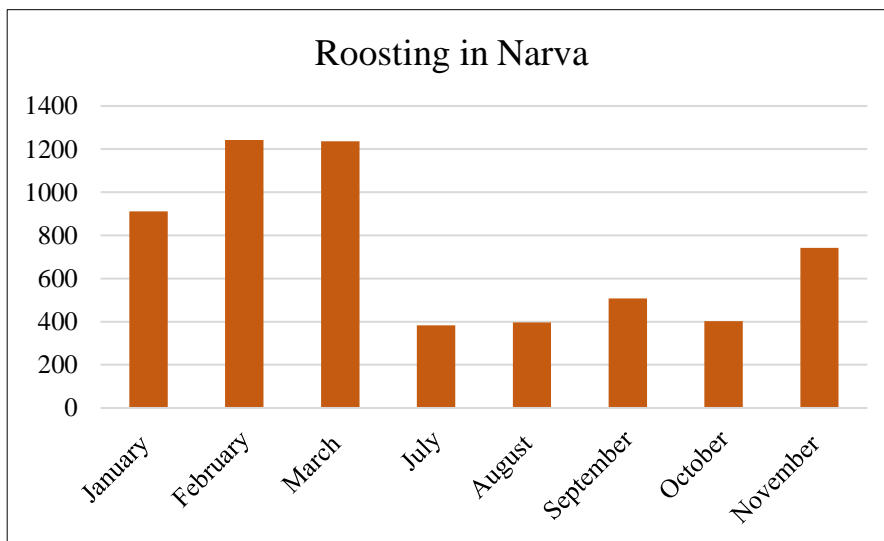


Fig 3: Pie chart showing feeding guild composition of Maina Curtorim-1 wetland

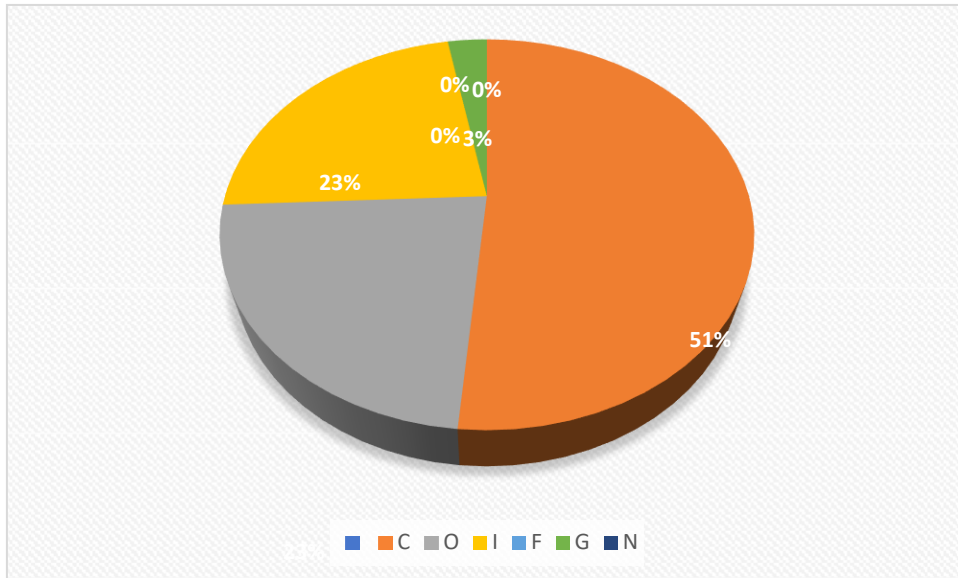


Fig 4: Pie chart showing feeding guild composition of Maina Curtorim-2 wetland

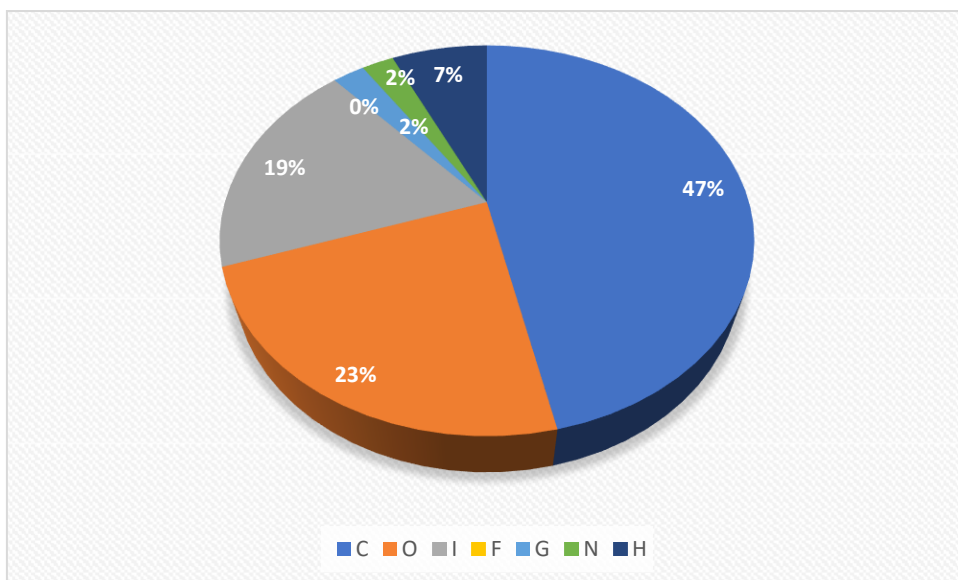


Fig 5: Pie chart showing feeding guild composition of Santemol wetland

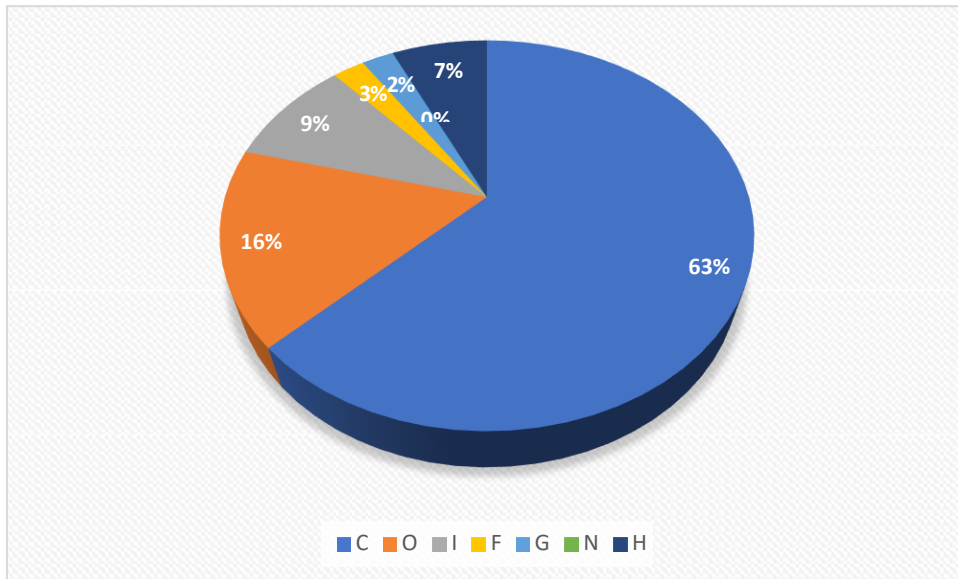


Fig 6: Pie chart showing feeding guild composition of Loutulim wetland

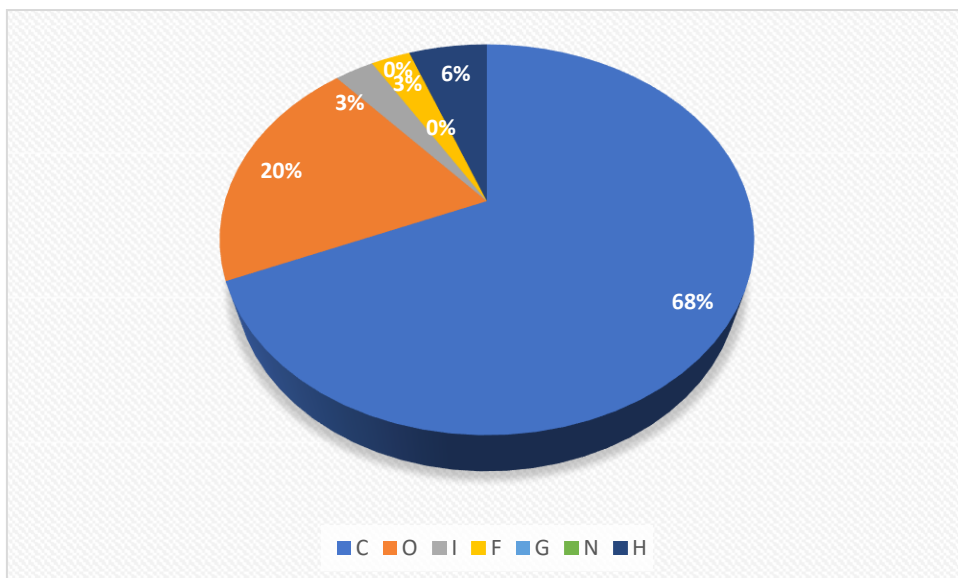


Fig 7: Pie chart showing feeding guild composition of Narva wetland

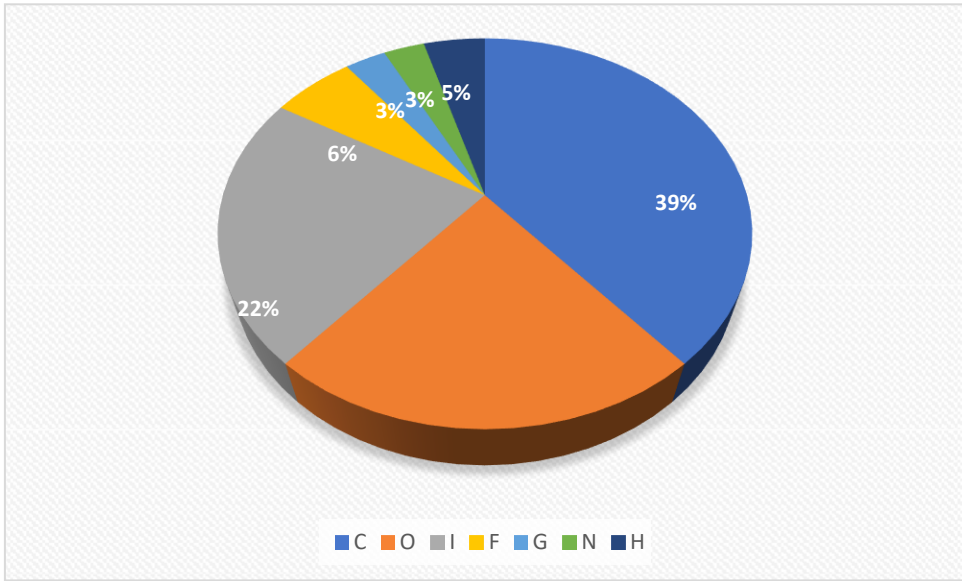


Fig 8: Pie chart depicting different feeding guilds and their Feeding guilds composition of birds

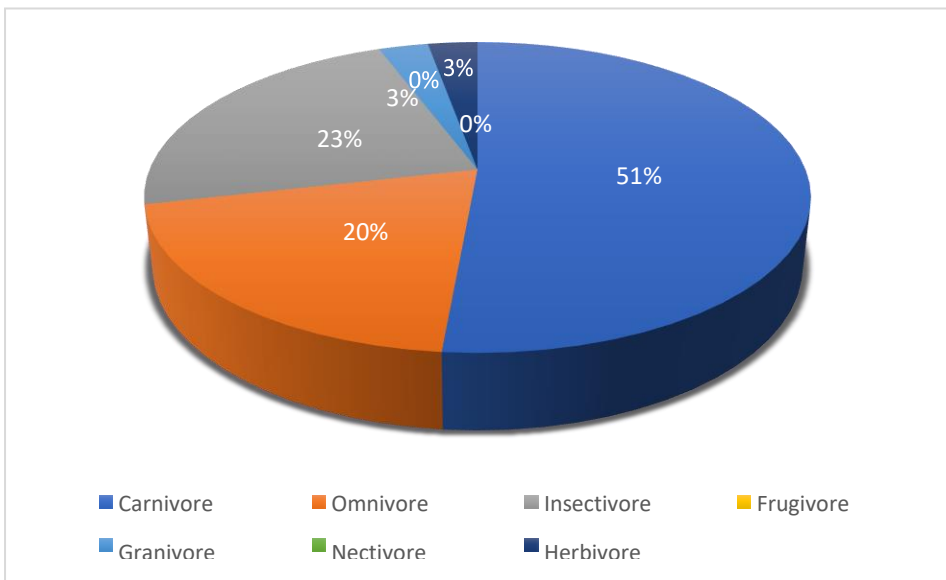


Fig 9: Bar graph showing distribution of feeding guilds in all five wetlands

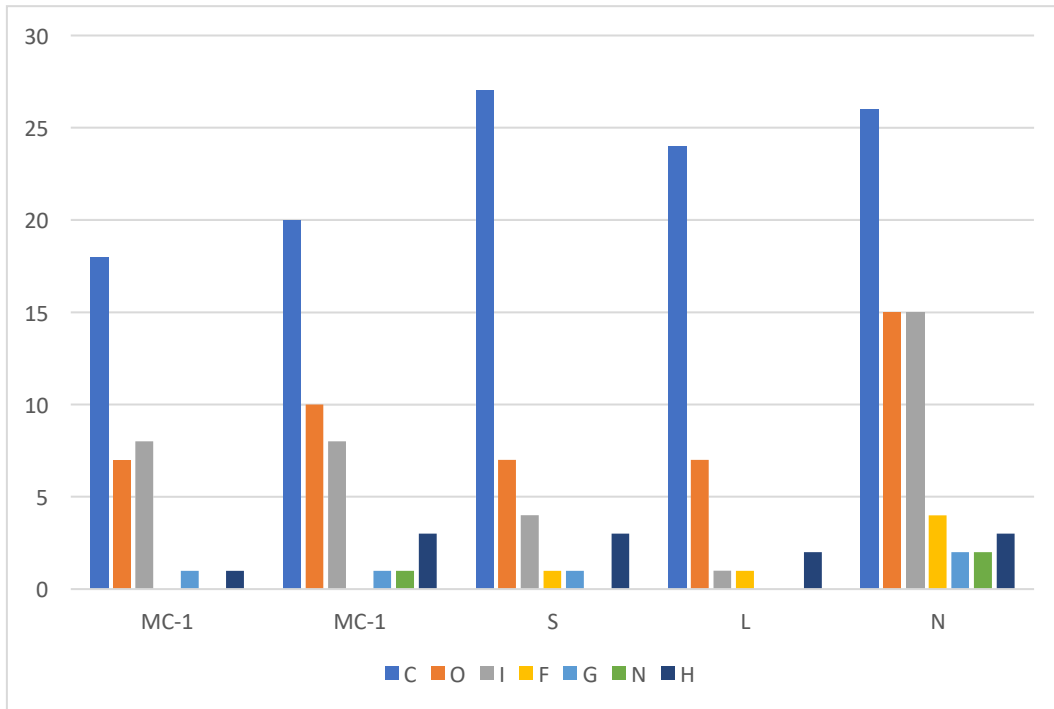


Table 3: Total bird species and their abundance according to feeding guilds

Guilds	Bird Species	Individual
Carnivore	C	35
Omnivore	O	21
Insectivore	I	19
Frugivore	F	4
Herbivore	H	3
Grainivore	G	2
Nectivore	N	2

Fig 10: Pie chart depicting the birds into different orders

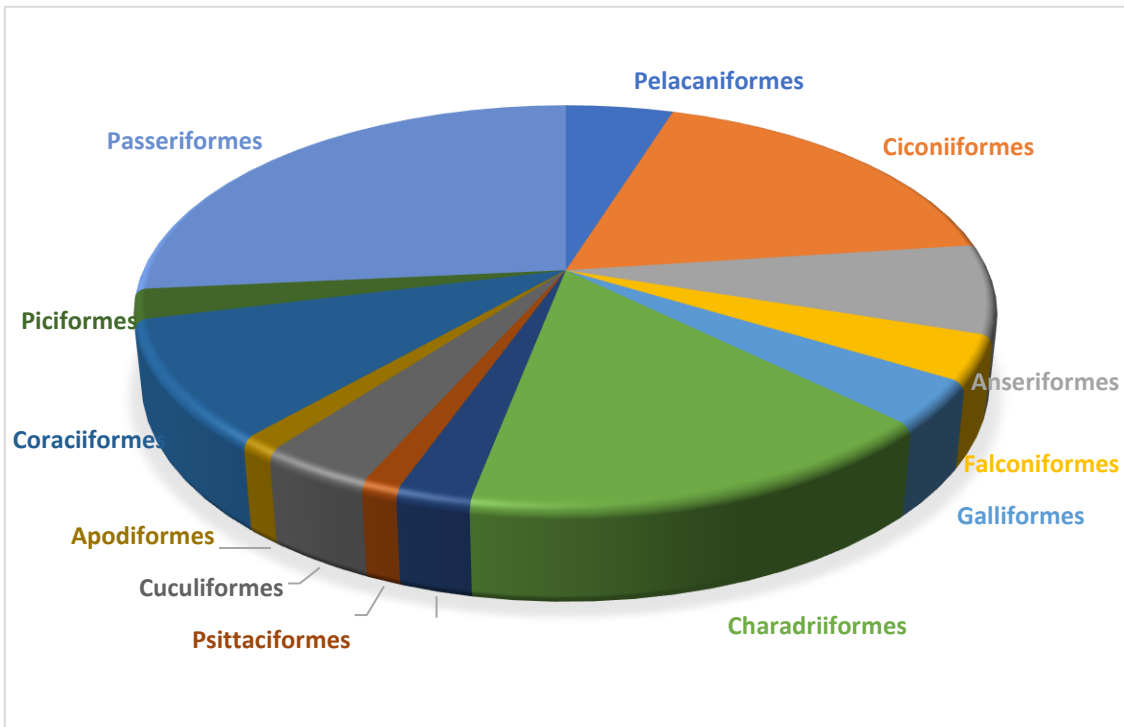


Fig 11: Bar graph showing migratory status of all five wetlands

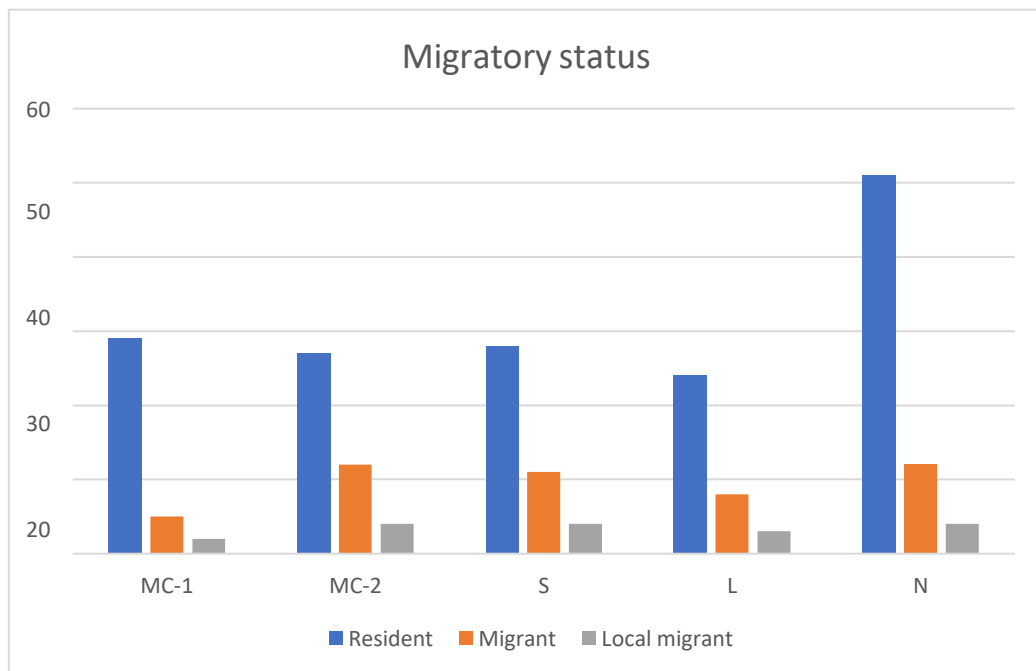


Table 1: List of birds observed in Narva with IUCN status, Migratory status and Feeding Guild

Sr No	Families	Bird Species	Scientific names	IUCN status	Migratory status	Feeding Guilds
Order- Galliformes						
1	Phasianidae	Indian Peafowl	<i>Pavo cristatus</i>	LC	R	G
Order- Pelacaniformes						
2	Phalacrocoracidae	Little Cormorant	<i>Microcarbo niger</i>	LC	R	C
3	Phalacrocoracidae	Indian Cormorant	<i>Phalacrocorax fuscicollis</i>	LC	R	C
4	Phalacrocoracidae	Darter	<i>Anhinga melanogaster</i>	NT	R	C
Order- Ciconiiformes						
5	Ardeidae	Pond Heron	<i>Ardeola grayii</i>	LC	R	C
6	Ardeidae	Purple Heron	<i>Ardea purpurea</i>	LC	R	C
7	Ardeidae	Grey Heron	<i>Ardea cinerea</i>	LC	R	C
8	Ardeidae	Cattle Egret	<i>Bubulcus ibis</i>	LC	R	C
9	Ardeidae	Little Egret	<i>Egretta garzetta</i>	LC	R	C
10	Ardeidae	Intermediate Egret	<i>Ardea intermedia</i>	LC	R	C
11	Ardeidae	Great Egret	<i>Ardea alba</i>	LC	R	C
12	Ciconiidae	Painted Stork	<i>Mycteria leucocephala</i>	NT	M	C
13	Ciconiidae	Woolly necked Stork	<i>Ciconia episcopus</i>	NT	R	C

14	Ciconiidae	Asian Openbill	<i>Anastomus oscitans</i>	LC	R	C
15	Ciconiidae	Lesser Adjutant	<i>Leptoptilos javanicus</i>	VU	R	C
16	Threskiornithiidae	Black headed Ibis	<i>Threskiornis melanocephalus</i>	NT	LM	C
17	Threskiornithiidae	Glossy Ibis	<i>Plegadis falcinellus</i>	LC	LM	C
Order- Anseriformes						
18	Anatidae	Indian Spot-billed Duck	<i>Anas poecilorhyncha</i>	LC	LM	H
19	Anatidae	Garganey	<i>Spatula querquedula</i>	LC	M	H
20	Anatidae	Lesser whistling Duck	<i>Dendrocygna javanica</i>	LC	R	H
21	Anatidae	Ruddy Shelduck	<i>Tadorna ferruginea</i>	LC	M	O
22	Anatidae	Comb Duck		LC		G
Order- Falconiformes						
23	Accipitridae	Brahminy Kite	<i>Haliastur indus</i>	LC	R	C
24	Accipitridae	Black Kite	<i>Milvus migrans</i>	LC	LM	O
25	Accipitridae	Eurasian marsh Harrier	<i>Circus aeruginosus</i>	LC	M	C
26	Accipitridae	Shikra	<i>Accipiter badius</i>	LC		C
Order- Galliformes						

27	Rallidae	Swamphen	<i>Porphyrio poliocephalus</i>	LC	R	O
28	Rallidae	White breasted Waterhen	<i>Amaurornis phoenicurus</i>	LC	R	C
Order- Charadriiformes						
29	Jacaniidae	Bronze winged Jacana	<i>Metopidius indicus</i>	LC	R	O
30	Recurvirostridae	Black winged Stilt	<i>Himantopus himantopus</i>	LC	M	O
31	Charadriidae	Red wattled Lapwing	<i>Vanellus indicus</i>	LC	R	I
32	Charadriidae	Little ring Plover	<i>Charadrius dubius</i>	LC	LM	I
33	Scolopacidae	Marsh Sandpiper	<i>Tringa stagnatilis</i>	LC	M	C
34	Scolopacidae	Wood Sandpiper	<i>Tringa glareola</i>	LC	M	C
35	Scolopacidae	Common Greenshank	<i>Tringa nebularia</i>	LC	M	C
36	Scolopacidae	Common Sandpiper	<i>Actitis hypoleucos</i>	LC	R	C
37	Scolopacidae	Common Red Shank	<i>Tringa nebularia</i>	LC	M	C
38	Scolopacidae	Common Snipe	<i>Gallinago gallinago</i>	LC	M	C
39	Glareolidae	Small Pratincole	<i>Glareola lactea</i>	LC	R	I
40	Lariidae	Gull bill Tern	<i>Sterna aurantia</i>	LC	R	C
Order- Columbiformes						
41	Columbidae	Common rock Pigeon	<i>Columba livia</i>	LC	R	G

42	Columbidae	Spotted Dove	<i>Spilopelia chinensis</i>	LC	R	G
Order- Psittaciformes						
43	Psittaculidae	Plum headed Parakeet	<i>Psittacula cyanocephala</i>	LC	R	F
44	Psittaculidae	Rose ringed Parakeet	<i>Psittacula krameri</i>	LC	R	F
Order- Cuculiformes						
45	Cuculidae	Southern Coucal	<i>Centropus sinensis</i>	LC	R	I
46	Cuculidae	Asian Koel	<i>Eudynamys scolopaceus</i>	LC	R	F
47	Cuculidae	Pied crested Cuckoo	<i>Clamator jacobinus</i>	LC	M	I
Order- Coraciiformes						
48	Alcedinidae	Common Kingfisher	<i>Alcedo atthis</i>	LC	R	C
49	Alcedinidae	White throated Kingfisher	<i>Halcyon smyrnensis</i>	LC	R	C
50	Alcedinidae	Pied Kingfisher	<i>Ceryle rudis</i>	LC	R	C
51	Alcedinidae	Stork billed Kingfisher	<i>Pelargopsis capensis</i>	LC	R	C
52	Alcedinidae	Collared Kingfisher	<i>Todiramphus chloris</i>	LC	R	C
53	Meropidae	Green Bee-eater	<i>Merops orientalis</i>	LC	R	I
54	Meropidae	Blue tailed Bee-eater	<i>Merops philippinus</i>	LC	M	I
55	Coraciidae	Indian Roller	<i>Coracias benghalensis</i>	LC	R	I

56	Bucerotidae	Indian grey Hornbill	<i>Ocyrceros birostris</i>	LC	R	O
57	Bucerotidae	Malabar pied Hornbill	<i>Anthracoceros coronatus</i>	NT	R	O
Order- Piciformes						
58	Capitonidae	Copper smith Barbet	<i>Psilopogon haemacephalus</i>	LC	R	F
59	Capitonidae	White cheeked Barbet	<i>Psilopogon viridis</i>	LC	R	F
60	Picidae	Greater flameback Woodpecker	<i>Chrysocolaptes guttacristatus</i>	LC	R	I
Order- Passeriformes						
61	Hirundinidae	Wire tailed Swallow	<i>Hirundo smithii</i>	LC	R	I
62	Hirundinidae	Barn Swallow	<i>Hirundo rustica</i>	LC	M	I
63	Hirundinidae	Red rumped Swallow	<i>Cecropis daurica</i>	LC	R	I
64	Laniidae	Long tailed Shrike	<i>Lanius schach</i>	LC	M	I
65	Dicruridae	Black Drongo	<i>Dicrurus macrocercus</i>	LC	R	I
66	Dicruridae	Ashy Drongo	<i>Dicrurus leucophaeus</i>	LC	M	I
67	Oriolidae	Indian golden Oriole	<i>Oriolus kundoo</i>	LC	R	O
68	Campephagiidae	Orange Minivet	<i>Pericrocotus cinnamomeus</i>	LC	R	I
69	Corvidae	House Crow	<i>Corvus splendens</i>	LC	R	O

70	Corvidae	Rufous Treepie	<i>Dendrocitta vagabunda</i>	LC	R	O
71	Cisticolidae	Ashy Prinia	<i>Prinia socialis</i>	LC	R	O
72	Cisticolidae	Plain Prinia	<i>Prinia inornate</i>	LC	R	I
73	Sylviidae	Blyth's reed Warbler	<i>Acrocephalus dumetorum</i>	LC	M	O
74	Pycnonotidae	Red whiskered Bulbul	<i>Pycnonotus jocosus</i>	LC	R	O
75	Pycnonotidae	Red vented Bulbul	<i>Pycnonotus cafer</i>	LC	R	O
76	Pycnonotidae	White browed Bulbul	<i>Pycnonotus luteolus</i>	LC	R	O
77	Muscicapidae	Jungle Babbler	<i>Argya striata</i>	LC	R	I
78	Muscicapidae	Orange headed Thrush	<i>Geokichla citrina</i>	LC	R	O
79	Muscicapidae	Indian Paradise Flycatcher	<i>Terpsiphone paradisi</i>	LC	R	I
80	Muscicapidae	Tickell's blue Flycatcher	<i>Cyornis tickelliae</i>	LC	R	I
81	Muscicapidae	Siberian Stonechat	<i>Saxicola maurus</i>	LC	R	I
82	Estrilididae	White rumped Munia	<i>Lonchura striata</i>	LC	R	I
83	Motacillidae	Pappy field Pipit	<i>Anthus rufulus</i>	LC	M	I
84	Motacillidae	Grey Wagtail	<i>Motacilla cinerea</i>	LC	R	I
85	Motacillidae	White browed Wagtail	<i>Motacilla maderaspatensis</i>	LC	R	C

86	Sturnidae	Jungle Myna	<i>Acridotheres fuscus</i>	LC	R	O
87	Sturnidae	Chestnut tailed Starling	<i>Acridotheres tristis</i>	LC	R	O
88	Aegithinidae	Common Iora	<i>Aegithina tiphia</i>	LC	R	O
89	Rhipiduridae	Spot breasted Fantail	<i>Rhipidura albogularis</i>	LC	R	I
90	Nectiriidae	Purple Sunbird	<i>Cinnyris asiaticus</i>	LC	R	N
91	Nectiriidae	Crimson Backed Sunbird	<i>Leptocoma minima</i>	LC	R	N
92	Nectiriidae	Purple rumped Sunbird	<i>Leptocoma zeylonica</i>	LC	R	N
93	Nectiriidae	Lotans Sunbird	<i>Cinnyris lotenius</i>	LC	R	N

IUCN status: NT- Near Threatened, VU- Vulnerable, LC- Least Concern

Migratory status: R- Resident, M- Migrant, LM- Local migrant

Feeding guilds: C- Carnivore, O- Omnivore, I- Insectivore, F- Frugivore, N- Nectivore,

G- Granivore, H- Herbivore

Table 2: List of birds found in selected wetland sites with IUCN status, Migratory status and Feeding guilds

Sr No	Families	Bird Species	Scientific names	IUCN status	Migratory status	Feeding Guilds	Sites				
							MC-1	MC-2	S	L	N
Order- Pelacaniiformes											
1	Phalacrocoracidae	Little Cormorant	<i>Microcarbo niger</i>	LC	R	C	+	+	+	+	+
2	Phalacrocoracidae	Indian Cormorant	<i>Phalacrocorax fuscicollis</i>	LC	R	C	-	+	+	+	+
3	Phalacrocoracidae	Great Cormorant	<i>Phalacrocorax carbo</i>	LC	M	C	-	+	+	+	-
4	Phalacrocoracidae	Darter	<i>Anhinga melanogaster</i>	NT	R	C	-	+	-	+	+
Order- Ciconiiformes											
5	Ardeidae	Pond Heron	<i>Ardeola grayii</i>	LC	R	C	+	+	+	+	+
6	Ardeidae	Purple Heron	<i>Ardea purpurea</i>	LC	R	C	+	+	+	+	+

7	Ardeidae	Grey Heron	<i>Ardea cinerea</i>	LC	R	C	-	+	+	+	+	+	+
8	Ardeidae	Cattle Egret	<i>Bubulcus ibis</i>	LC	R	C	+	+	+	+	+	+	+
9	Ardeidae	Little Egret	<i>Egretta garzetta</i>	LC	R	C	+	+	+	+	+	+	+
10	Ardeidae	Intermediate Egret	<i>Ardea intermedia</i>	LC	R	C	+	-	+	+	+	+	-
11	Ardeidae	Great Egret	<i>Ardea alba</i>	LC	R	C	+	+	+	+	+	+	+
12	Ardeidae	Western reef Egret	<i>Egretta gularis</i>	LC	R	C	-	-	-	+	+	+	-
13	Ciconiidae	Painted Stork	<i>Mycteria leucocephala</i>	NT	M	C	-	-	-	+	+	+	+
14	Ciconiidae	Woolly necked Stork	<i>Ciconia episcopus</i>	NT	R	C	-	-	-	+	+	+	+
15	Ciconiidae	Asian Openbill	<i>Anastomus oscitans</i>	LC	R	C	-	-	-	+	+	+	+
16	Ciconiidae	Lesser Adjutant	<i>Leptoptilos javanicus</i>	VU	R	C	+	-	+	+	+	+	+
17	Threskiornithidae	Black headed Ibis	<i>Threskiornis melanocephalus</i>	NT	LM	C	+	+	+	+	+	+	+

18	Threskiornithidae	Glossy Ibis	<i>Plegadis falcinellus</i>	LC	LM	C	+	+	+	+	+	+	+
19	Threskiornithidae	Eurasian Spoonbill	<i>Platalea leucorodia</i>	LC	M	O	-	+	+	-	-	-	-
Order- Anseriformes													
20	Anatidae	Indian Spot-billed Duck	<i>Anas poecilorhyncha</i>	LC	LM	H	-	+	+	+	-	+	+
21	Anatidae	Northern Shoveler	<i>Spatula clypeata</i>	LC	M	O	-	+	+	-	-	-	-
22	Anatidae	Garganey	<i>Spatula querquedula</i>	LC	M	H	-	+	+	-	-	+	+
23	Anatidae	Lesser whistling Duck	<i>Dendrocygna javanica</i>	LC	R	H	+	+	+	+	+	+	+
24	Anatidae	Cotton Pygmy Goose	<i>Nettapus coromandelianus</i>	LC	R	O	-	+	+	-	-	-	-
25	Anatidae	Ruddy Shelduck	<i>Tadorna ferruginea</i>	LC	M	O	-	-	-	-	-	-	+

Order- Falconiformes														
26	Accipitridae	Brahminy Kite	<i>Haliastur indus</i>	LC	R		C		+	-	+	+	+	+
27	Accipitridae	Black Kite	<i>Milvus migrans</i>	LC	LM		O		+	+	+	+	+	+
28	Accipitridae	Eurasian marsh Harrier	<i>Circus aeruginosus</i>	LC	M		C		-	-	-	-	-	+
Order- Galliformes														
29	Rallidae	Swamphen	<i>Porphyrio poliocephalus</i>	LC	R		O		+	+	+	+	+	+
30	Rallidae	Eurasian Coot	<i>Fulica atra</i>	LC	R		O		-	+	-	-	-	-
31	Rallidae	White breasted Waterhen	<i>Amauromis phoenicurus</i>	LC	R		C		-	+	+	-	-	+
Order- Charadriiformes														
32	Jacaniidae	Pheasant tailed Jacana	<i>Hydrophasianus chirurgus</i>	LC	R		O		+	+	+	+	+	-

33	Jacaniidae	Bronze winged Jacana	<i>Metopidius indicus</i>	LC	R	O	+	+	-	+	+
34	Recurvirostridae	Black winged Stilt	<i>Himantopus himantopus</i>	LC	M	O	+	+	+	+	+
35	Charadriidae	Little ring Plover	<i>Charadrius dubius</i>	LC	LM	I	-	-	-	-	+
36	Scolopacidae	Red wattled Lapwing	<i>Vanellus indicus</i>	LC	R	I	+	+	+	+	+
37	Scolopacidae	Black Tailed Godwit	<i>Limosa limosa</i>	NT	M	C	-	+	+	-	-
38	Scolopacidae	Marsh Sandpiper	<i>Tringa stagnatilis</i>	LC	M	C	+	+	+	+	+
39	Scolopacidae	Wood Sandpiper	<i>Tringa glareola</i>	LC	M	C	+	+	+	+	+
40	Scolopacidae	Green Sandpiper	<i>Tringa ochropus</i>	LC	M	C	-	+	+	+	-
41	Scolopacidae	Common Sandpiper	<i>Actitis hypoleucos</i>	LC	R	C	+	-	+	-	+
42	Scolopacidae	Common Red Shank	<i>Tringa nebularia</i>	LC	M	C	-	-	+	-	-
43	Scolopacidae	Common Snipe	<i>Gallinago gallinago</i>	LC	M	C	-	-	+	-	+

44	Glareolidae	Small Pratincole	<i>Glareola lactea</i>	LC	R	I	-	-	-	+	-	-
45	Lariidae	River Tern	<i>Sterna aurantia</i>	VU	R	C	+	-	+	+	+	-
46	Lariidae	Common Tern	<i>Sterna hirundo</i>	LC	M	C	-	-	-	-	+	-
Order- Columbiformes												
47	Columbidae	Common rock Pigeon	<i>Columba livia</i>	LC	R	G	-	-	-	-	-	+
48	Columbidae	Spotted Dove	<i>Spilopelia chinensis</i>	LC	R	G	-	-	-	-	-	+
Order- Psittaciformes												
49	Psittacidae	Plum headed Parakeet	<i>Psittacula cyanocephala</i>	LC	R	F	-	-	-	-	-	+
Order- Cuculiformes												
50	Cuculidae	Blue faced Malkoha	<i>Phaenicophaeus viridirostris</i>	LC	R	I	-	+	-	-	-	-
51	Cuculidae	Southern Coucal	<i>Centropus sinensis</i>	LC	R	I	-	-	-	-	-	+

52	Cuculidae	Asian Koel	<i>Eudynamys scolopaceus</i>	LC	R	F	-	-	-	+	+	+	+
Order- Apodiformes													
53	Apodidae	Little Swift	<i>Apus affinis</i>	LC	R	I	+	-	-	-	-	-	-
Order- Coraciiformes													
54	Alcedinidae	Common Kingfisher	<i>Alcedo atthis</i>	LC	R	C	+	+	+	+	+	+	+
55	Alcedinidae	White throated Kingfisher	<i>Halcyon smyrnensis</i>	LC	R	C	+	+	+	+	+	+	+
56	Alcedinidae	Pied Kingfisher	<i>Ceryle rudis</i>	LC	R	C	-	+	+	-	-	-	+
57	Meropidae	Green Bee-eater	<i>Merops orientalis</i>	LC	R	I	+	+	+	+	+	-	+
58	Meropidae	Blue tailed Bee-eater	<i>Merops philippinus</i>	LC	M	I	-	+	+	-	-	-	+
59	Coraciidae	Indian Roller	<i>Coracias benghalensis</i>	LC	R	I	-	-	-	-	-	-	+
60	Bucerotidae	Indian grey Hornbill	<i>Ocyeros birostris</i>	LC	R	O	-	-	-	-	-	-	+

61	Bucerotidae	Malabar pied Hornbill	<i>Anthracoeros coronatus</i>	NT	R	O	-	-	-	-	-	-	-	-	-	-	-	-	-	+
Order- Piciformes																				
62	Capitonidae	Copper smith Barbet	<i>Psilopogon haemacephalus</i>	LC	R	F	-	-	-	-	-	-	-	-	-	-	-	-	-	+
63	Capitonidae	White cheeked Barbet	<i>Psilopogon viridis</i>	LC	R	F	-	-	-	-	-	-	-	-	-	-	-	-	-	+
Order- Passeriformes																				
64	Hirundinidae	Wire tailed Swallow	<i>Hirundo smithii</i>	LC	R	I	-	-	-	-	-	-	-	-	-	-	-	-	-	+
65	Hirundinidae	Barn Swallow	<i>Hirundo rustica</i>	LC	M	I	-	-	-	-	-	-	-	-	-	-	-	-	-	-
66	Laniidae	Long tailed Shrike	<i>Lanius schach</i>	LC	M	I	-	-	-	-	-	-	-	-	-	-	-	-	-	+
67	Dicruridae	Black Drongo	<i>Dicrurus macrocerus</i>	LC	R	I	-	-	-	-	-	-	-	-	-	-	-	-	-	+
68	Campephagidae	Small Minivet	<i>Pericrocotus cinnamomeus</i>	LC	R	I	-	-	-	-	-	-	-	-	-	-	-	-	-	+
69	Corvidae	House Crow	<i>Corvus splendens</i>	LC	R	O	-	-	-	-	-	-	-	-	-	-	-	-	-	-

70	Corvidae	Rufous Treepie	<i>Dendrocitta vagabunda</i>	LC	R	O	-	-	-	-	-	+
71	Cisticolidae	Ashy Prinia	<i>Prinia socialis</i>	LC	R	O	-	-	-	-	-	+
72	Pycnonotidae	Red whiskered Bulbul	<i>Pycnonotus jocosus</i>	LC	R	O	+	-	-	-	-	+
73	Pycnonotidae	Red vented Bulbul	<i>Pycnonotus cafer</i>	LC	R	O	-	-	-	-	-	+
74	Muscicapidae	Jungle Babbler	<i>Argya striata</i>	LC	R	I	-	-	-	-	-	+
75	Muscicapidae	Orange headed Thrush	<i>Geokichla citrina</i>	LC	R	O	-	-	-	-	-	+
76	Muscicapidae	Indian Paradise Flycatcher	<i>Terpsiphone paradisi</i>	LC	R	I	-	-	-	-	-	+
77	Motacillidae	Pappy field Pipit	<i>Anthus rufulus</i>	LC	M	I	+	+	-	-	-	+
78	Motacillidae	Grey Wagtail	<i>Motacilla cinerea</i>	LC	R	I	+	+	-	-	-	+
79	Motacillidae	White browed Wagtail	<i>Motacilla maderaspatensis</i>	LC	R	C	+	-	-	-	-	+

80	Sturnidae	Jungle Myna	<i>Acridotheres fuscus</i>	LC	R	O	+	+	+	+	-	+
81	Sturnidae	Common Myna	<i>Acridotheres tristis</i>	LC	R	O	-	-	-	-	-	+
82	Aegithinidae	Common Iora	<i>Aegithina tiphia</i>	LC	R	O	-	-	-	-	-	+
83	Rhipiduridae	Spot breasted Fantail	<i>Rhipidura albogularis</i>	LC	R	I	-	-	-	-	-	+
84	Nectriidae	Purple Sunbird	<i>Cinnyris asiaticus</i>	LC	R	N	-	+	-	-	-	+
85	Nectriidae	Crimson Backed Sunbird	<i>Leptocoma minima</i>	LC	R	N	-	-	-	-	-	+

IUCN status: NT- Near Threatened, VU- Vulnerable, LC- Least Concern

Migratory status: R- Resident, M- Migrant, LM- Local migrant

Feeding guilds: C- Carnivore, O- Omnivore, I- Insectivore, F- Frugivore, N- Nectivore, G- Granivore, H- Herbivore

Table 3: Results showing Kruskal Wallis Test done for bird species in selected study sites

Serial No	Bird Species	Kruskal Wallis Test		
		H	df	Significance
1	Little Cormorant	5.272	4	0.261
2	Indian Cormorant	14.820	4	0.005*
3	Great Cormorant	3.568	4	0.468
4	Darter	3.988	4	0.408
5	Pond Heron	13.609	4	0.009*
6	Purple Heron	11.603	4	0.021*
7	Grey Heron	11.070	4	0.026*
8	Cattle Egret	5.660	4	0.226
9	Little Egret	5.304	4	0.258
10	Intermediate Egret	3.568	4	0.468
11	Great Egret	13.742	4	0.008*
12	Western reef Egret	8.348	4	0.080
13	Painted Stork	9.291	4	0.054
14	Woolly necked Stork	7.378	4	0.117
15	Asian Openbill	9.714	4	0.046*
16	Lesser Adjutant	5.179	4	0.269
17	Black headed Ibis	13.973	4	0.007*
18	Glossy Ibis	2.631	4	2.631
19	Eurasian Spoonbill	3.133	4	0.536
20	Indian Spot-billed Duck	6.888	4	0.142
21	Northern Shoveler	8.333	4	0.080
22	Garganey	12.894	4	0.012*
23	Lesser whistling Duck	19.434	4	0.001*
24	Cotton Pygmy Goose	21.636	4	0.001*
25	Ruddy Shelduck	18.113	4	0.001*
26	Brahminy Kite	15.624	4	0.004*
27	Black Kite	1.738	4	0.784
28	Eurasian marsh Harrier	4.000	4	0.406
29	Swamphen	12.735	4	0.013*
30	Eurasian Coot	4.000	4	0.406

31	White breasted Waterhen	3.944	4	0.411
32	Pheasant tailed Jacana	15.076	4	0.005*
33	Bronze winged Jacana	11.511	4	0.021*
34	Black winged Stilt	16.448	4	0.002*
35	Red wattled Lapwing	18.831	4	0.001*
36	Black Tailed Godwit	15.368	4	0.004*
37	Marsh Sandpiper	3.543	4	0.471
38	Wood Sandpiper	13.133	4	0.011*
39	Green Sandpiper	6.951	4	0.138
40	Common Sandpiper	4.732	4	0.316
41	Common Red Shank	18.113	4	0.001*
42	Common Snipe	8.333	4	0.080
43	Little ring Plover	18.113	4	0.001*
44	Small Pratincole	4.000	4	0.406
45	River Tern	4.429	4	0.351
46	Common Tern	4.000	4	0.406
47	Common rock Pigeon	2.194	4	0.700
48	Spotted Dove	8.333	4	0.080
49	Plum headed Parakeet	4.000	4	0.406
50	Blue faced Malkoha	4.000	4	0.406
51	Southern Coucal	4.000	4	0.406
52	Asian Koel	7.158	4	0.128
53	Little Swift	13.028	4	0.011*
54	Common Kingfisher	8.062	4	0.089
55	White throated Kingfisher	12.035	4	0.017*
56	Pied Kingfisher	3.133	4	0.536
57	Green Bee-eater	7.327	4	0.120
58	Blue tailed Bee-eater	8.984	4	0.061
59	Indian Roller	4.000	4	0.406
60	Indian grey Hornbill	8.333	4	0.080
61	Malabar pied Hornbill	4.000	4	0.406
62	Copper smith Barbet	13.091	4	0.011*

63	White cheeked Barbet	13.043	4	0.011*
64	Wire tailed Swallow	12.428	4	0.014*
65	Barn Swallow	4.000	4	0.406
66	Long tailed Shrike	18.182	4	0.001*
67	Black Drongo	12.655	4	0.013*
68	Small Minivet	4.000	4	0.406
69	House Crow	13.192	4	0.010*
70	Rufous Treepie	4.000	4	0.406
71	Ashy Prinia	8.348	4	0.080
72	Red whiskered Bulbul	18.403	4	18.403
73	Red vented Bulbul	4.000	4	0.406
74	Jungle Babbler	8.348	4	0.080
75	Orange headed Thrush	8.348	4	0.080
76	Indian Paradise Flycatcher	8.348	4	0.080
77	Pappy field Pipit	6.621	4	0.157
78	Grey Wagtail	10.560	4	0.032*
79	White browed Wagtail	5.818	4	0.213
80	Jungle Myna	3.424	4	0.489
81	Common Myna	4.00	4	0.406
82	Common Iora	8.348	4	0.080
83	Spot breasted Fantail	4.000	4	0.406
84	Purple Sunbird	3.130	4	0.536
85	Crimson Backed Sunbird	8.348	4	0.080

*Significant difference



Fig 12: Woolly necked Stork



Fig 13: Copper smith Barbet



Fig 14: Indian grey Hornbill



Fig 15: Green Bee-eater



Fig 16: Malabar pied Hornbill



Fig 17: Swamphen



©Anuraj Gaonkar

Fig 18: Small Pratincole



©Vaishnavi Naik

Fig 19: Black headed Ibis



©Vaishnavi Naik

Fig 20: Black winged stilt and Common Redshank



©Vaishnavi Naik

Fig 21: Painted Stork and Great Egret



©Vaishnavi Naik

Fig 22: Indian Spot billed Duck



©Vaishnavi Naik

Fig 23: Garganey

Chapter 6: Discussion

Discussion

A total 15067 individuals of 85 species belonging to 34 families were observed. Among all the sites, Narva had significantly greater bird species diversity ($H=14.694$, $df=4$, $p=0.005$), followed by Santemol, Maina Curtorim-2, Maina Curtorim-1 and Loutulim. In case of abundance, Maina Curtorim has significantly more abundance than other wetlands ($H=15.094$ $df=4$ $p=0.005$), followed by Santemol, Maina Curtorim-1, Loutulim and Narva. The reason for high bird diversity in Narva could be attributed to low human disturbances, which was noticed in other four sites. It could be also due to other reasons such as mosaic of different habitat (Kumaret. al. 2009), presence of agricultural feed in proximity and availability of roosting site (Ashkenazi et. al. 1998).

Out of 85 species, 15 were migrants which included Great Cormorant, Painted Stork, Northern Shoveler, Ruddy Shelduck, Black winged Stilt, Common Redshank, Wood Sandpiper, Marsh Sandpiper, Green Sandpiper, Common Snipe, Black tailed Godwit, Common Tern, Blue tailed Bee-eater, long tailed shrike, Paddy field Pipit and Barn Swallow. Ruddy Shelduck was significantly found exclusively in Narva ($H=18.113$, $df=4$, $p=0.001$). Black winged Stilt was found significantly more in Santemol ($H=16.448$, $df=4$, $p= 0.002$). From the rest population, majority were resident with few being resident migrant.

7 threatened species were observed which were Painted Stork, Darter, Woolly necked Stork, Lesser adjutant Stork, Black tailed Godwit, Black headed Ibis and River tern. The density of threatened bird was highest at Santemol with 5 species and lowest density was observed in Maina Curtorim-1 and Maina Curtorim-2 with 3 species each.

The most abundant specie recorded was Lesser whistling Duck which was present in only four wetlands excluding Narva. Narva might be lacking suitable habitat for this species as the water level was also low. The second most abundant specie was Swamphen. This species was present in all five sites. All the study sites either had a part of agricultural area or were adjacent

to it. Maeda(2001) in their study indicated the importance of rice field, as it provides valuable habitat for waterbirds.

Among 34 families, the most dominant families include Scolopacidae comprising 8 species, followed by Ardeidae comprising 8 species and Anatidae with 6 species. Phalacrocoraciidae and Ciconiidae were represented by 4 species each. The least dominant families were Charadriidae, Recurvirostridae, Psittacidae, Apodidae, Laniidae, Dicruridae, Campephagiidae, Cisticolidae, Aegithinidae, Rhipiduridae and Glareolidae with one species each.

Determining bird community structure is crucial for monitoring the bird population of different species and to document a baseline data for future conservation and management aspects (Rajpar and Zakaria, 2013). Presence of 86 species which included residents, migrant and resident migrants indicates that these wetlands provide suitable habitat for these birds. The study site had mosaics of habitats including deep water, shallow water, emergent vegetation (eg: water lilies) resulting in higher bird diversity.

The birds used a wide range of foraging techniques to obtain food (Rajpar et. al. 2010). Based on their foraging tactics, birds were classified into 7 different feeding guilds; carnivore, omnivore, insectivore, herbivore, frugivore, granivore and nectivore. Carnivore was the dominant guild in all 5 wetlands with 35 bird species followed by omnivore (21), insectivore (19), frugivore (4), herbivore (3), granivore (2) and nectivore (2). Santemol had highest record of carnivore with 27 species, followed by Narva (26), Loutulim (24), Maina Curtorim-2 (20) and Maina- Curtorim-1 (18). This might be due to presence of large field area available for birds for foraging. Maina Curtorim recorded highest omnivore with 20 species.

Water birds are usually at the top of wetland food change; thus, they are more susceptible to the changes in habitat and hence form a good indicator of healthy ecosystem (Kushlan, 1992;

Jayson and Mathew, 2002; Kler, 2002). High number of bird species obtained might be due to presence of microhabitats within the wetlands that are suitable for waterbirds (Kumar and Gupta, 2009). All the five study areas had agricultural field in close proximity which added to the food resource available for birds (Maeda, 2001)

Chapter 7: Conclusion

Conclusion

The study shows that all the wetlands have rich bird diversity and composition including that of migratory and threatened birds. More than half of the bird species recorded belonged to carnivore feeding guilds. This

that wetland provide suitable habitat for carnivores.

Narva supports a high bird diversity. It provides appropriate combination of resources to waterbirds that satisfies their need of food, shelter, water and roosting site. this can be seen based on presence of a greater number of bird species in general including threatened and migratory birds in the wetland. This indicates that Narva is an important bird hub and it must be protected.

Chapter 8: References

References

- Baidya, P. (2018). All Goa Waterbird Count 2018 & The Status of Goa's Migratory Ducks. 10.13140/RG.2.2.31203.66087.
- Bock, A., Naef-Daenzer, B., Keil, H., Korner-Nievergelt, F., Perrig, M., & Gruebler, M. U. (2013). Roost site selection by *Little Owl* (*Athene noctua*) in relation to environmental conditions and life-history stages. *Ibis*, *155*(4), 847-856.
- Borges, S. D. (2002). *Studies on the Ecology of Water Birds in the Mandovi Estuary of Goa, India* (Doctoral dissertation, Goa university).
- Chastant, J. E., Petersen, M. L., & Gawlik, D. E. (2017). Nesting substrate and water-level fluctuations influence wading bird nesting patterns in a large shallow eutrophic lake. *Hydrobiologia*, *788*, 371-383.
- Chatterjee, A., Adhikari, S., Pal, S., & Mukhopadhyay, S. K. (2020). Foraging guild structure and niche characteristics of waterbirds wintering in selected sub-Himalayan wetlands of India. *Ecological Indicators*, *108*, 105693.
- Gatto, A., Quintana, F., & Yorio, P. (2008). Feeding behavior and habitat use in a waterbird assemblage at a marine wetland in coastal Patagonia, Argentina. *Waterbirds*, *31*(3), 463-471.
- http://www.bnhsenvi.nic.in/Database/MigratorybirdsIndia_835.aspx
- Jagruti, R., & Geeta, P. Feeding Guilds of urban birds of Vadodara city.
- Kumar, P., & Gupta, S. K. (2009). Diversity and abundance of wetland birds around Kurukshetra, India. *Our Nature*, *7*(1), 212-217.
- Liordos, V. (2010). Foraging guilds of waterbirds wintering in a Mediterranean coastal wetland. *Zool Stud*, *49*(3), 311-23.
- Ma, Z., Cai, Y., Li, B., & Chen, J. (2010). Managing wetland habitats for waterbirds: an international perspective. *Wetlands*, *30*, 15-27.

- Mistry, J., Berardi, A., & Simpson, M. (2008). Birds as indicators of wetland status and change in the North Rupununi, Guyana. *Biodiversity and Conservation*, 17, 2383-2409.
- Paclík, M., & Weidinger, K. (2007). Microclimate of tree cavities during winter nights—implications for roost site selection in birds. *International Journal of Biometeorology*, 51, 287-293.
- Panda, B. P., Prusty, B., Panda, B., Pradhan, A., & Parida, S. P. (2021). Habitat heterogeneity influences avian feeding guild composition in urban landscapes: evidence from Bhubaneswar, India. *Ecological Processes*, 10(1), 1-10.
- Rajpar, M. N., & Zakaria, M. (2013). Assessing an artificial wetland in Putrajaya, Malaysia, as an alternate habitat for waterbirds. *Waterbirds*, 36(4), 482-493.
- Rajpar, M. N., Zakaria, M., Yusof, E., & Kudus, K. A. (2010). Species abundance and feeding guilds of waterbirds at Putrajaya artificial freshwater wetland, Selangor peninsular Malaysia. *Pakistan J Forestry*, 60(2).
- Rathod, J., Deshkar, S., Gavali, D., & Sankhwal, A. (2015). Birds of coastal jamnagar and their feeding guilds. *Bulletin of Environment, Pharmacology and Life Sciences*, 4(10), 15-19.
- Ringim, A. S., & Shafi'u, A. (2019). Composition and diversity of birds: A comparative study between two wetlands. *FUTY Journal of the Environment*, 13(1), 75-83.
- Ringim, A. S., Magige, F. J., & Jasson, R. M. (2017). A comparative study of species diversity of migrant birds between protected and unprotected areas of the Hadejia-Nguru Wetlands, Nigeria. *Tanzania Journal of Science*, 43(1), 108-120.
- Sohil, A., & Sharma, N. (2020). Assessing the bird guild patterns in heterogeneous land use types around Jammu, Jammu and Kashmir, India. *Ecological Processes*, 9, 1-15.
- Suryakant, P. N. (2017). Avifauna and Comparative Study of Threatened Birds at Urban Wetlands of Kolhapur, Maharashtra, India. *International J. of Life Sciences*, 5(4), 649-660.

- Zakaria, M., Rajpar, M. N., & Sajap, A. S. (2009). Species diversity and feeding guilds of birds in Paya Indah Wetland Reserve, Peninsular Malaysia.
- Zhang, Y., Zhou, L., Cheng, L., & Song, Y. (2021). Water level management plan based on the ecological demands of wintering waterbirds at Shengjin Lake. *Global Ecology and Conservation*, 27, e01567.