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ECOLOGICAL DRIVERS OF FORAGING HABITAT SELECTION BY WADERS IN NOAKHALI WETLANDS, BANGLADESH

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Abstract: A study was conducted to examine which ecological factors affecting foraging habitat selection by waders within the wetland habitats of Noakhali, Bangladesh. A total of 16 wading bird species belonging to 11 genera, 6 families, and 4 orders were recorded during the study period. The shallow water level, abundance of emergent vegetation, dietary items and length of their legs were key factors that facilitated independent foraging by waders. Among the four study sites, three exhibited similarity in vegetation diversity which corresponded with the preference by wading birds. One site exhibited the highest water depth (2.13 m) and the lowest (12 species) diversity of emergent vegetation. Correspondingly, this site experienced minimal visitation by wading birds. Dietary analysis revealed, the recorded food items of wading birds were predominantly of animal origin (72.7%), particularly chordates (56.25%), arthropods (25%), and molluscs (18.75%); whereas 27% were plant origin. This study highlights the critical role of ecological variables, particularly foraging depth, water depth, vegetation diversity, and prey resources in determining foraging site selection among wading birds. These findings contribute valuable insights into the habitat requirements of these species and may inform future conservation strategies aimed at preserving wetland ecosystems and their associated avifauna.

***Key words*:** foraging habitat, foraging depth, wading birds, water depth and vegetation.

INTRODUCTION

Bangladesh is a low-lying riverine country in South Asia, bordered by India to its west, north and east, and Myanmar to its southeast (Hasnat *et al.* 2018). Due to its unique biophysical setting and abundant water resources, Bangladesh is endowed with a rich heritage of plant and animal species and supports a diverse array of ecosystems (Rahman *et al.* 2011). Bangladesh has a tropical monsoon characterized by wide seasonal variations in rainfall, high temperatures, and high humidity. The national

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list of the birds of Bangladesh owns as many as 650 species; of which, 143 are vagrant (occurring very irregularly or seen as extremely rare) in the country, and the rest 477 are regular species (Siddiqui *et al.* 2008). One-tenth of the 650 species of birds are waders, of which about ten per cent are resident and the rest are migratory (Siddiqui *et al.* 2008).

Wading birds are long-legged birds that are capable of wading through knee-deep water. Wading birds rely heavily on wetland habitats including inland and coastal emergent marshes and wooded swamps (Balwan and Kour 2021). Habitats used by wading birds are diverse; ranging from aquatic complexes to dry upland meadows, pastures, and crop fields (Sorensen *et al.* 2020). Inland freshwater ponds, lakes, streams, wetlands with emergent aquatic vegetation, coastal marshes, riparian and wooded wetlands and bogs, mangroves, and estuaries are the most common sites used for feeding and nesting (Weller 1999). Upland forest communities and small clusters of trees and shrubs near wetland habitats provide nesting and roosting sites for some wading birds (Lewis 1983).

Wading birds prey fishes, aquatic and terrestrial invertebrates, amphibians and crustaceans which are common foods consumed by wading birds (Frederick 2001). Wading birds diets also include wetland plant seeds, small mammals such as voles, shrews, and pocket gophers, and occasionally other birds (Morse 1975). However, most also eat insects, small reptiles, and other prey found on land (Cooke 2019). Their long and sometimes curved bills enable them to live and feed in shallow-water habitats (Frederick 2001).

Wading birds' diversity and richness are open linked to the vegetation structure and water level, especially the shallowness (Rajpar and Zakaria 2009). Moreover, the richness and diversity of food are a major factor that influences wading bird distribution and diversity in different wetland ecosystems (Hamza and Selmi 2018). Kushlan (1986) reported the responses of wading birds to seasonally fluctuating water levels of large tropical wetlands; whereas the distribution of wading birds relative to vegetation and water depths was recorded by Bancroft *et al.* (2002). On the other hand, Lantz *et al.* (2011) described the effects of water depth and emergent vegetation on foraging success and habitat selection of wading birds in the Everglades.

The wetland habitats of the coastal plains of Noakhali, Bangladesh are dominated by a variety of heterogeneous aquatic vegetation, which is considered a suitable habitat for fish, amphibians, reptiles, and birds. These wetlands serve as critical feeding, resting and wintering grounds for many wading birds. Detailed information on both physical and biological factors of the wetlands would be supportive of understanding the habitat selection of wading birds. The objectives of the present study were to (1) document the total number of wading bird species within the study area, (2) determine the key ecological factors influencing their habitat selection, (3) list the aquatic vegetation across the wetlands and analyze vegetation similarity among the sites, and (4) identify the dietary composition of wading bird communities.

MATERIAL AND METHODS

Study Area: The present study was conducted in wetlands of the Noakhali Science and Technology University Campus. It is located at the village Sonapur under Maijdee Upazila of Noakhali District, Bangladesh. The NSTU lies approximately between 22° 47' 31" N latitude and 91° 06' 03" E longitude. It is part of the southern coastal area in Noakhali.

This area is covered with different types of emergent and submerged vegetation. The campus area is a mixture of several habitats, featuring wetlands (ponds and marshlands), forests, agricultural lands, and grasslands, all mixed with human habitation. As a result, the university campus gives birds plenty of area for feeding and resting, as well as nesting facilities. The vast majority of the total areas of water were freshwater marshlands and ponds. The present study was conducted in four distinct wetlands of the NSTU campus. Those were: Site A- Moyna Dwip marshland (area 43,876 m^2), Site B- Garage adjacent marshland (area 11,126 m^2), Site C- Student Dormitory adjacent marshland (area 16,800 m^2) and Site D- Nil Dighi pond (area 11,700 m^2). There are various types of aquatic vegetation surrounding the wetlands.

The climate of the area is naturally monsoon and distinguished by fairly high temperatures, heavy rainfall and excessive humidity. The monthly temperature, humidity and precipitation were varied during the study period. The average temperature was lowest (21.5℃) in January and highest (27.7℃) in March. The average humidity was minimum (52%) in February and maximum (79%) in October. The average precipitation was 5 to 135mm during the study period. *Study Procedure:* The present study was conducted from October 2023 to March 2024. We performed fieldworks three times (morning, afternoon and evening) in a day and four days were spent in each month to collect data. The timing of the fieldwork was selected based on the visibility of wading bird species. During data collection, we used Bushnell 10X42 binoculars to observe birds. Nikon D80 SLR camera was used to take photographs and record videos. For the identification of birds, Grimmett *et al.* (2021) field guide was used.

Measurement of Foraging Depth: Foraging depth refers to the depth how far the bird's legs are submerged while foraging. In the present study, the foraging depth of all wading bird species occupied in the study area was observed and measured with a meter scale. Measurements were taken for all wading birds across different microhabitats, such as marshlands, and ponds, to account for species- specific and habitat- specific variations.

Measurement of Water Depth: The water depth of all four study sites was measured using a dipstick and a meter scale. At each study site, the dipstick was inserted vertically into the water until it reached the bottom substrate. Then the water level mark was observed and the depth was measured. To ensure the accuracy, the procedure was repeated four times at different locations within each study site. The four values were obtained then averaged to calculate the mean water depth for each study site.

Identification of Emergent Vegetation: The vegetation within the shallow water zones of each study site was observed by direct visual observation. To identify the distant vegetation a dip net was used to bring them closer to the bank for detailed examination. Morphological characteristics such as stem structure, leaf shape and arrangement, floral features, and seed morphology were carefully observed to facilitate accurate identification.

Identification of Food Items: The food items consumed by wading birds were identified and recorded through direct observation. To enhance accuracy and clarity, photographic and video recordings were also employed during field observations. Taxonomic identification of animal source food items was confirmed using the databases of FishBase and iNaturalist, ensuring accurate species-level confirmation. The proportional contribution of each phylum was calculated using the following equation:

$$\text{Percentage contribution of phylum} = \frac{\text{Number of prey species in a given phylum}}{\text{Total number of recorded prey species}} \times 100$$

Data Analysis: Jaccard Similarity Index (J) was employed to determine the degree of similarity among aquatic emergent vegetation of four studied wetlands (Jaccard 1901). The index was calculated using the following formula:

$$J\,(A, B) = |A \cap B| \;/\; |A \cup B|$$

Where, $|A \cap B|$ is the number of vegetation present in both study sites,

$|A \cup B|$ is the number of vegetation present in either study sites.

The collected data was analyzed using both calculator and computer. Subsequently, Microsoft Excel software (version 2010) and SPSS (version 25) was utilized for statistical analysis and graphical representation of the data. Additionally, Google Earth was also employed to calculate the area of the four study sites.

RESULTS AND DISCUSSION

Wading Birds: Over the six months of the study, a total of 16 species of wading birds have been compiled representing 11 genera, 6 families and 4 orders. The identified birds were distributed under the order: Pelecaniformes (8 species), Charadriiformes (4 species), Gruiformes (2 species), and Ciconiiformes (2 species). All the 16 species of wading birds were categorized as Least Concerned (Table 1). Previous studies have also documented the occurrence of wading birds in various coastal habitats of Bangladesh, including Saint Martin's Island where 31 species of wader birds were recorded (Jaman *et al.* 2000; Sultana *et al.* 2018) and reported 26 species of wader birds from Noakhali Char Bata coastal area (Jaman *et al.* 2004), highlighting the importance of coastal ecosystems as habitats for these birds. Sultana *et al.* (2018) documented a greater diversity of wading birds from Saint-Martins-Island, reporting 36 species under 4 orders, namely Anseriformes, Charadriiformes, Gruiformes, and Pelecaniformes. She also documented 34 Least Concerned and 2 Near Threatened species of wading birds. Similarly, Jaman *et al.* (2022) listed 29 species of wading birds belonging to 6 families from Sandwip Island. In comparison, Mostafa and Alam (2025) recorded 16 wader bird species representing only 2 orders, Charadriiformes and Pelecaniformes, in Nijhum Dwip National Park.

Foraging Habitat Selection: The selection of foraging habitat influenced by multiple ecological and morphological factors including their leg length, water depth, the presence of emergent vegetation, and food resources.

Foraging Depth: The foraging depth of wading birds mostly depends on the length of their legs. The maximum foraging depth was recorded for the Great Egret (*Ardea alba;* 11 cm) whereas the minimum foraging depth was recorded for the Purple Swamphen (*Porphyrio porphyrio;* 3 cm). In contrast, some wading birds exhibited comparatively higher foraging depth varied from 7-10 cm. These included the Red-wattled Lapwing (*Vanellus indicus;* 7 cm), Grey Heron (*Ardea cinerea;* 8 cm), Asian Openbill (*Anastomus oscitans;* 8 cm), Cattle Egret (*Bulbulcus ibis;* 8 cm), Black Stork (*Ciconia nigra;* 8 cm), Little Egret (*Egretta garzetta;* 9 cm), and Intermediate Egret (*Ardea intermedia;* 10 cm). Conversely, some wading birds used shallow foraging depths which varied from 3-6 cm. These included the Purple Swamphen (*Porphyrio porphyrio;* 3 cm), Cinnamon Bittern (*Ixobrychus cinnamomeus;* 3.5 cm), Bronze-winged Jacana (*Metopidius indicu*s; 4 cm), White-breasted Waterhen (*Amauror phoenicuru*s; 5 cm), Pond Heron (*Ardeola grayii;* 5 cm), Lesser Sandplover (*Charadrius mongolus;* 5 cm), Common Ringed Plover (*Charadrius hiaticula;* 6 cm), and Yellow bittern (*Ixobrychus sinensis;* 6 cm) (Fig 1). The observations of foraging depth indicate a clear relationship between leg morphology and foraging behavior. Species with shorter legs were predominantly observed foraging along shallow water edges, where access to prey is limited to minimal depths. In contrast, species possessing longer legs demonstrated a capacity to forage in deeper water zones, thereby expanding their ecological niche. Such morphological adaptations play a significant role in habitat selection, resource partitioning, and ultimately, the coexistence of multiple wading bird species within the same wetland ecosystems. Moreover, all observed wading bird species foraged at water depths less than 12 cm, indicating a general preference for shallow-water habitats. Similar findings were reported by Harrington and Streever (1999), who reported that, wading birds including sandpipers, plovers, and rails commonly utilized water depths of less than 5 inches (≈12.7 cm). Likewise, Lantz *et al.* (2011) conducted a study in the Everglades and found that, wading birds preferentially foraged in shallow water (approximately 10 cm) rather than deeper water. Similarly, McKinney *et al.* (2010) noted that wading birds typically forage in shallow water less than 15 cm in depth.

Water Depth: During the study period, notable variations in water depth were observed across the four sampling sites (Table 2). The water depth at Site A was highest (1.13 m) in October 2023. Subsequently, water levels exhibited a gradual decline, reaching the minimum depth of 0.25 m in March 2024. The mean water depth of Site A was 0.73 m. At Site B, water depth fluctuated between a maximum of 1.03 m and a minimum of 0.10 m, with an overall mean depth of 0.55 m. Site C exhibited slightly higher water levels, with a mean depth of 0.92 m. The highest depth at this site was recorded in October 2023 (1.46 m), while the lowest (0.25 m) occurred in March 2024. Site D consistently maintained the highest water depths among all study sites. The water depth of Site D ranges from 2.56 m in October 2023 to 1.55 m in March 2024 and the mean water depth was 2.13 m (Table 2).

Among the four study sites, Site D consistently exhibited the highest water depth throughout the observation period, whereas Site B consistently recorded the lowest water levels. A clear temporal trend was observed across all sites, characterized by noticeable decrease in water depth from October 2023 to March 2024, suggesting potential seasonal changes. Notably, during the monsoon (June to October) water level showed the highest peak in all study sites, which might be attributable due to increased precipitation. In contrast, during the winter (November to February) water levels showed a marked decline. This reduction in water depth can be primarily attributed to the low precipitation, resulting in lower water levels across the wetlands. These seasonal dynamics in water availability play a critical role in influencing vegetation structure, aquatic invertebrate abundance, and the foraging of wading birds.

Table 1. Wading birds observed in the study area

Taxonomic Position	Scientific name	English name	National status
O- Gruiformes F- Rallidae	*Amauror phoenicurus*	White-breasted Waterhen	LC
O- Gruiformes F- Rallidae	*Porphyrio porphyrio*	Purple Swamphen	LC
O- Charadriiformes F- Jacanidae	*Metopidius indicus*	Bronze-winged Jacana	LC
O- Charadriiformes F- Charadriidae	*Charadrius hiaticula*	Common Ringed Plover	LC
O- Charadriiformes F- Charadriidae	*Vanellus indicus*	Red-wattled Lapwing	LC
O- Charadriiformes F- Charadriidae	*Charadrius mongolus*	Lesser Sandplover	LC
O- Pelecaniformes F- Ardeidae	*Ixobrychus sinensis*	Yellow Bittern	LC
O- Pelecaniformes F- Ardeidae	*Egretta garzetta*	Little Egret	LC
O- Pelecaniformes F- Ardeidae	*Ardea alba*	Great Egret	LC
O- Pelecaniformes F- Ardeidae	*Bubulcus ibis*	Cattle Egret	LC
O- Pelecaniformes F- Ardeidae	*Ardea intermedia*	Intermediate Egret	LC
O- Pelecaniformes F- Ardeidae	*Ardeola grayii*	Pond Heron	LC
O- Pelecaniformes F- Ardeidae	*Ardea cinerea*	Grey Heron	LC
O- Pelecaniformes F- Ardeidae	*Ixobrychus cinnamomeus*	Cinnamon Bittern	LC
O- Ciconiiformes F- Ciconiidae	*Anastomus oscitans*	Asian Openbill	LC
O- Ciconiiformes F- Ciconiidae	*Ciconia nigra*	Black Stork	LC

Note: LC- Least Concerned

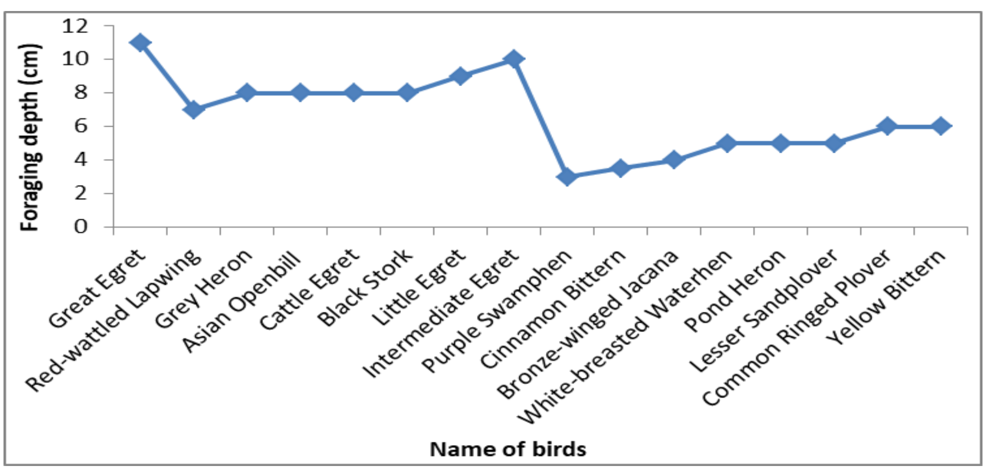

Fig.1. Foraging depth of the waders observed in different study sites

Table 2. Average water depth (m) in different study sites

Month	Water depth (m) in different study sites			
	Site A- Moyna Dwip marshland	Site B- Garage adjacent marshland	Site C- Student dormitory adjacent marshland	Site D- Nil Dighi pond
Oct (2023)	1.13	1.03	1.46	2.56
Nov (2023)	1.06	0.83	1.31	2.44
Dec (2023)	0.90	0.60	1.10	2.35
Jan (2024)	0.62	0.49	0.80	2.08
Feb (2024)	0.42	0.25	0.58	1.80
Mar (2024)	0.25	0.10	0.25	1.55
Average depth (m)	0.73	0.55	0.92	2.13

Site-wise Vegetation and Occurrence of Waders: Site A or Moyna Dwip marshland is characterized by a rich assemblage of emergent aquatic vegetation. A total of 21 aquatic plant species have been documented from this site during the study period (Table 3). All 16 species of wading birds recorded during the study were observed utilizing the Moyna Dwip marshland and actively engaged in foraging. The site provides abundant prey resources, such as aquatic invertebrates, small fish, and amphibians, which are commonly, associated with densely vegetated wetland areas.

Site B or garage adjacent marshland serves as an ecologically important habitat. A total of 16 species of emergent vegetation were identified within this site which greatly influenced the wading birds to choose this wetland as their foraging site (Table 3). All 16 species of wading birds were observed utilizing this site during the study period.

Site C or student dormitory adjacent marshland is characterized by an abundance of aquatic vegetation, along with a rich presence of phytoplankton and zooplankton. A total of 19 species of emergent vegetation were identified within this habitat (Table 3). Throughout the study period, all 16 documented species of wading birds were consistently observed utilizing this site.

Site D or Nil Dighi pond is the primary water source on the NSTU campus. This site supported the lowest diversity of aquatic vegetation, with only 12 species of plants documented during the study period (Table 3). The pond was rich in aquatic fauna, including small fish, aquatic insects, and a range of invertebrates. During the study period, only one species of wading bird, White-breasted Waterhen (*Amauror phoenicurus*) was observed utilizing this habitat.

All four study sites were characterized by a diverse assemblage of aquatic vegetation a wide variety of prey species consumed by wading birds. The availability of both factors probably played a significant role in influencing habitat selection and foraging behavior among the observed bird species. Previous studies also revealed the importance of vegetation type in determining wading bird habitat selection. Lantz *et al.* (2010) reported that submerged aquatic vegetation influences the habitat selection of wading birds. In contrast, Pierce and Gawlik (2010) described that wading birds choose foraging sites that had less emergent vegetation, a thicker flocculent layer and higher prey density relative to random sites.

However, avian diversity at Site D was markedly limited, which had the highest average water depth among all study sites. During the study period, only White-breasted Waterhen (*Amauror phoenicurus*) was seen foraging frequently. Due to abundance of aquatic fauna, White-breasted Waterhen preferred this habitat for foraging. In contrast, other wading bird species were rarely recorded at this site which might be caused by the limited presence of emergent vegetation and highest water depth. Shallow water habitats provide more accessible foraging opportunities, as prey such as fish, amphibians, and aquatic invertebrates are more concentrated and within reach of the birds' bills and legs. These observations are supported by the findings of Lantz *et al.* (2010), who noted that both water depth and vegetation density significantly influence the vulnerability and accessibility of aquatic prey to wading birds. Similarly, Colwell and Taft (2000) reported that shallow wetlands accommodate more species and greater numbers of waterbirds than deep wetlands. Likewise, Borges and Shanbhag (2018) found in their study that wading bird density tends to increase during the dry season as water levels decline. In site D, the combination of deep water and sparse emergent vegetation may have reduced the foraging efficiency and habitat suitability for most wading bird species, thus limiting their presence at the site.

Similarity among the Site-wise Vegetation: The pairwise results of Jaccard Similarity Index (J) revealed that, three of the wetlands—Site A, Site B, and Site C exhibited comparatively higher degrees of similarity in their aquatic plant communities (Table 4). The highest similarity value (J = 0.321) was recorded between Site A and Site B, suggesting considerable overlap in species composition. A moderate similarity value (J = 0.212) was observed between Site A and Site C, while the lowest similarity (J = 0.100) was found between Site A and Site D.

The findings of Jaccard Similarity Index (J) suggest that Sites A, B, and C share a relatively similar assemblage of emergent vegetation. The similarity in vegetation composition may also contribute to the observed patterns of wading bird habitat use, as these sites were more frequently visited by a wide range of wading bird species. In contrast, Site D's lower similarity index and distinct plant composition may indicate its reduced

Table 3. List of emergent vegetation present in four study sites

Common name	Scientific name	Family	Site A	Site B	Site C	Site D
Scutch Grass	*Cynodon dactylon*	Poaceae	√	-	-	-
Water Lily	*Nymphaea nouchali*	Nymphaeaceae	√	√	√	-
Japanese Stiltgrass	*Microstegium vimineum*	Poaceae	√	-	-	√
Broad Leaf Cattail	*Typha latifolia*	Typhaceae	√	-	√	-
Water Hayacinth	*Eichhornia crassipes*	Pontederiaceae	√	√	√	-
Sessile Joyweed	*Alternanthera sessilis*	Amaranthaceae	√	-	-	-
Alligator Weed	*Alternanthera philoxeroides*	Amaranthaceae	√	-	√	-
Morning Glory Bush	*Ipomoea carnea*	Convolvulaceae	√	-	-	-
False Indigo Bush	*Amorpha fruticosa*	Fabaceae	√	-	-	-
Softstem Bulrush	*Schoenoplectus tabernaemontani*	Cyperaceae	√	√	-	-
Turkey Tangle Frogfruit	*Phyla nodiflora*	Verbenaceae	√	-	-	-
Field Mint	*Mentha arvensis*	Lamiaceae	√	-	-	-
Little Hogweed	*Portulaca oleracea*	Portulacaceae	√	√	√	-
Kochu	*Colocasia esculenta*	Araceae	√	√	-	-
Water Spinach	*Ipomoea aquatica*	Convolvulaceae	√	-	√	-
Fall Panicum	*Panicum dichotomiflorum*	Poaceae	√	-	-	-
Tea-leafed Willow	*Salix planifolia*	Salicaceae	√	√	-	-
Horny Goat Weed	*Epimedium sp.*	Berberidaceae	√	-	-	-
Beaked Sedge	*Carex rostrata*	Cyperaceae	√	√	-	√
Carpet Grass	*Axonopus compressus*	Poaceae	√	√	-	-
Floating Primrose-willow	*Ludwigia peploides*	Onagraceae	√	√	√	-
Ranawara	*Senna auriculata*	Fabaceae	-	√	-	-
True Indigo	*Indigofera tinctoria*	Fabaceae	-	√	-	-
Kudri	*Coccinia grandis*	Cucurbitaceae	-	√	-	-
Carolina Leafflower	*Phyllanthus caroliniensis*	Phyllanthaceae	-	√	-	-
Oregano	*Origanum vulgare*	Lamiaceae	-	√	-	-
Giant Sword Fern	*Polystichum munitum*	Dryopteridaceae	-	√	-	-
Maidencane	*Panicum hemitomon*	Poaceae	-	√	√	√
Vine Plant	*Cayratia japonica*	Vitaceae	-	-	√	√
Shame Plant	*Mimosa pudica*	Fabaceae	-	-	√	-
Giant Cane	*Arundo donax*	Poaceae	-	-	√	-

Spreading Dogbane	*Apocynum androsaemifolium*	Apocynaceae	-	-	√	-
Simple-stem Bur-reed	*Sparganium erectum*	Typhaceae	-	-	√	-
Kans Grass	*Saccharum spontaneum*	Poaceae	-	-	√	-
Soft Water Fern	*Parablechnum minus*	Blechnaceae	-	-	√	-
Bitter Vine	*Mikania micrantha*	Asteraceae	-	-	√	-
Blue Pea	*Clitoria ternatea*	Fabaceae	-	-	√	-
Blume Diels	*Diploclisia glaucescens*	Menispermaceae	-	-	√	-
Smooth Frogbit	*Limnobium laevigatum*	Hydrocharitaceae	-	-	√	-
Guinea Rush	*Cyperus articulatus*	Cyperaceae	-	-	-	√
Velvet Leaf	*Cissampelos pareira*	Menispermaceae	-	-	-	√
Black Galangal	*Alpinia sp.*	Zingiberaceae	-	-	-	√
Greater- Hard-fern	*Parablechnum cordatum*	Blechnaceae	-	-	-	√
Caesar Weed	*Urena lobata*	Malvaceae	-	-	-	√
Three Flower Ticktrefoil	*Desmodium triflorum*	Fabaceae	-	-	-	√
Primrose Willow	*Ludwigia octovalvis*	Onagraceae	-	-	-	√
Wavy Hair Grass	*Avenella flexuosa*	Poaceae	-	-	-	√

attractiveness to wading birds. This analysis supports the view that vegetation composition plays a key role in the habitat preferences of wading birds. Similar observations were reported by Baschuk *et al.* (2012), who found that vegetation compositions within wetlands significantly influence the densities of marsh birds.

Table 4. Pairwise Jaccard Similarity Index (J) values among the four wetlands

Value of J	Site A	Site B	Site C	Site D
Site A	1	0.321	0.212	0.1
Site B	0.321	1	0.167	0.12
Site C	0.212	0.167	1	0.107
Site D	0.1	0.12	0.107	1

Dietary Composition: In the present study, a sum of 22 food items was recorded consumed by wading birds. Of these, 16 species (73%) were of animal sources, whereas 6 species (27%) were derived from plant sources (Fig. 2). The recorded animal food items were belonging to 13 families, 11 orders, and 3 phyla (Table 5). Chordates constituted the most diverse prey group, representing 56.25% (9 species) of the identified prey species and comprising fishes and tadpoles. Arthropods, including aquatic insects, spiders and crustaceans comprised 25% (4 species) of the diet, while molluscs, represented by gastropods, accounted for 18.75% (3 species) (Fig

3). On the other hand, the recorded 6 plant-based food items consists of various plant parts, including fruits, seeds, flowers, and leaves (Table 6).

Comparative studies have reported variations in the diet composition of wading birds. Kober (2004) noted that the diet composition of wading birds was dominated by polychaetes (20 taxa) and crustaceans (18 taxa), which provided together 70% of all taxa. Miranda and Collazo (1997) identified 11 prey groups, including fishes (7 families), crabs, shrimps, lizards, and insects. Similarly, Guerra and Galvis (2019) recorded four prey groups in the diet of wading birds, including fishes (5 families), spiders, crustaceans, and insects.

Table 5. List of the animal-sourced food items consumed by the wading birds

Common name	Scientific name	Order	Class	Phylum
Apple Snail	*Pila globosa*	Architaenioglossa	Gastropoda	Mollusca
Land Snail	*Monachoides vicinus*	Stylommatopphora	Gastropoda	Mollusca
Land Snail	*Euomphalia strigella*	Stylommatophora	Gastropoda	Mollusca
White Shrimp	*Litopenaeus setiferus*	Decapoda	Crustacea	Arthropoda
Common Water Strider	*Gerris lacustris*	Hemiptera	Insecta	Arthropoda
Pirate Wolf Spiders	*Pirata piraticus*	Araneae	Arachnida	Arthropoda
Mayflies	*Ephemera danica*	Ephemeroptera	Insecta	Arthropoda
Tadpoles	*Hoplobatrachus*	Anura	Amphibia	Chordata
Punti Fish	*Puntius chola*	Cypriniformes	Actinopterygii	Chordata
Carplet	*Amblypharyngodon microlepis*	Cypriniformes	Actinopterygii	Chordata
Elongated Glassfish	*Channa nama*	Perciformes	Actinopterygii	Chordata
Gourami	*Trichogaster fasciata*	Anabantiformes	Actinopterygii	Chordata
Common Bleak	*Alburnus arborella*	Cypriniformes	Actinopterygii	Chordata
Indian River Shad	*Gudusia sp.*	Clupeiformes	Actinopterygii	Chordata
Indian Glassy Fish	*Parambassis ranga*	Perciformes	Actinopterygii	Chordata
Flying Barb	*Esomus danrica*	Cypriniformes	Actinopterygii	Chordata

Among the dietary composition, all recorded animal-based food items were observed to be abundant and widely distributed across the four studied wetlands. This widespread availability of prey might influence the foraging site selection of wading birds, as animal-sourced foods provide higher nutritional value and energy density compared to plant matter. On the other hand, three out of the four study sites had a significant amount of aquatic plants covering them. In contrast, Site D exhibited the lowest diversity and abundance of aquatic plants. Notably, all but one of the plant species were recorded to be consumed by wading birds were absent in Site D. This lack of preferred plant food sources, combine with the deeper water levels contributed to the infrequent use of this habitat by most wading bird species.

Table 6. List of plant-sourced food items consumed by the wading birds

Common name	**Scientific name**	**Family**
Smooth Frogbit	*Limnobium laevigatum*	Hydrocharitaceae
Water Spinach	*Ipomoea aquatica*	Convolvulaceae
Water Hayacinth	*Pontederia crassipes*	Pontederiaceae
Water Lily	*Nymphaea nouchali*	Nymphaeaceae
Little Hogweed	*Portula oleracea*	Portulacaceae
Floating Primrose-willow	*Ludwigia peploides*	Onagraceae

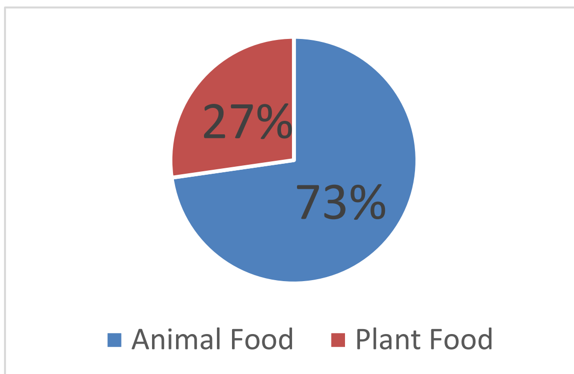

Fig. 2 Food items consumed by waders in the study sites

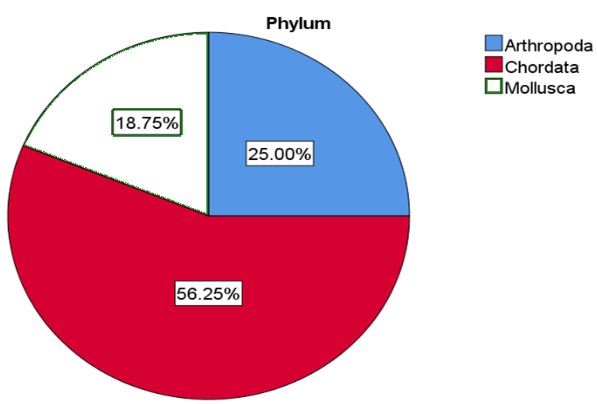

Fig. 3 Animal-sourced food items under different phyla consumed by waders

CONCLUSION

The ecological features collectively create favorable conditions for supporting a variety of wading bird species. Field observation during the study indicates a clear preference among wading birds for shallow wetland areas, which facilitate efficient foraging. Shallow water enables birds to utilize their long legs for wading while accessing prey items such as small fish, crustaceans, aquatic insects, and other invertebrates. In addition, emergent vegetation within these wetlands serves as a good source of food, which attracts wading birds to forage.

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