

**Foraging Guild Structure and Niche Characteristics of Waterbirds in
Pong Wetland, Himachal Pradesh**

by

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in
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Under the supervision of

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June 2025



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DECLARATION

I hereby declare that the work conducted under the thesis entitled “Foraging Guild structure and niche characteristics of waterbirds in Pong wetland, Himachal Pradesh”, is a record of original and independent research work done by me and subsequently submitted for the award of the degree of Master’s in Wildlife Science at the Academy of Scientific and Innovative Research. This research work has been carried out under the guidance and supervision of Dr. Gautam Talukdar (Scientist F), and co-supervision of Dr. Gopi G.V. (Scientist F), Ms. Amarjeet Kaur (Scientist C) of Wildlife Institute of India, Dehradun. The work has not formed the basis for the award of any other degree, diploma, or any other qualification. I also declare that the thesis embodies my own work, analysis, observation, understanding and the particulars given in it are true to the best of my knowledge.

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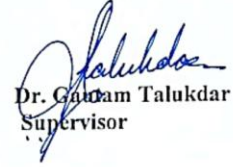


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This is to certify that the thesis by Abhishek entitled “Foraging Guild structure and niche characteristics of waterbirds in Pong wetland, Himachal Pradesh” is an original and independent research work submitted to the Academy of Scientific and Innovative Research, for the award of the degree of Master’s in Wildlife Science.

Abhishek has put one semester of research work embodied in this thesis under my guidance and supervision. The work presented in this thesis has not been submitted to any other University or Institute for the award of any degree, diploma or distinction.


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Abhishek
(XIX MSc.)

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1. Abstract

Wetlands are one of the important habitats for waterbirds, yet the mechanism of niche segregation among the waterbird communities is understudied. This study focused on the foraging guild structure and niche characteristics of waterbirds in Pong wetland during the wintering season. The study takes into account foraging habitat (water depth, secchi depth and vegetation type) and foraging technique used by the waterbird species to understand resource partition and coexistence. The study was carried out from December 2024 to March 2025 using the point count method in two different sites of the Pong wetland i.e., Meenu khad and Gaj khad each having five replicates. The total sampling effort was 56 days with 26 days in Meenu khad and 30 days in Gaj khad. The species richness analysis of both the sites revealed Meenu khad to be more species rich than Gaj khad likely due to variation in water depth in the region, resulting in different habitat conditions. The monthly abundance of waterbirds in Pong wetland was found to be at its peak in the month of January. Generalist species such as the Eurasian Coot and Tufted Duck occupied the broadest habitat and combined niche breadth than that of specialists such as the River Tern. Furthermore, in terms of extensive foraging strategy, species such as the Northern Shoveler and Intermediate Egret occupied broader niche breadth, demonstrating behavioral flexibility in resource acquisition. The clustering of waterbird communities resulted in four functional guilds that are responsible for reducing competition and allowing species coexistence. It was found that the intraguild overlap was significantly higher than the interguild overlap ($F = 54.34, p < 0.001$). The null models further showed the mechanism that could be responsible for structuring the communities. It resulted in higher observed niche overlap than expected, signifying that community structure of waterbirds is largely influenced by morphological variations leading to different foraging habits, variable abundance of waterbird species and presence of abundant resources at Pong Dam.

This study is the first in providing deeper understanding on seasonal waterbird abundance, niche requirements and community structure at Pong Lake. This study serves as a baseline to continue future studies in the region and assess the impacts of changing land use practices as well as changing climate on species occurrence and abundance and community structure. Furthermore, the study also showed the region to be an important staging ground for many migratory species, therefore, focusing on targeted habitat management will be crucial to support the diversity of waterbird species.

2. Introduction

Wetlands are defined as areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six meters (Ramsar Convention Secretariat, 2016). They are among the most productive ecosystems that form a bridge between permanently aquatic and complex terrestrial systems (Prasad et al., 2002). Wetlands play an important role in balancing the ecosystem and supporting biodiversity. They provide countless ecosystem services contributing more than 25% of the total value of global ecosystem services (Kingsford et al., 2016). They keep the water table stable by retaining water during dry spells, mitigate floods by storing excess rainfall and improving water quality by trapping sediments and pollutants. They also play a significant role in climate change mitigation through carbon sequestration (Asare et al., 2022). Wetlands also provide critical habitat for the survival and well-being of wildlife communities. They are home to a variety of plants and animal species including rare, threatened and endangered.

Waterbirds are among those wildlife communities that are completely dependent on wetlands for their survival. Wetlands provide resources such as food, nesting sites and shelter to the waterbirds making them ideal for feeding, breeding and protection. They act as crucial stopover points for waterbirds to rest, feed and refuel during migration. Beyond their dependence on wetlands, many waterbird species also contribute significantly to shape and maintain wetland ecosystems. Grazing of seagrass beds by geese and wigeon prevents the accumulation of mud in these habitats (Nacken & Reise, 2000). The introduction of foxes in Aleutian Island led to the elimination of native cackling geese contributing to low plant diversity due to release in grazing pressure (Maron et al., 2006). The number and health of waterbirds in a wetland is an important indicator of wetland health (Luo et al., 2019). For example, changes in abundance of ducks and coots can indicate variation in the abundance of submerged macrophytes (Wicker & Endres, 1995). The absence of commonly breeding species such as Mallard (*Anas platyrhynchos*) and Eurasian teal (*Anas crecca*) from Scandinavian wetlands suggest an extremely low abundance of invertebrates (Gunnarsson et al., 2004). Human activities such as urbanization, pollution, and land-use changes are known to damage around 30% of the wetlands threatening 21% of the waterbird species (Vasumathi V. et al., 2023). Therefore, effective management of wetlands is urgently needed to safeguard the

waterbirds, which depend on wetland habitats. International conventions such as Ramsar and Bonn Convention are playing an important role in protection, conservation and effective management of the wetlands.

The habitat heterogeneity of wetlands is necessary for maintaining rich waterbird diversity and supporting complex food webs. The diverse habitat of wetlands includes grasslands, mudflats and open waters that allows large congregations of different species of waterbirds. Therefore, understanding the mechanism of resource partitioning among waterbirds is of great interest. The waterbirds communities are often studied as per their guild structure and niche characteristics (Chatterjee et al., 2020) to understand coexistence. The species within a guild exploit resource in a similar manner and are more prone to competitive interaction over shared resources (Pérez-Crespo et al., 2013). Studies have revealed that these species use different or similar resources in different ways to avoid competition. For example, herbivorous water birds such as geese and swans separate their niches by foraging in exposed riparian grasslands and shallow waters or mudflats, respectively (Jia et al., 2019). Herons, egrets and ibis also exhibit feeding segregation by exploiting different taxa or life stages of odonata (Samraoui et al., 2012).

Foraging habitat and foraging techniques are two trophic components of resource utilization. Foraging habitat influences the distribution of waterbird species that occupy ecological niches at varying water depths (Bai et al., 2021). The unique anatomical adaptations such as bill shape, neck length and tarsus length allow them to use different foraging techniques. The combination of differences in foraging habitat and technique is responsible for the resource partitioning in the waterbirds (Chatterjee et al., 2020). Foraging techniques among waterbirds includes grazing, upending, diving etc., each adapted to specific prey types and environmental conditions. Shallow water species may forage using upending while others may use diving in deeper waters to catch fish. These differences in foraging behavior helps to reduce direct competition for food resources and allow multiple species to inhabit the same wetland area.

The present study is focusing on the Foraging technique and Foraging habitat used by the waterbirds to understand their coexistence in an important Ramsar site of India- the Pong Wetland. The study aims to provide an insight on the influence of factors such as water depth, secchi depth and vegetation type on waterbirds and their distribution. It will also help to understand the mechanism of resource partitioning among the largely co-existing species in the wetland. The findings of the study will be helpful to manage waterbird habitat and track threats such as habitat loss and degradation.

The present study was undertaken with the following objectives:

1. To estimate the population of waterbirds in selected sites in Pong Wetland across the wintering season.

Question: How is the population of waterbirds changing with different months across the wintering season?

2. To understand the habitat-use by different waterbird species and the ecological mechanism governing their co-existence and resource partitioning.

Question: How are the waterbird communities segregating their niches from each other?

Question: What are the ecological mechanisms that structure waterbird communities?

3. Literature Review

3.1 Wetlands as habitat for waterbirds

Wetlands are the most diverse and productive ecosystems of the biosphere. They are known to provide varying ecosystem services classified broadly as provisioning, regulating, supporting and cultural services (Mitsch et al., 2015). Wetlands cover an area of approximately 15.26 million hectares (Arya et al., 2020), and solely support around 20% of Biodiversity in India (Prasad et al., 2002). Waterbirds are the important communities that are dependent on wetlands for foraging, nesting, breeding and roosting. The structural complexity and high productivity of wetlands allow different waterbird species to exploit diverse ecological niches and support high species richness. Wetland degradation has caused a significant decline in waterbird population through pollution, hydrological changes and land-use conversion (Davidson, 2014). Conservation of wetlands is therefore vital not only for biodiversity but also for maintaining ecological functions and services. Ramsar Convention has played an important role in the conservation and sustainable utilization of wetlands.

3.2 Foraging Ecology of waterbirds

The availability of adequate food resources is essential for the survival, nesting and breeding of waterbirds. It is super-abundant in their breeding areas but becomes a limiting factor in the wintering grounds (Boula, 1985). Waterbirds have evolved with various strategies to overcome this situation by using traditional migratory routes which pass through key staging areas. These areas provide important feeding and resting spots for long distance migration. These areas are also called as “geographic bottlenecks” because the environmental conditions overthere, can affect the entire population within the migratory corridor (Myers, 1983). The energy expenditure of waterbirds in non-breeding season mainly includes maintaining normal body temperature, escaping predators and to cover up food gathering costs (Evans, 1976). Increase in any or all of these components can increase the overall energy requirement of the species. Therefore, Habitat selection becomes an important factor to meet up the energy requirement of waterbirds.

3.3 Habitat use and preferences of waterbirds

Wetlands are heterogeneous habitats that harbor resources in the form of different microhabitats (Paracuellos, 2006). It includes grasslands, muddy shores and open water with varying depths. Waterbirds select a suitable microhabitat according to anatomical adaptations such as bill shape, neck length and tarsus length to access these resources (Bai et al., 2021). Therefore, habitat selection becomes important for waterbirds to fulfil their energy requirement.

Foraging habitat and technique are important factors that determine habitat selection by the waterbirds. It not only provides adequate resources to the waterbirds but also helps them to segregate their niches from the other waterbird species. Different foraging techniques based on the habitat are evolved in the water birds to access resources easily and maximize the net energy gain. It includes diving in deep water, upending in shallow water, grazing in grasslands etc. These techniques form the framework of foraging theory which states that the ways animals use to acquire food is to maximize the energy gain.

To evaluate the pattern of resource utilization, spatial models such as niche breadth and niche overlap are used. Niche breadth refers to the range of resources used by a species, while niche overlap indicates the joint use of resources by two or more species (Colwell & Futuyma, 1971). These models are useful for understanding both interspecific and intraspecific resource partitioning within waterbird communities.

3.4 Niche theory and resource partitioning

According to classical niche theory, stable species coexistence depends on niche segregation, which reduces competition for limited food resources and enables multiple species to forage in the same area simultaneously (MacArthur, 1958). The seasonal changes in wetlands can also lead to scarce resources resulting in competition between the waterbird species. It can be minimized through habitat differentiation and resource partitioning (Xu et. al., 2021).

Habitat differentiation can be defined as the use of different habitats or parts of a habitat to reduce competition. It minimizes stress on the shared resources and promotes resource partitioning. Waterbirds segregate their niches by occupying different microhabitats within a wetland. Water depth is one of those variables that affect waterbird species that occupy ecological niches at different water depths (Mei et al.,2016). For example, diving ducks forage in deeper water whereas dabbling ducks feed in shallow areas.

Guild structure and niche characteristics are important indicators to understand niche partitioning in waterbirds (Chatterjee et al., 2020). Guild is defined as the group of individuals that exploit similar resources in a similar manner. Guild members that use multiple foraging techniques are called generalists while those which use specific foraging techniques are called specialists (Elafri et al., 2017). These species avoid inter-guild and intra-guild overlap by adopting more specific foraging techniques and utilizing different foraging depths respectively.

3.5 Human disturbance and guild specific responses

Wetlands and waterbirds are facing severe pressure from human activities such as habitat destruction, pollution, hunting and recreation (Robinson & Cranswick, 2003). They respond to such disturbances through both behavioral and physiological changes which negatively impacts them to varying degrees (Gill, 2007). These include increased heart rates and body temperature (Ackerman et al., 2004), elevated stress hormone levels (Saino et al., 2005), and changes in behavior such as increased vigilance rate, anti-predator responses, and fleeing—activities that reduce feeding and resting time while increasing energy expenditure (Gill, 2007).

Different waterbird guilds respond differently to these anthropogenic activities. According to Li et al. (2022), ducks, shorebirds, and herons exhibited distinct patterns in species richness, population abundance, and Shannon–Wiener diversity in response to human-induced landscape changes over a period of nine years. Wang et al. (2020), in their study on fragmented wetland habitats, found that low-sensitivity species (such as ducks, shorebirds, and herons) exhibit greater tolerance than high-sensitivity species (such as cranes and spoonbills).

3.6 International framework for wetland conservation

A number of global frameworks acknowledge the ecological value of wetlands. The Ramsar Convention (Ramsar Convention Secretariat, 2016) is among the first international conventions particularly concerned with conservation and sustainable use of wetlands. The Convention on Biological Diversity (CBD) encourages conservation of biological diversity and equitable sharing of genetic resources. Similarly, the Convention on Migratory Species (CMS) aims to conserve all terrestrial, marine and avian migratory species. The United Nations Framework Convention on Climate Change (UNFCCC) also highlights the importance of stabilizing greenhouse gases to safeguard wildlife. Most recently, the Kunming-Montreal Global Biodiversity Framework (KM-

GBF) established aggressive goals to end biodiversity loss by 2030, with an emphasis on restoration and sustainable use of ecosystems, including wetlands (Convention on Wetlands, 2023).

3.7 Review of waterbird studies in India

In India studies on waterbirds are largely carried out around anthropogenic threats or just documentation of species, only few studies have looked into the niche segregation and niche overlap among waterbird species. Studies carried out on niche characteristics revealed that generalist species exploit a wide range of habitat thereby exhibit lower niche overlap than specialist species (Chatterjee et al., 2020). Studies have also revealed that foraging strategies, prey preferences, water depth and time activity budget are key factors responsible in reducing interspecific competition (Ishtiaq et al., 2009; Sharma et al., 2019). While niche-based studies are limited, a lot of research has highlighted the negative impact of human activities on waterbird communities. These studies found that sand mining, commercial fishing, road expansion and human settlements are responsible for significant decline in waterbird population (Parameshwaram et al., 2023; Mahar et al., 2023).

3.8 Justification of the study

The study focuses on a least studied yet critical wetland of north Indian landscape, the Pong dam. It holds a record of supporting a great population of wintering waterfowl especially of Central Asian Flyway. However, with emerging threats such as agricultural expansion, human disturbance, pollution etc., it becomes even more critical to document the species wintering in the Pong Wetland to inform effective conservation strategies.

The present study is the first attempt to record wintering waterbirds systematically for an entire wintering season from the region. It helped to understand dominant and non-dominant communities and the mechanism used by them to segregate from each other. The information generated can help fill critical knowledge gaps and support better management of the wetland.

4. Methods

4.1 Study area

The study was carried out in Pong Wetland located in the Kangra district of Himachal Pradesh. It is also known as Maharana Pratap Sagar, created by damming of the River Beas. It is located in the foothills of Himalayas on the northern edge of the Indo-Gangetic plain. The northern edge of the wetland is flat with mudflats and wet grasslands that attracts a large number of waterbirds. It covers an area of 207 km² falling under Nurpur and Dehra Forest divisions. It is divided into two ranges, Nagrota Surian & Dhameta and each range is further subdivided into four beats. It holds large records of the number of waterbirds that come to the lake each winter and is also known to support great populations of wintering waterfowl especially of Central Asian Flyway. It was therefore declared as a Bird Sanctuary in 1983 and Ramsar site in 2002. The wetland is surrounded by agricultural fields and patches of dry mixed deciduous forests of acacia and pines. The wetland is facing a lot of emerging threats such as agriculture expansion, Human disturbance etc. Therefore, it becomes even more critical to document the species wintering in the wetland and understanding their habitat use. The present study is the first attempt to record wintering waterbirds systematically for an entire wintering season which will help in documenting the seasonality of waterbirds arrival and departure from the region. It is also helpful to understand the mechanism used by the waterbirds to segregate their niches.

Two sites namely Gaj Khad and Meenu Khad were selected based on their varying habitat characteristics. Gaj Khad is a tributary of the Beas River that originates from the Dhauladhar Range in Kangra District, Himachal Pradesh. It flows through different villages of the district and ends up in the Pong Dam. It forms a deep-water area after merging with the dam making it suitable for Diving waterbirds. It is less preferred for fishing activities because of its deep water.

Meenu Khad is a rainfed river that originates from the mountains near Masroor in Kangra District, Himachal Pradesh. It flows through different villages of the district and ends up in Pong Dam. It forms a shallow water area after merging with the dam making it suitable for Dabbling ducks. It is one of those areas that is preferred for fishing activities.

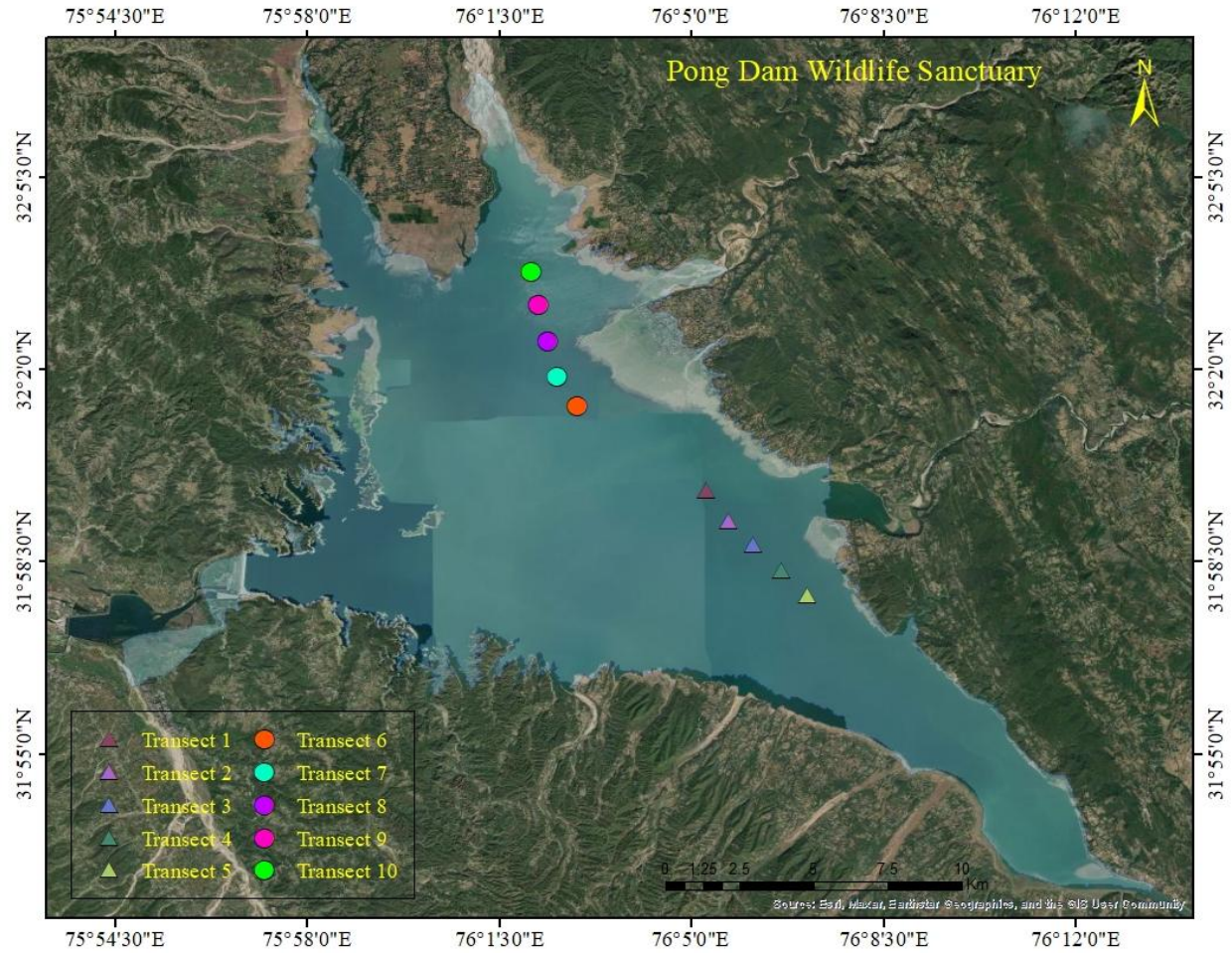


Figure 1: Map of study area: Pong Wetland in Kangra district of Himachal Pradesh, India. Circles and triangles represent two different sites, i.e., Gaj Khad and Meenu Khad, respectively.



Figure 2: Landscape heterogeneity across Pong Dam Lake Wildlife Sanctuary.

4.2 Field methods

Sampling was done in two different sites of the Pong dam i.e., Meenu Khad and Gaj Khad. In each site 5-point count locations were chosen based on the accessibility of boats at these points. Sampling in the two sites was done in an alternating pattern with five days of the month spent at the first site, followed by five days at another site and subsequently returning to the first site. The sampling effort of Meenu Khad and Gaj Khad was 26 days and 30 days respectively. Water bottles coloured with red colour (for visibility) were installed in the lake using nylon rope and stone. Three water bottles were installed at every point at 30m, 60m and 90m, from the shore. The data on following variables were collected during the sampling period:

4.2.1 Water depth

Water depth was measured at every point at 30m, 60m and 90m, from the shore. This exercise was done once in every month in both the sites. The measurement was done by lowering down a rope attached with weight into the lake. The rope was then measured with the measuring tape and the exact depth was noted down. Water depth can be categorized into following categories:

Table1: Classification of water depth

| Water depth categories | Water depth (m) |
|------------------------|------------------------|
| Grassland | None |
| Muddy shoreline | None |
| Shallow | >0 to ≤ 1.15 |
| Medium | >1.15 to ≤ 2.30 |
| Deep | >2.30 |

4.2.2 Secchi depth

Secchi depth was measured once in every month in both the sites at 30m, 60m and 90m, from the shore. Secchi disc was used to measure the secchi depth. The Secchi disc was lowered down from a boat and the first reading was taken when the disc disappeared. The second reading was taken when the disc reappeared after raising it up. The average of both readings makes up the secchi depth. It is an important indicator of turbidity of water in the lake. Secchi depth can be categorized into following categories:

Table 2: Classification of secchi depth

| Secchi depth categories | Secchi depth (m) |
|-------------------------|-----------------------------------|
| High clarity | Secchi depth = Water depth |
| Medium clarity | Secchi depth \geq Water depth/2 |
| Low clarity | Secchi depth $<$ Water depth/2 |

4.2.3 Vegetation Sampling

Vegetation sampling was also done at the points where water depth and secchi depth were recorded. It was carried out from a boat using a rake tied to a bamboo stick. The rake was inserted into the lake and dragged along the base to allow the collection of submerged vegetation (if present). The type of vegetation that was recorded during vegetation sampling was Terrestrial, Emergent and Submerged Vegetation.

4.2.4 Waterbird sampling

Sampling of birds was done using the point count method from 10:00 am to 02:00 pm in the selected sites of the Pong wetland. A point count of 15 minutes was done using Nikon prostaff P3 (8×42) binoculars. The data was recorded by species foraging technique and foraging habitat. Sampling was avoided during periods of rain and fog to ensure visibility.

4.3 Analytical methods

4.3.1 *Monthly trends in wintering waterbirds population*

Line plots were used to understand the seasonal change in the abundance of wintering waterbird species. The x-axis represented different months, while the y-axis indicated species abundance. These plots helped in identifying patterns of increase or decline in the number of individuals for various species over time. Data were grouped by species and summarized monthly to highlight trends across the wintering period.

4.3.2 *Estimating niche breadth of waterbird species*

To quantify the niche breadth of wintering waterbird species, I applied Levin's measure of niche breadth across three resource dimensions: foraging habitat, foraging technique, and both dimensions together. For each dimension, the proportion of resource use by each species was calculated and used to estimate the niche breadth.

The niche breadth values were then standardized to a 0–1 scale to account for differences in the number of available categories across dimensions. A value closer to 1 indicated a broader niche, while values closer to 0 indicated specialization.

This analysis was conducted in R using custom functions for both niche breadth calculation and standardization. Bar plots were generated to visualize and compare standardized niche breadths across species in each dimension using base R graphics.

4.3.3 *Estimating niche overlap among waterbird species*

To quantify the degree of resource overlap among waterbird species, Pianka's index of niche overlap was computed for three ecological dimensions—foraging habitat, foraging technique, and a combined dataset—using the “spaa” package in R (Ahmad et al., 2021). The input data for this analysis consisted of proportional resource use matrices, where rows represented species and columns represented different habitat types, foraging techniques, or their combinations. These

matrices were transposed to meet the input requirements of the `niche.overlap()` function, and interguild niche overlap values were calculated using Pianka's method.

The resulting overlap matrices were rounded to three decimal places for clarity and interpreted as symmetric, undirected relationships among species. To aid visualization and interpretation of these multidimensional associations, the overlap matrices were represented as weighted network graphs using the “igraph” package in R. In these network diagrams, nodes represented species, and edge thickness was scaled according to the strength of niche overlap. Separate graphs were generated for habitat, foraging technique, and combined dimensions to highlight patterns of potential competition and resource sharing across different ecological axes.

4.3.4 Identifying guild structure through cluster analysis

To classify waterbird species into ecological guilds based on resource use, hierarchical cluster analysis was conducted separately for foraging habitat, foraging technique, and a combined dataset. Proportional matrices of resource use were first subjected to an angular (arcsine square-root) transformation to normalize the data and stabilize variance (Pérez-Crespo et al. 2013). Following transformation, pairwise Euclidean distance matrices were computed for each dimension.

Cluster analysis was performed using the Unweighted Pair Group Method with Arithmetic Mean (UPGMA) via the `hclust()` function with method set to "average". Dendrograms were generated to visualize the grouping of species, and clusters were defined using a fixed number of groups ($k = 4$) to identify distinct guilds. The clustering and dendrogram visualizations were implemented using the `factoextra` package in R.

This approach allowed the identification of groups of species that exhibited similar patterns of resource use, providing ecological insights into functional guild structure within the waterbird community at Pong Wetland.

4.3.5 Assessment of niche overlap significance using null models

To evaluate whether the observed niche overlap among waterbird species deviated from random expectations, null model analyses were conducted using the EcoSimR package in R. The null models tested the significance of Pianka's niche overlap metric for habitat use, foraging technique, and their combined dimensions.

The RA3 algorithm was selected for randomization, which maintains species-specific resource use frequencies while relaxing constraints on resource availability (De los Ríos-Escalante & Ghory, 2024). This method effectively randomizes resource utilization patterns while preserving niche breadths. Each null model was run for 1,000 replicates to generate distributions of expected niche overlap under random assembly.

Comparisons of observed overlap values to the null distributions allowed inference on whether species exhibit non-random niche partitioning or overlap, indicating ecological processes such as competition or resource specialization structuring the waterbird community.

5. Results

5.1 Variability in the two sites

The species richness analysis of Gaj khad and Meenu khad in the species accumulation curve (Figure 3) shows that Meenu khad accommodates more waterbird species diversity than the Gaj khad. This difference in the species abundance can be attributed to the difference in water depth of the two sites (Figure 4). Meenu khad has relatively shallow water than Gaj khad which allows rapid shift in the waterline leaving behind mudflats that provide important foraging habitat for many waterbird species. On the other hand, Gaj khad because of deeper water depth undergoes slow change in waterline leaving very less mudflat habitat.

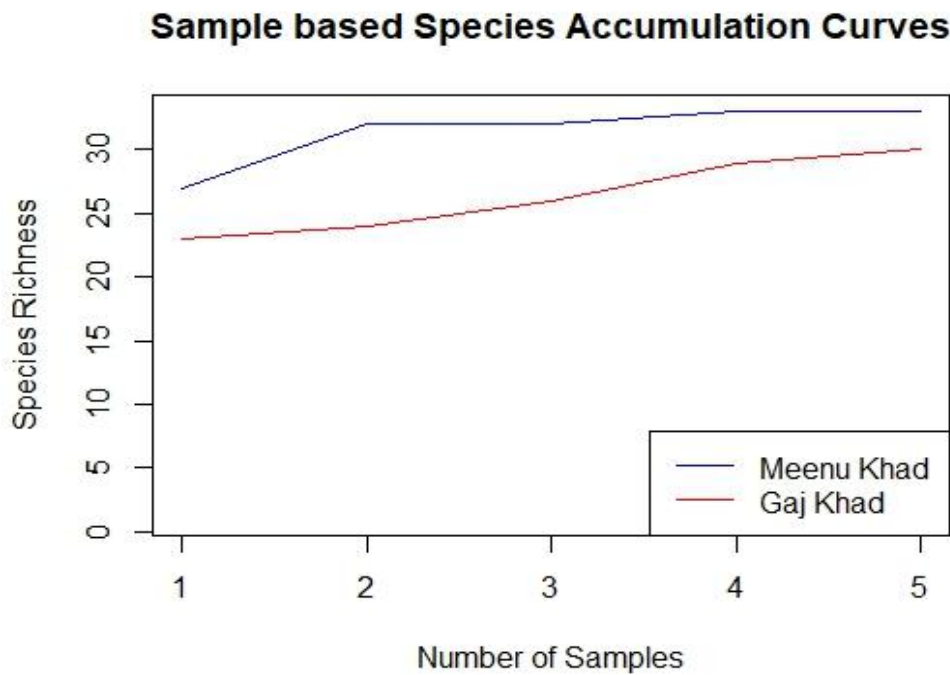


Figure 3: Sample based species accumulation curve for two sites i.e., Gaj khad and Meenu khad.



Figure 4: Bar plot showing difference in water depth of two sites, i.e., Gaj Khad and Meenu Khad.

5.2 Monthly abundance patterns of waterbirds

The estimation of change in abundance of wintering waterbirds throughout the study period (mid-December 2024– late March 2025) helped to understand the population peaks of different species of wintering waterbirds. The general trend indicates that the species abundance peaks in the month of January and gradually declines towards March. This information is important to understand seasonal dynamics of waterbird population in the region. It also highlights species with low observations or no significant change which could suggest low migratory patterns or resident populations.

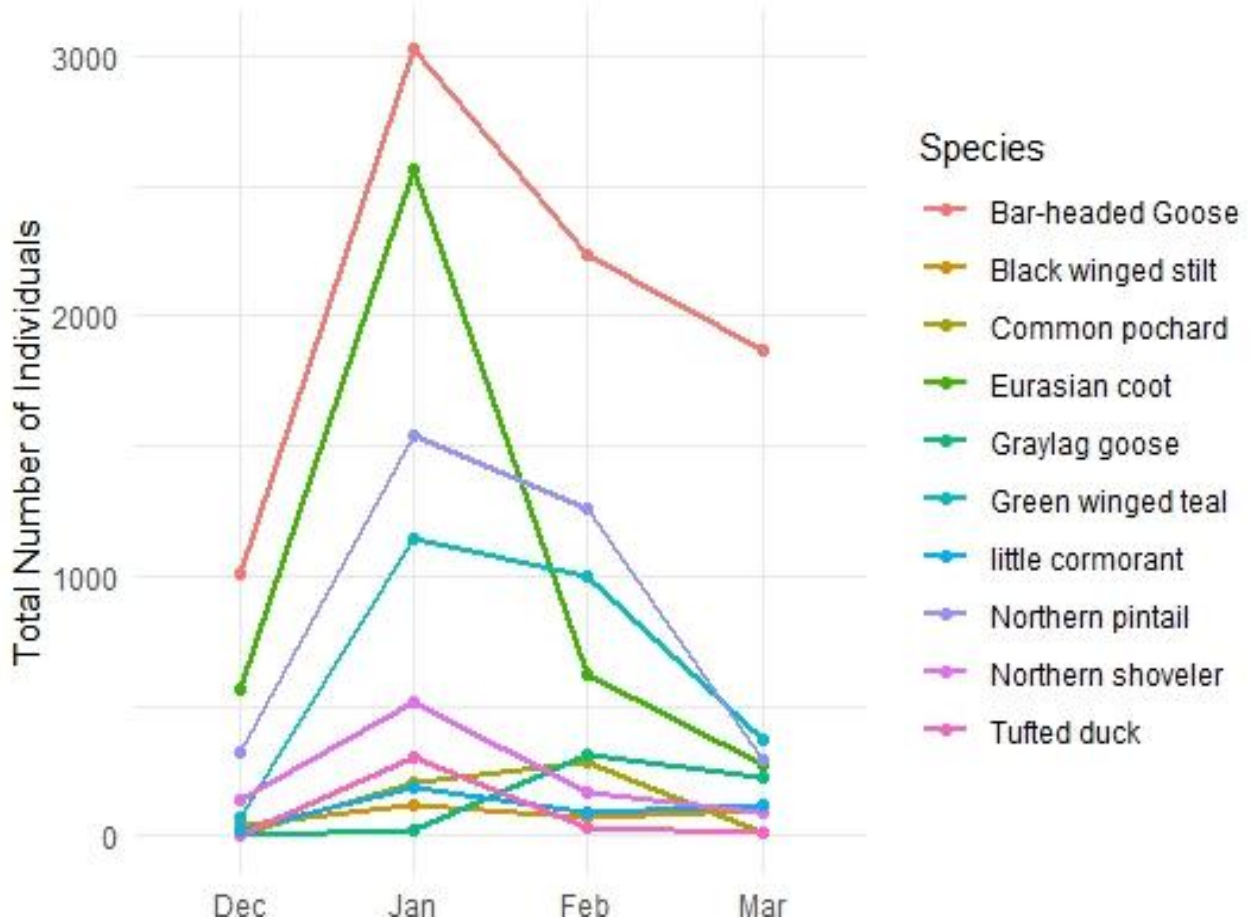


Figure 5: Line plot showing monthly abundance pattern of top ten waterbird species.

5.3 Species use of foraging techniques and habitat types

A total of eight foraging techniques and eight habitat types were recorded during the study at Pong Wetland. The pie charts (Figure 6a and 6b) illustrate the number of bird species associated with each foraging technique and habitat type. Among the foraging techniques, *picking from mud* emerged as the most commonly used method, employed by 24 species. In terms of habitat use, the *muddy shoreline with emergent vegetation* was the most frequently utilized habitat, supporting the highest number of species in the study area.

Number of Waterbird Species Using Each Foraging Technique

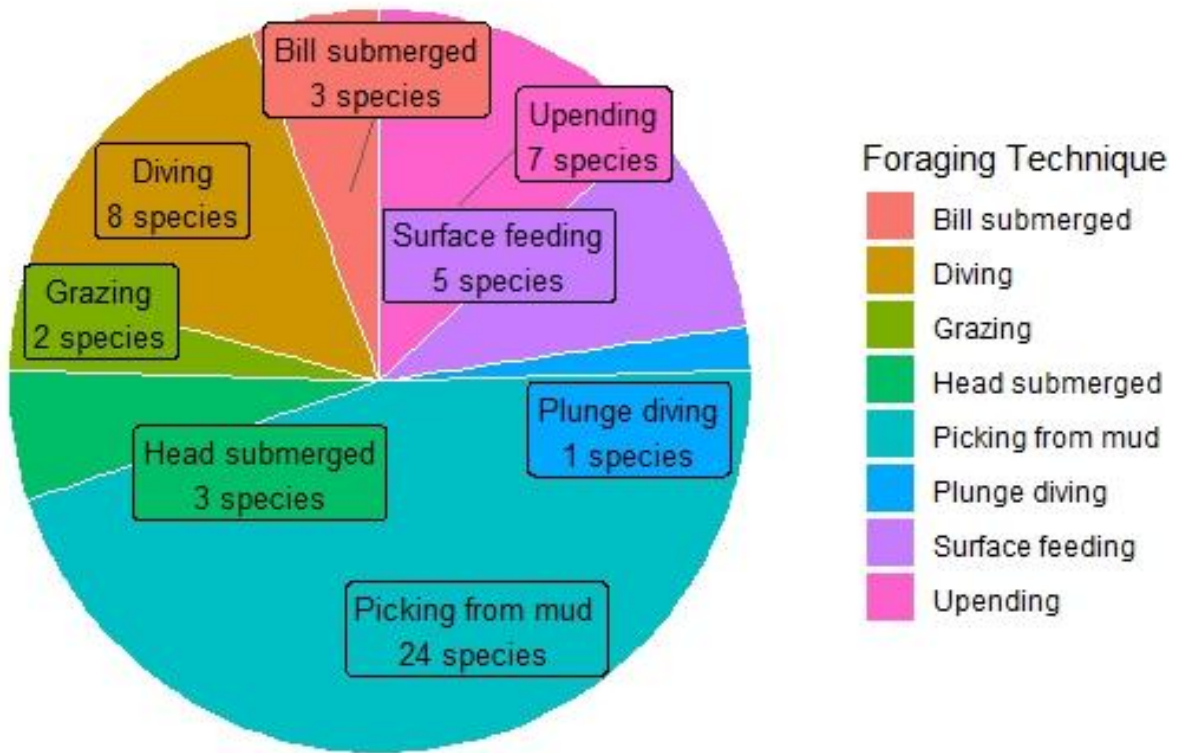


Figure 6a: Pie chart showing the number of waterbird species using each foraging technique.

Number of Waterbird Species Using Each Habitat

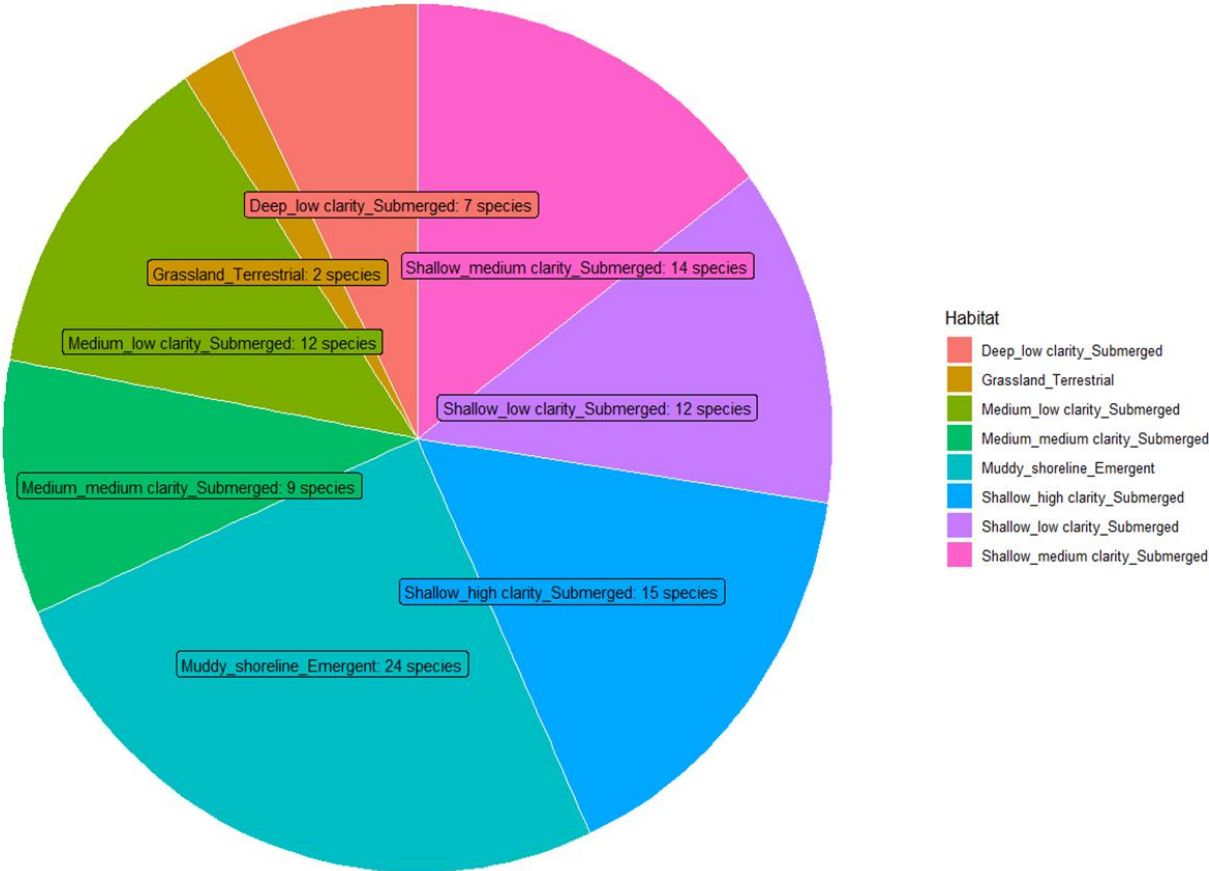


Figure 6b: Pie chart showing number of waterbird species using each foraging habitat.

5.4 Niche breadth of species

The niche breadth of different species was estimated based on three variables i.e., Foraging habitat (including water depth, secchi depth and vegetation type), Foraging technique and Combined dimension (including both foraging habitat and foraging technique). Eurasian coot exhibits the highest habitat and combined niche breadth followed by tufted duck indicating that they occupy a wide range of habitats or resources effectively (Figures 7a and 7c). The highest value of technique niche breadth was observed for Northern shoveler followed by Intermediate egret indicating usage of a broad range of foraging techniques (Figure 7b).

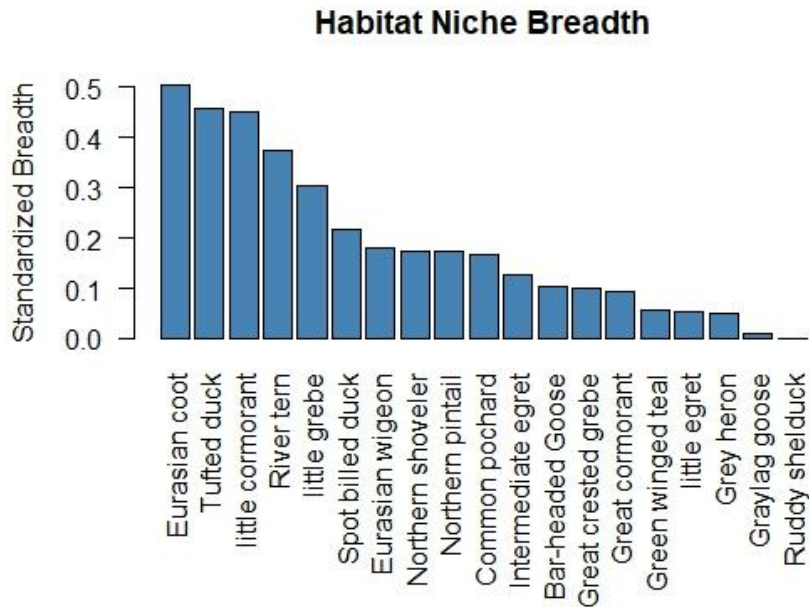


Figure 7a: Bar plot showing habitat niche breadth of waterbird species.

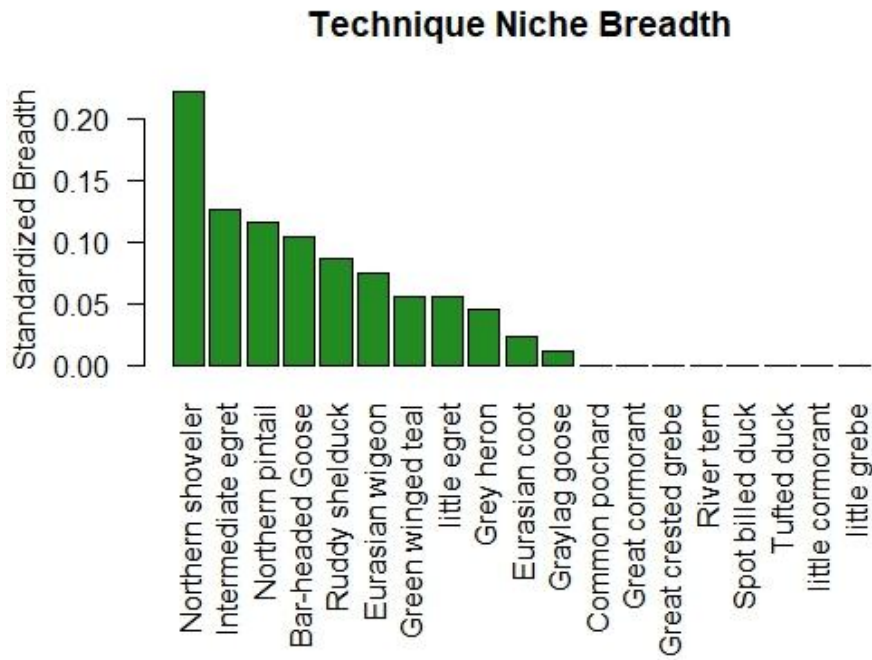


Figure 7b: Bar plot showing technique niche breadth of waterbird species.

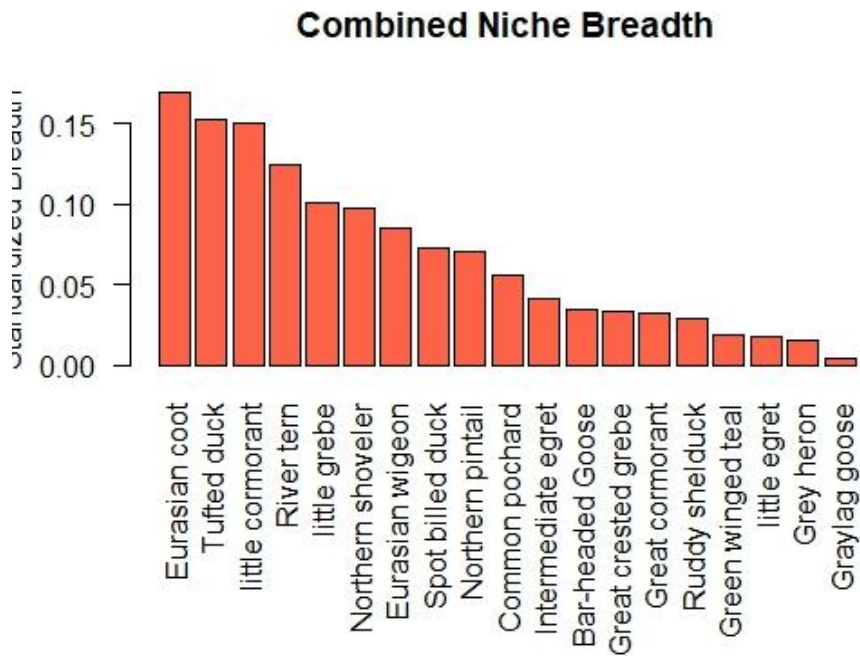


Figure 7c: Bar plot showing combined niche breadth of waterbird species.

5.5 Niche overlap between species

The niche overlap between different species was also estimated based on Foraging habitat, technique and combined dimension. A total of 8 foraging habitats and 8 foraging techniques were observed during the sampling period making 64 possible combinations of combined dimension. Out of 64 possible combinations, unrealistic combinations were omitted such as upending in grassland and diving in mud etc. A total of 22 realistic combinations were considered for the combined dimension. Each node in the graph (Figures 8a, 8b and 8c) represent a different species and the lines connecting the nodes indicate the degree of niche overlap between the species. The thickness of the lines suggesting the strength of overlap between the species. It clearly indicates that the species have overlapping niches with the other species.

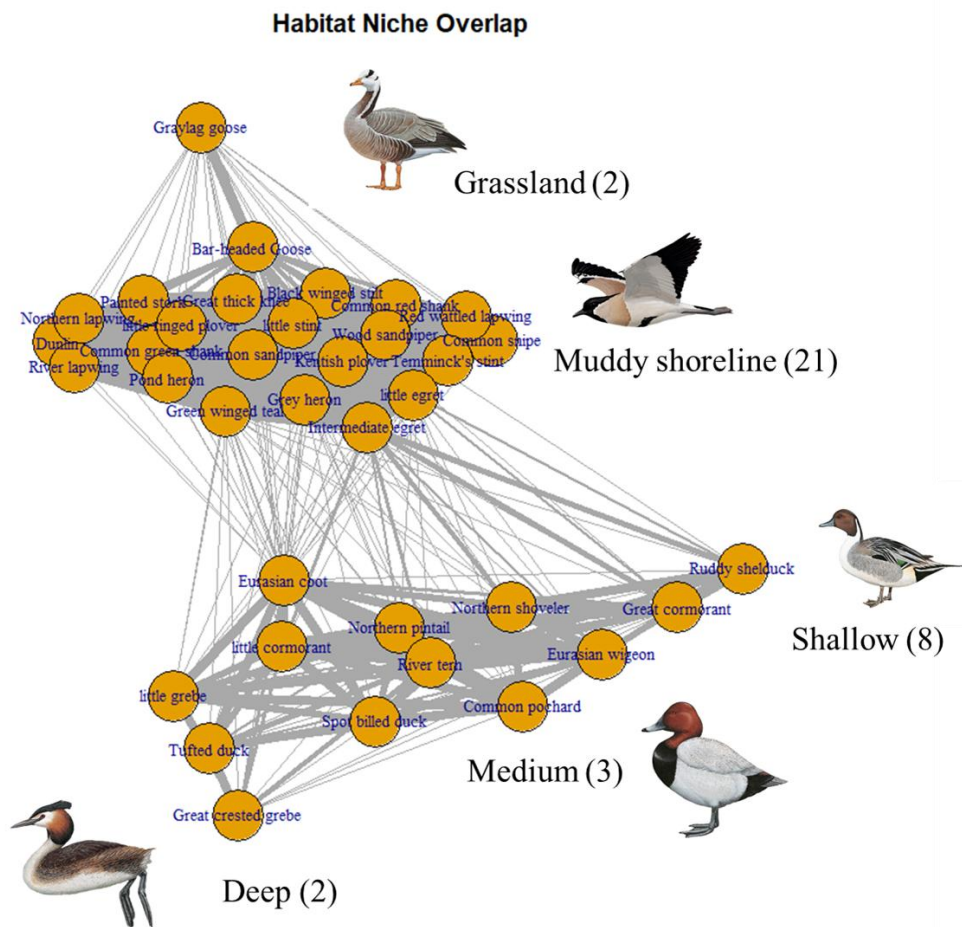


Figure 8a: Graph showing habitat niche overlap between species.

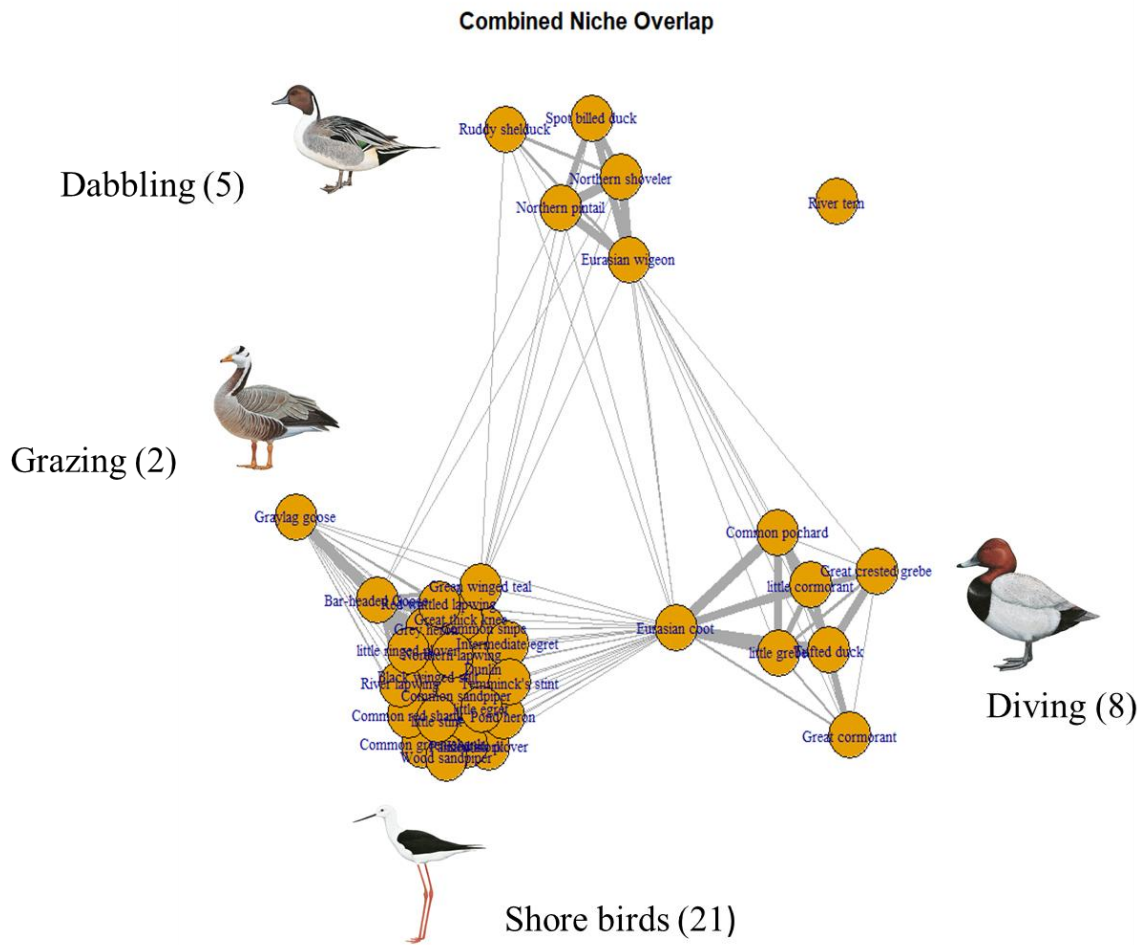


Figure 8c: Graph showing combined niche overlap between species.

5.6 Cluster analysis

Cluster analysis was done to group similar species together based on their foraging habitat, foraging technique and both dimensions. A total of 36 waterbird species were grouped into 4 guilds in each dendrogram.

Foraging habitat: Cluster analysis based on foraging habitat defines four species clusters known as guilds. Guild 1 and Guild 3 are represented by 2 species each, Guild 2 represents 11 species and guild 4 represents 21 species (Figure 9a).

Foraging technique: Cluster analysis based on foraging technique defines four species clusters known as guilds. Guild 1 is represented by only 1 species, Guild 2 represents 7 species, Guild 3 represents 5 species and Guild 4 represents 23 species (Figure 9b).

Combined dimension: Cluster analysis based on combined dimension defines four species clusters known as guilds. Guild 1 is represented by 5 species, Guild 2 represents 8 species, Guild 3 represents 2 species and Guild 4 represents 21 species (Figure 9c).

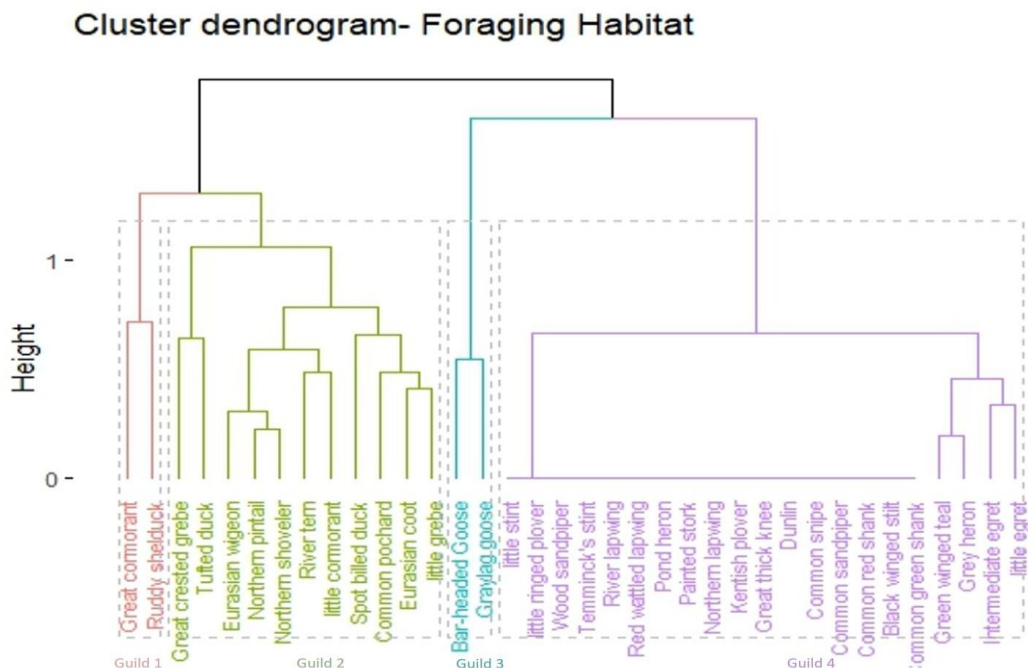


Figure 9a: Habitat cluster dendrogram of waterbird species.

Cluster dendrogram- Foraging Technique

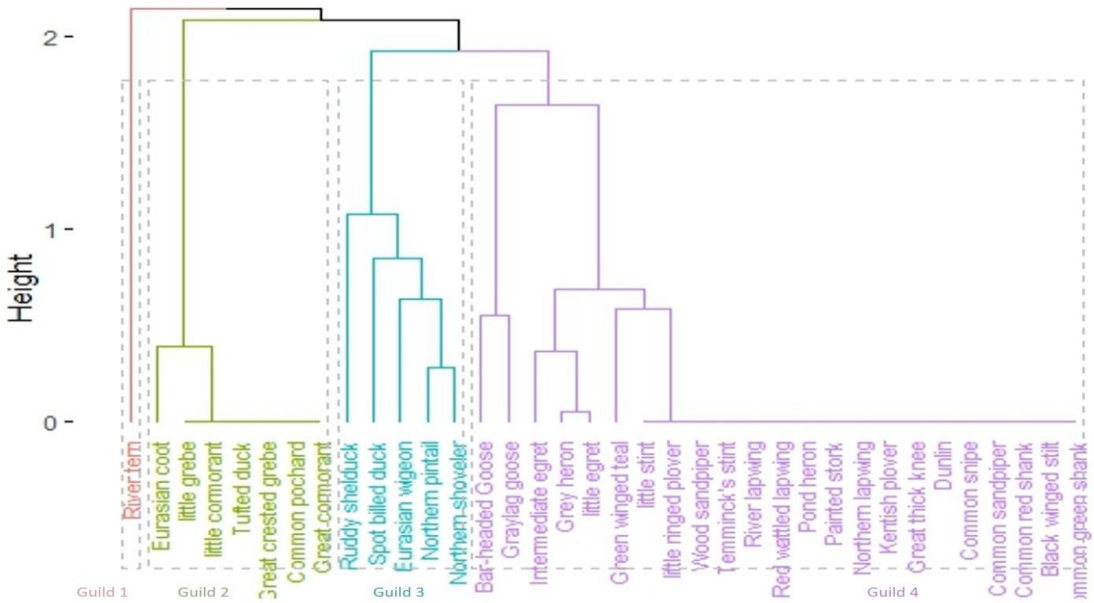


Figure 9b: Technique cluster dendrogram of waterbird species.

Cluster dendrogram- Combined Dimension

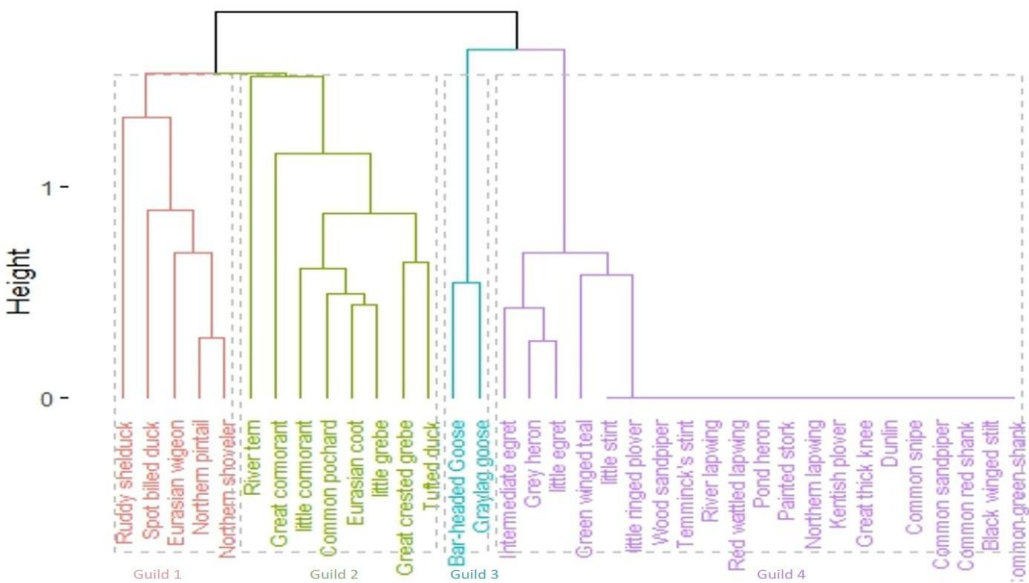


Figure 9c: Combined cluster dendrogram of waterbird species.

5.7 Niche breadth by guilds

Niche breadth was calculated for species guild formed after cluster analysis based on foraging habitat, foraging technique and combined dimension.

Foraging habitat: Niche breadth based on foraging habitat is highest for guild 2 followed by guild 3, guild 1 and guild 4 (Figure 10a). It indicates that members of guild 2 are very generalist in terms of their habitat choices.

Foraging technique: Niche breadth based on foraging technique is highest for guild 3 followed by guild 4, guild 2 and guild 1 (Figure 10b). It indicates that members of guild 3 are very generalist in terms of using different foraging techniques.

Combined dimension: Niche breadth based on combined dimension is highest for guild 2 followed by guild 1, guild 3 and guild 4 (Figure 10c). It indicates that members of guild 2 are very generalist in terms of their choices for foraging habitat and foraging technique.

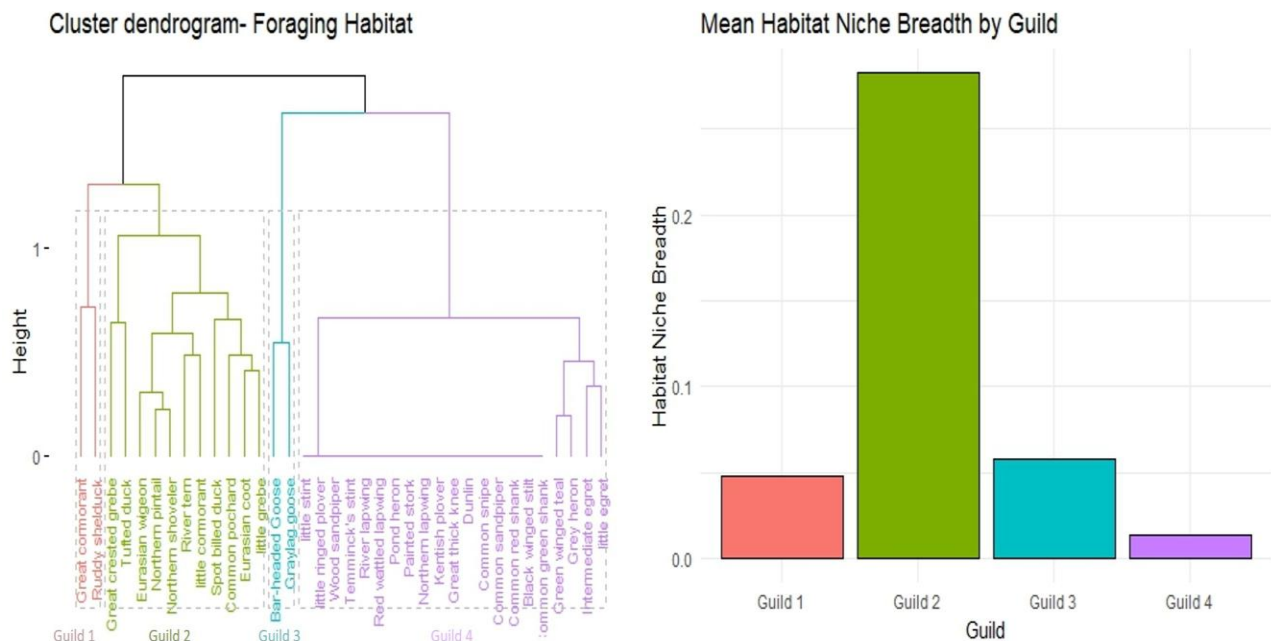


Figure 10a: Habitat cluster dendrogram of waterbird species (left) and bar plot showing mean habitat niche breadth by guild (right).

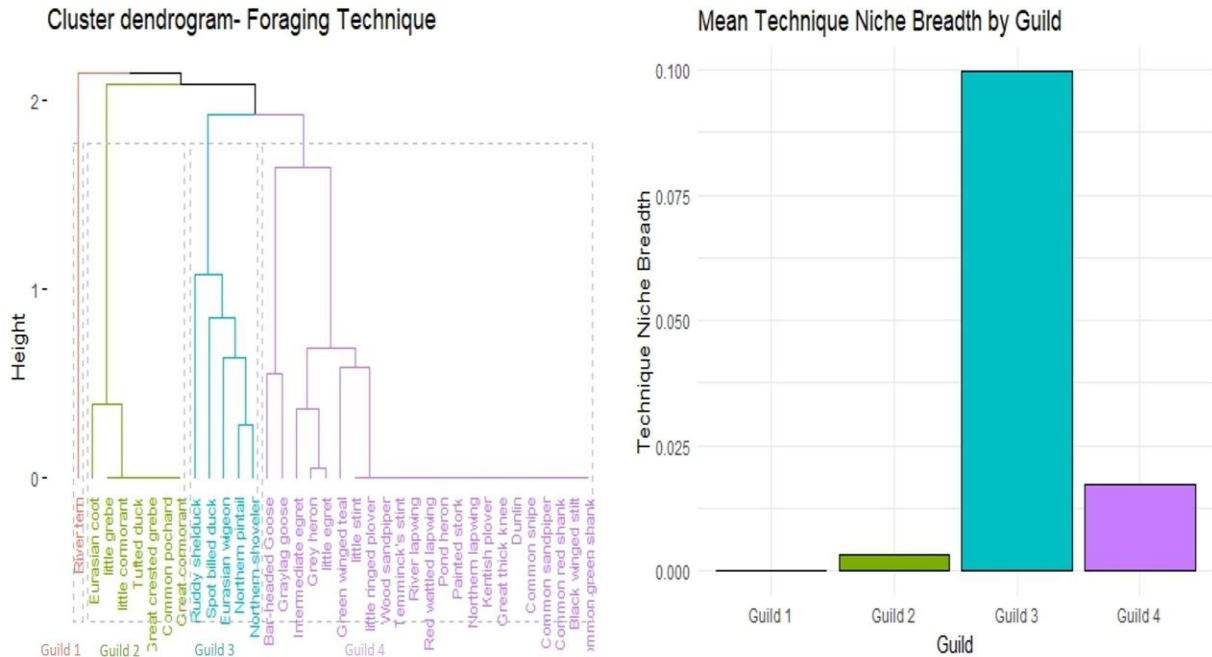


Figure 10b: Technique cluster dendrogram of waterbird species (left) and bar plot showing mean technique niche breadth by guild (right).

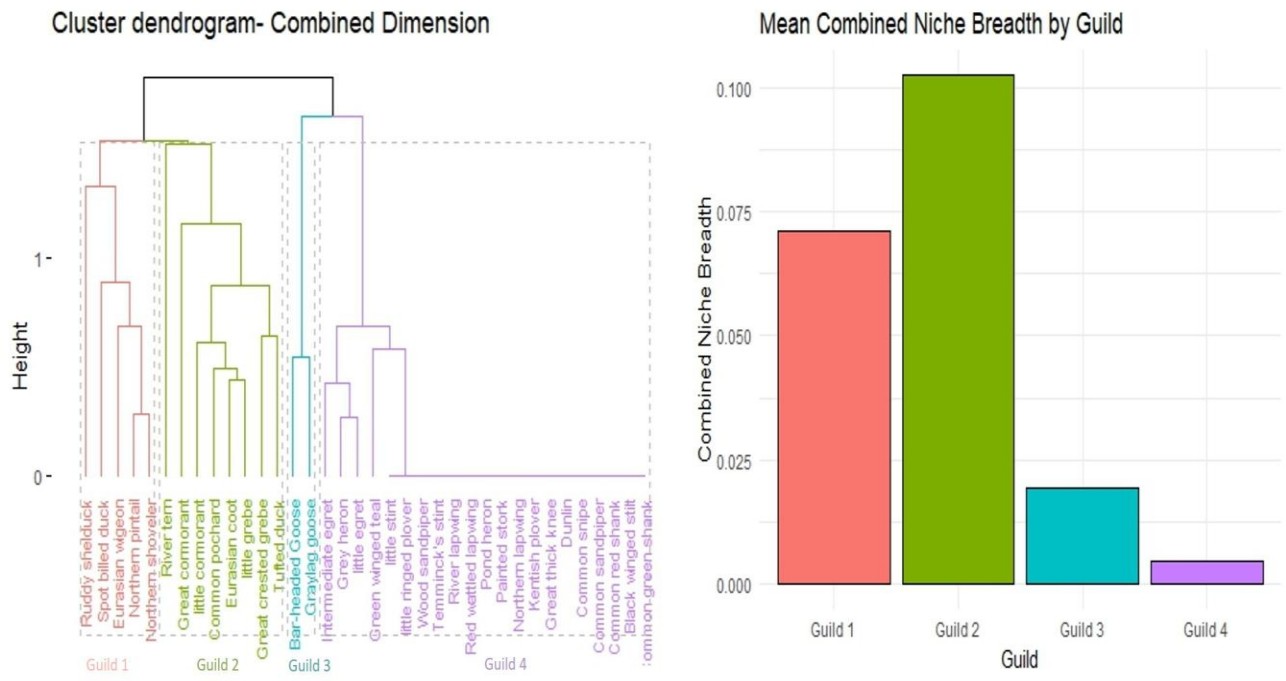


Figure 10c: Combined cluster dendrogram of waterbird species (left) and bar plot showing mean combined niche breadth by guild (right).

5.8 Niche overlap by guilds

Niche overlap was calculated between species guilds formed after cluster analysis based on foraging habitat, foraging technique and combined dimension. It clearly indicates that overlap between the species of the same guild is higher than the species of other guilds (Figure 11a, 11b, 11c).

To assess the extent of resource sharing within and across waterbird guilds, niche overlap values were aggregated at the guild level and statistically compared. Across all dimensions (habitat, foraging style, and combined), intraguild niche overlap was much larger than interguild overlap, indicating that species within the same guild shared resources more extensively than those from other guilds. One-way ANOVAs demonstrated substantial differences between intraguild and interguild overlaps (Habitat: $F = 90.92$, $p < 0.001$; Technique: $F = 603.1$, $p < 0.001$; Combined: $F = 54.34$, $p < 0.001$). Post-hoc Tukey HSD tests corroborated these findings, with the technique dimension showing the greatest mean difference (difference = 0.86), followed by habitat (0.78) and combined (0.67). These patterns indicate that guilds created from foraging techniques have the highest degree of internal similarity, most likely due to the strict limits imposed by unique foraging habits. Meanwhile, the smaller but still significant overlap in the combined dimension suggests that species integrate numerous niche axes while maintaining hierarchical partitioning consistent with their guild identities. This provides strong evidence for the ecological relevance of the discovered guilds and demonstrates the value of multidimensional niche analysis in understanding community organization and resource partitioning among waterbirds.

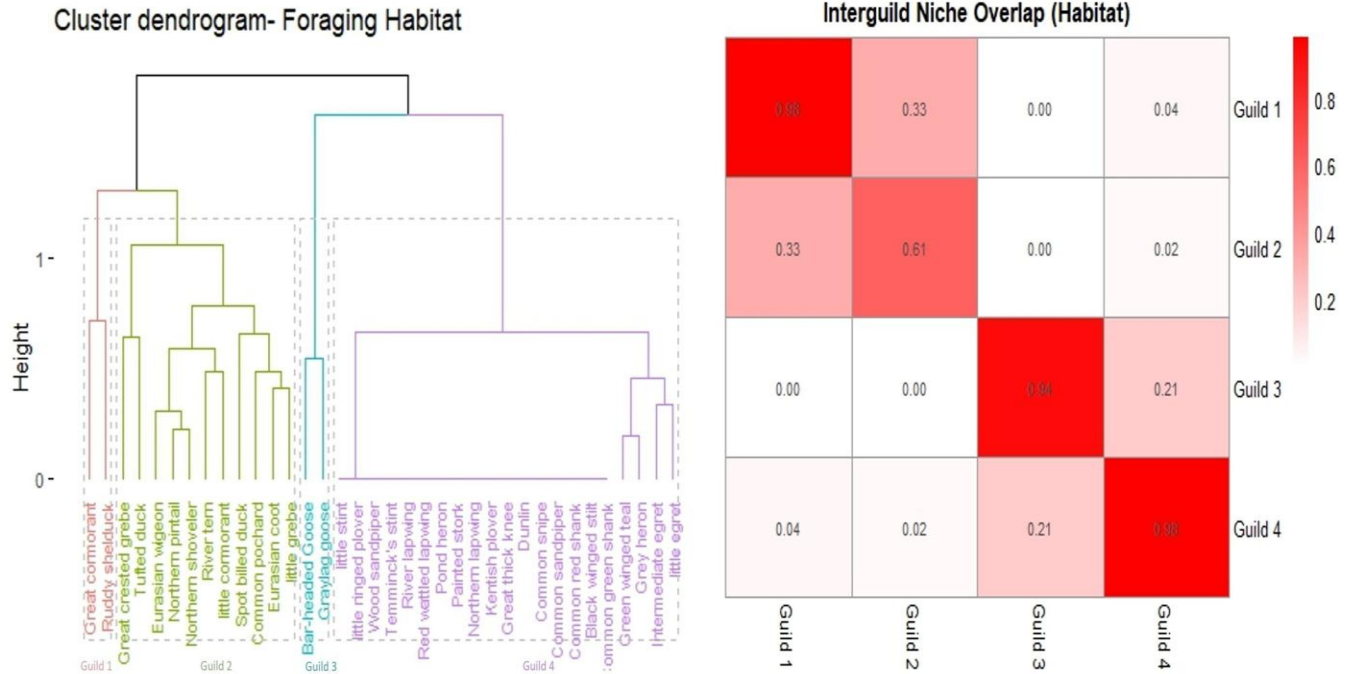


Figure 11a: Habitat cluster dendrogram of waterbird species (left) and Heatmap showing habitat niche overlap between guilds (right).

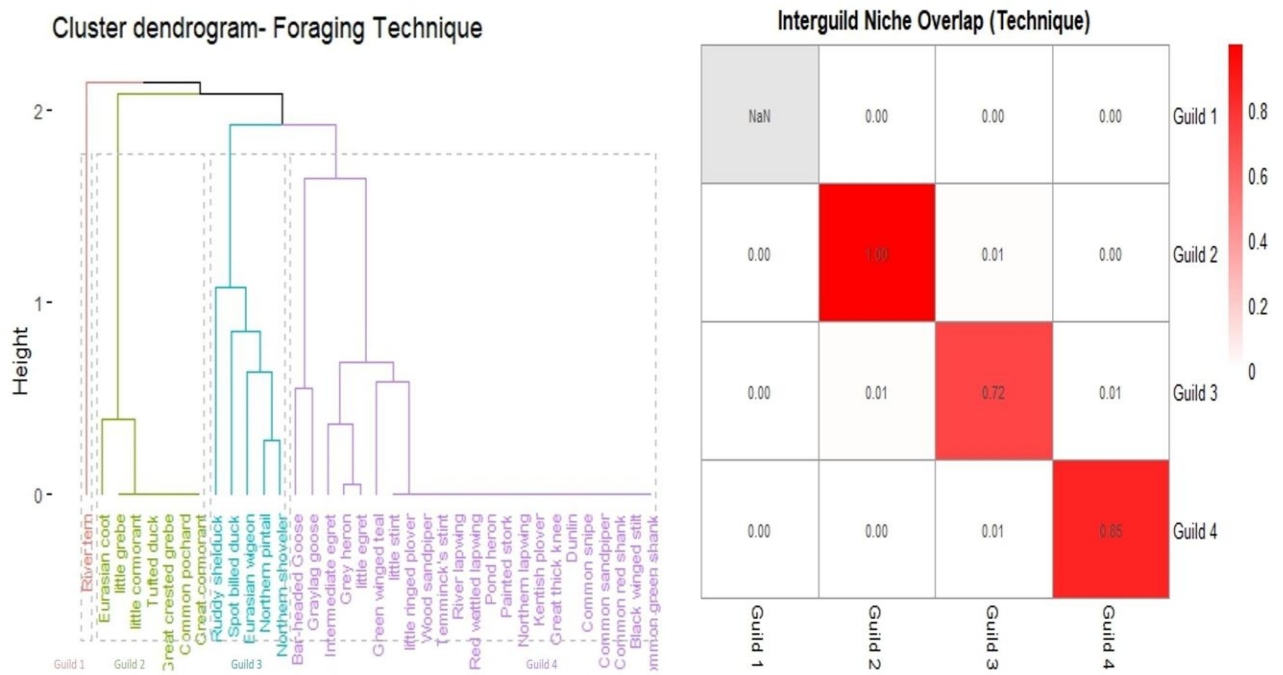


Figure 11b: Technique cluster dendrogram of waterbird species (left) and Heatmap showing technique niche overlap between guilds (right).

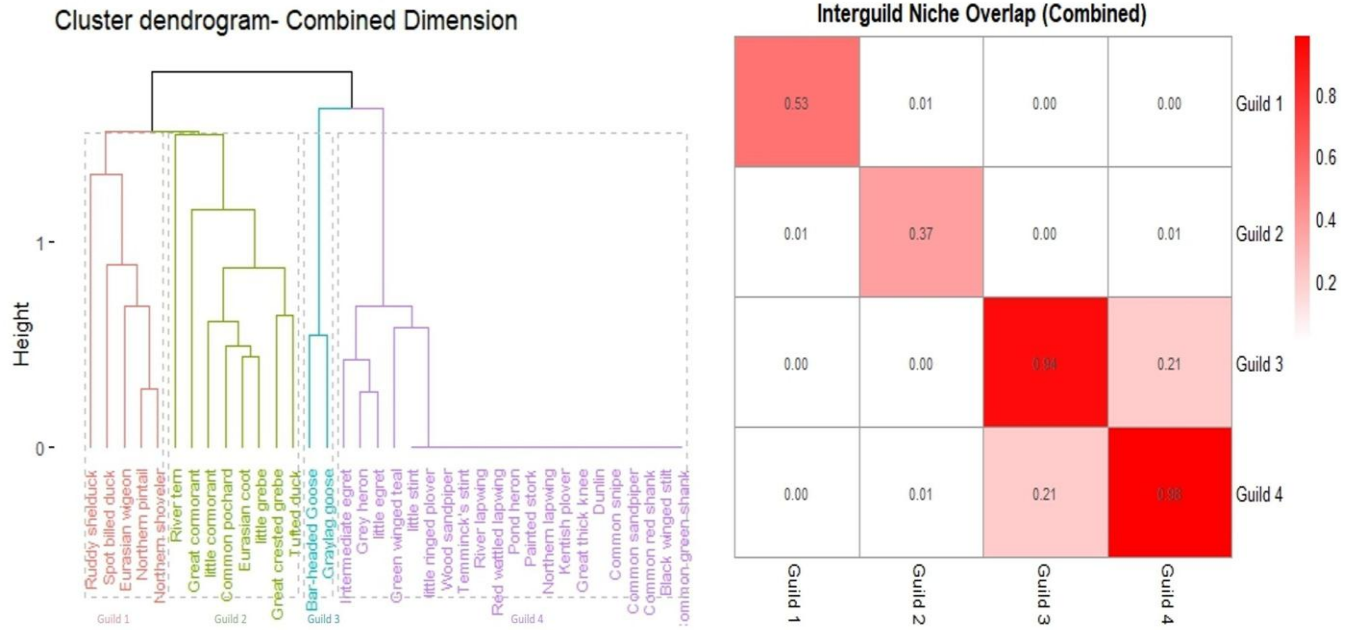


Figure 11c: Combined cluster dendrogram of waterbird species (left) and Heatmap showing combined niche overlap between guilds (right).

5.9 Null model analysis of niche overlap

Null models were used to compare the observed niche overlap with the expected niche overlap. The results revealed that observed niche overlap was significantly higher than expected under the null model for all three dimensions: habitat, foraging technique, and the combined dimension (Figure 12a, 12b, 12c). For habitat use, the observed overlap index (0.421) was significantly greater than the mean of simulated values (0.198), with a standardized effect size (SES) of 18.50 ($p < 0.001$). Similarly, for foraging technique, the observed overlap (0.391) was much higher than the simulated mean (0.144), with an SES of 20.49 ($p < 0.001$). The most pronounced deviation from null expectations was observed in the combined dimension, where the observed overlap (0.372) far exceeded the simulated mean (0.075), with an SES of 37.31 ($p < 0.001$). The results indicate that processes such as morphological variations, species abundance differences, resource fluctuation or clumped resources are responsible for structuring waterbird communities.

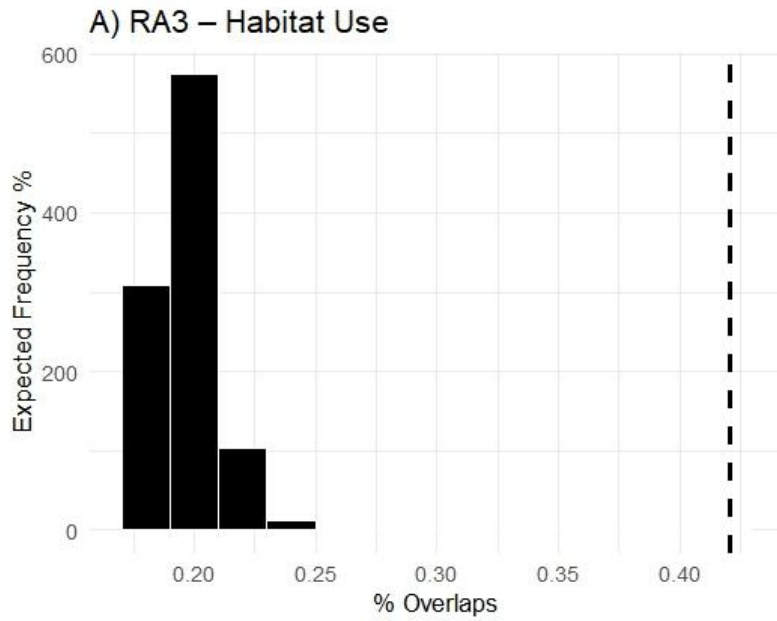


Figure 12a: Histogram showing expected habitat niche overlap and the dashed vertical line indicates observed mean habitat niche overlap among species.

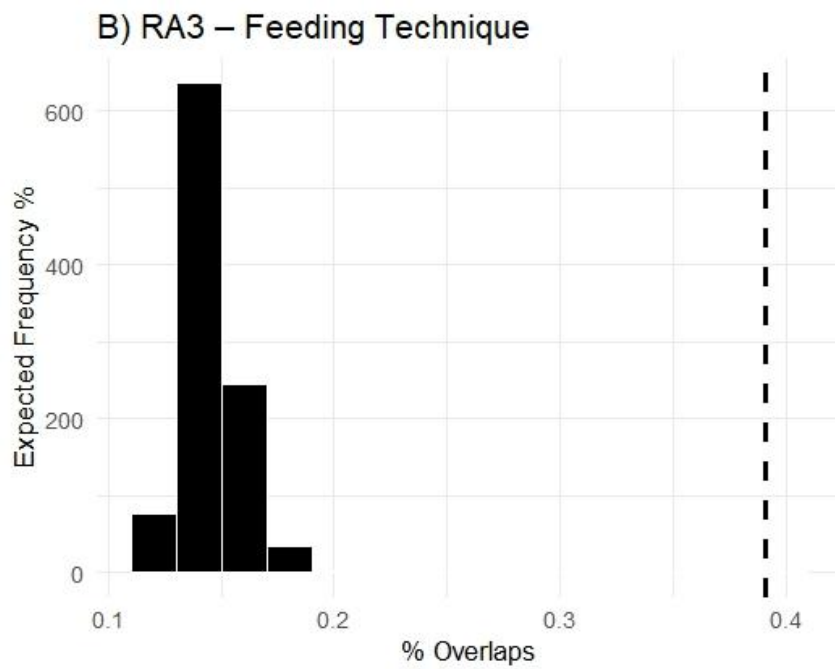


Figure 12b: Histogram showing expected technique niche overlap and the dashed vertical line indicates observed mean technique niche overlap among species.

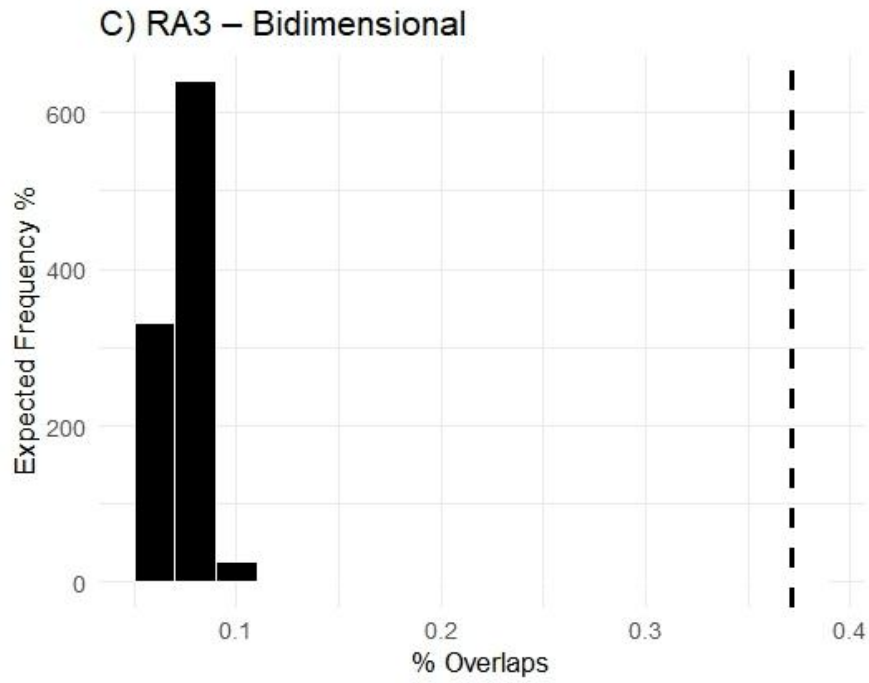


Figure 12c: Histogram showing expected combined niche overlap and the dashed vertical line indicates observed mean combined niche overlap among species.

6. Discussion

6.1 Importance of Pong wetland

Pong wetland is the important staging and stopover ground for many migratory waterbird species in northern India. The heterogeneous habitat ranging from grasslands, mudflats and deep water supports a wide range of avian biodiversity, with over 169 bird species recorded, including several globally threatened and near-threatened species (Sharief et al., 2018). Bar-headed goose is the most abundant species of the landscape with around 37,000 individuals reported in annual bird census 2024 (HP Forest Department, 2024).

Beyond its biodiversity value, Pong wetland serves as a critical site for monitoring emerging infectious diseases among wild bird populations. Several past reports confirm the emergence of avian influenza and mass mortality of thousands of waterbird species in the wetland (Hindustan Times, 2021; The Hindu, 2021; The Economic times, 2021). These disease outbreaks highlight the importance of integrated monitoring that connects habitat quality, bird movements and epidemiological hazards. Therefore, maintaining habitat diversity and managing anthropogenic pressures are important for preserving the ecological integrity of Pong wetland.

6.2 Monthly abundance patterns of waterbirds

The temporal analysis found that species abundance peaked in January and then gradually declined approaching March. This tendency is consistent with recognized patterns of waterbird migration in northern India, where the peak arrival of winter migrants usually corresponds with mid-winter conditions that provide excellent foraging chances with minimal disturbance (Wani et al., 2021). The decrease in numbers by late March most likely represents the start of migratory departure as species return to their breeding areas. Some species saw little variation in abundance, indicating either local residence or little migratory turnover. Understanding seasonal patterns is crucial for determining when to implement wetland management treatments and conduct conservation monitoring.

6.3 Niche breadth and resource use pattern

Analysis of niche width across foraging habitat, technique, and combined dimensions reveals significant heterogeneity in species ecological roles. Species such as the Eurasian coot and Tufted duck had the broadest habitat and combined niche breadth, indicating generalist tactics for exploiting different habitats and resource conditions. In contrast, the Northern shoveler and Intermediate egret showed extensive foraging strategy niches, demonstrating behavioral flexibility in resource acquisition.

Such generalist tendencies may provide competitive benefits in dynamic environments such as wetlands, where habitat structure and prey availability fluctuate fast (Richmond et al., 2005). Meanwhile, species with smaller niches such as shorebirds may be more specialized, rendering them more susceptible to environmental perturbation or habitat destruction. The muddy shoreline of the Pong wetland acts as critical habitat for many shorebird species. Human induced changes such as urbanization, pollution and land use change are destroying these habitats leading to decline in the population of shorebirds (Fernández & Lank, 2008). Therefore, effective long-term management is necessary to avoid changes in these habitats.

6.4 Niche overlap and species coexistence

The study revealed that the waterbird species have overlapping niches across habitat, technique and combined dimension. It is also found that generalist species have more overlapping niches than the specialist species (Gobin et al., 2022). River tern with its entirely different foraging technique shows very lower overlap with the other species whereas Eurasian coot because of its broad niche shows overlap with most of the species. These generalist and specialist tactics help the waterbirds to avoid competition among them and promote coexistence.

6.5 Guild structure and functional grouping

Cluster analysis successfully classified waterbird species into various guilds based on ecological characteristics. The distinct difference in niche overlap between guilds, combined with statistical support from ANOVA and post-hoc tests, implies that functional guilds are ecologically significant entities within the waterbird community. These guilds most likely reflect evolutionary traits that reduce interspecific competition, allowing a wide range of species to coexist in a relatively limited wetland environment.

Interestingly, several guild pairs (e.g., Guild 1 vs Guild 3) had little or no overlap, not due to similar resource utilization, but due to total specialty segregation. This could suggest significant ecological differentiation, possibly caused by spatial, behavioral, or dietary specialization (Pérez-Crespo et al. 2013). Therefore, understanding the pattern of resource partitioning among waterbirds is crucial for conservation efforts. It allows targeted strategies that ensure availability of diverse habitat and resources.

6.6 Null model analysis

Null models were used to understand the ecological mechanism responsible for structuring the communities. Null models provided a comparative overview of observed niche overlap with the expected niche overlap. The higher values of observed niche overlap among waterbird communities in Pong wetland indicates that their community structure is not random, but rather shaped by some ecological processes. It could be morphological variations, species abundance differences, resource fluctuation that are responsible for structuring the waterbird communities.

7. Conclusions

The study describes the monthly abundance pattern and guild structure of the waterbird community in Pong wetland. The results provide insight into community structure and resource partitioning among co-occurring waterbird species. The temporal abundance analysis of waterbirds provided important information regarding the critical time period for habitat management. This information is very useful for the forest department to initiate various management programs, making the Pong wetland one of the preferred sites for the migratory waterbird species. The computation of niche breadth and niche overlap provided valuable information about the generalist and specialist species visiting the area. It also provided a detailed overview of niche partitioning among these species and the mechanism that is responsible for structuring these communities.

Overall, the study shows that the coexistence of waterbird species in Pong Wetland is influenced by both common and different ecological strategies. The identification of functional guilds and multidimensional resource partitioning broadens our understanding of wetland community organization. These findings are critical for targeted conservation strategies that preserve habitat variability and resource diversity, ensuring the long-term viability of waterbird populations in the region.

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Appendix

The figure shows a glimpse of a dataset including variables such as water depth, secchi depth, vegetation type and foraging technique. A total of 1610 rows of data was collected across 4 months during the study period:

| | A | B | C | D | E | F | G | H | I | J | K |
|----|------------|----------|------------|----------------------------|--------------------|--------------|-----------------|--------------------|--------------------|--------|---|
| 1 | Date | Transect | Site | Distance from shore (in m) | water depth (in m) | Secchi depth | Vegetation type | Foraging technique | Bird species | Number | |
| 2 | 19-12-2024 | T1 | Meenu Khad | 0 | 0 | 0 | Emergent | Picking from mud | Black winged stilt | 2 | |
| 3 | 19-12-2024 | T1 | Meenu Khad | 0 | 0 | 0 | Emergent | Picking from mud | Kentish plover | 5 | |
| 4 | 19-12-2024 | T1 | Meenu Khad | 0 | 0 | 0 | Emergent | Picking from mud | Common sandpiper | 2 | |
| 5 | 19-12-2024 | T1 | Meenu Khad | 0 | 0 | 0 | Emergent | Picking from mud | Common red shank | 1 | |
| 6 | 19-12-2024 | T1 | Meenu Khad | 0 | 0 | 0 | Emergent | Picking from mud | Common green shank | 1 | |
| 7 | 19-12-2024 | T1 | Meenu Khad | 0 | 0 | 0 | Emergent | Picking from mud | Bar-headed Goose | 58 | |
| 8 | 19-12-2024 | T1 | Meenu Khad | 30 | 0.2286 | 0.2286 | Submerged | Bill submerged | little egret | 2 | |
| 9 | 19-12-2024 | T1 | Meenu Khad | 60 | 0.3302 | 0.3302 | Submerged | Head submerged | Northern shoveler | 22 | |
| 10 | 19-12-2024 | T1 | Meenu Khad | 60 | 0.3302 | 0.3302 | Submerged | Head submerged | Northern pintail | 18 | |
| 11 | 19-12-2024 | T1 | Meenu Khad | 60 | 0.3302 | 0.3302 | Submerged | Upending | Eurasian coot | 13 | |
| 12 | 19-12-2024 | T1 | Meenu Khad | 60 | 0.3302 | 0.3302 | Submerged | Diving | little cormorant | 6 | |
| 13 | 19-12-2024 | T1 | Meenu Khad | 90 | 0.6096 | 0.3048 | Submerged | Upending | Northern shoveler | 8 | |
| 14 | 19-12-2024 | T1 | Meenu Khad | 90 | 0.6096 | 0.3048 | Submerged | Upending | Northern pintail | 5 | |
| 15 | 19-12-2024 | T2 | Meenu Khad | 0 | 0 | 0 | Emergent | Picking from mud | Black winged stilt | 3 | |
| 16 | 19-12-2024 | T2 | Meenu Khad | 0 | 0 | 0 | Emergent | Picking from mud | Green winged teal | 10 | |
| 17 | 19-12-2024 | T2 | Meenu Khad | 0 | 0 | 0 | Emergent | Picking from mud | Common sandpiper | 6 | |
| 18 | 19-12-2024 | T2 | Meenu Khad | 30 | 0.3048 | 0.3048 | Submerged | Bill submerged | Intermediate egret | 1 | |
| 19 | 19-12-2024 | T2 | Meenu Khad | 60 | 0.3556 | 0.3556 | Submerged | Head submerged | Northern shoveler | 8 | |
| 20 | 19-12-2024 | T2 | Meenu Khad | 60 | 0.3556 | 0.3556 | Submerged | Head submerged | Northern pintail | 15 | |
| 21 | 19-12-2024 | T2 | Meenu Khad | 90 | 0.5588 | 0.2794 | Submerged | Diving | Eurasian coot | 18 | |
| 22 | 19-12-2024 | T3 | Meenu Khad | 0 | 0 | 0 | Emergent | Picking from mud | Black winged stilt | 2 | |
| 23 | 19-12-2024 | T3 | Meenu Khad | 0 | 0 | 0 | Emergent | Picking from mud | Bar-headed Goose | 75 | |
| 24 | 19-12-2024 | T3 | Meenu Khad | 30 | 0.1778 | 0.1778 | Submerged | Bill submerged | Grey heron | 1 | |
| 25 | 19-12-2024 | T3 | Meenu Khad | 60 | 0.381 | 0.381 | Submerged | Diving | little cormorant | 1 | |
| 26 | 19-12-2024 | T3 | Meenu Khad | 90 | 0.5842 | 0.2921 | Submerged | Head submerged | Northern shoveler | 8 | |
| 27 | 19-12-2024 | T3 | Meenu Khad | 90 | 0.5842 | 0.2921 | Submerged | Head submerged | Northern pintail | 12 | |
| 28 | 19-12-2024 | T4 | Meenu Khad | 0 | 0 | 0 | Emergent | Picking from mud | Black winged stilt | 2 | |
| 29 | 19-12-2024 | T4 | Meenu Khad | 0 | 0 | 0 | Emergent | Picking from mud | Common sandpiper | 8 | |
| 30 | 19-12-2024 | T4 | Meenu Khad | 30 | 0.5842 | 0.2921 | Submerged | Diving | Eurasian coot | 17 | |
| 31 | 19-12-2024 | T4 | Meenu Khad | 60 | 0.6096 | 0.3048 | Submerged | Diving | Eurasian coot | 7 | |
| 32 | 19-12-2024 | T4 | Meenu Khad | 90 | 0.7366 | 0.3683 | Submerged | Diving | Eurasian coot | 4 | |
| 33 | 19-12-2024 | T5 | Meenu Khad | 0 | 0 | 0 | Emergent | Picking from mud | Kentish plover | 10 | |
| 34 | 19-12-2024 | T5 | Meenu Khad | 0 | 0 | 0 | Emergent | Picking from mud | Kentish plover | 10 | |

| | A | B | C | D | E | F | G | H | I | J | K |
|------|------------|----|------------|----|--------|--------|-------------|------------------|----------------------|----|---|
| 1458 | 13-03-2025 | T1 | Meenu Khad | 30 | 0.4064 | 0.4064 | Submerged | Head submerged | Northern pintail | 12 | |
| 1459 | 13-03-2025 | T1 | Meenu Khad | 30 | 0.4064 | 0.4064 | Submerged | Head submerged | Northern shoveler | 8 | |
| 1460 | 13-03-2025 | T2 | Meenu Khad | 0 | 0 | 0 | Emergent | Picking from mud | Black winged stilt | 2 | |
| 1461 | 13-03-2025 | T2 | Meenu Khad | 0 | 0 | 0 | Emergent | Picking from mud | Kentish plover | 3 | |
| 1462 | 13-03-2025 | T2 | Meenu Khad | 30 | 0.508 | 0.254 | Submerged | Bill submerged | Grey heron | 1 | |
| 1463 | 13-03-2025 | T2 | Meenu Khad | 60 | 0.8382 | 0.4191 | Submerged | Diving | Eurasian coot | 13 | |
| 1464 | 13-03-2025 | T3 | Meenu Khad | 0 | 0 | 0 | Terrestrial | Grazing | Bar-headed Goose | 32 | |
| 1465 | 13-03-2025 | T3 | Meenu Khad | 0 | 0 | 0 | Emergent | Picking from mud | Green winged teal | 5 | |
| 1466 | 13-03-2025 | T3 | Meenu Khad | 30 | 0.4318 | 0.4318 | Submerged | Head submerged | Northern pintail | 21 | |
| 1467 | 13-03-2025 | T3 | Meenu Khad | 60 | 0.7112 | 0.3556 | Submerged | Diving | Common pochard | 5 | |
| 1468 | 13-03-2025 | T4 | Meenu Khad | 0 | 0 | 0 | Terrestrial | Grazing | Bar-headed Goose | 41 | |
| 1469 | 13-03-2025 | T4 | Meenu Khad | 0 | 0 | 0 | Terrestrial | Grazing | Graylag goose | 7 | |
| 1470 | 13-03-2025 | T4 | Meenu Khad | 30 | 0.6604 | 0.3302 | Submerged | Diving | little cormorant | 3 | |
| 1471 | 13-03-2025 | T4 | Meenu Khad | 60 | 0.8636 | 0.4318 | Submerged | Diving | Eurasian coot | 2 | |
| 1472 | 13-03-2025 | T5 | Meenu Khad | 0 | 0 | 0 | Emergent | Picking from mud | Eurasian coot | 3 | |
| 1473 | 13-03-2025 | T5 | Meenu Khad | 0 | 0 | 0 | Emergent | Picking from mud | Black winged stilt | 2 | |
| 1474 | 13-03-2025 | T5 | Meenu Khad | 30 | 0.558 | 0.2794 | Submerged | Upending | Green winged teal | 5 | |
| 1475 | 13-03-2025 | T5 | Meenu Khad | 30 | 0.558 | 0.2794 | Submerged | Upending | Northern pintail | 10 | |
| 1476 | 13-03-2025 | T5 | Meenu Khad | 30 | 0.558 | 0.2794 | Submerged | Upending | Northern shoveler | 7 | |
| 1477 | 16-03-2025 | T6 | Gaj Khad | 0 | 0 | 0 | Terrestrial | Grazing | Bar-headed Goose | 48 | |
| 1478 | 16-03-2025 | T6 | Gaj Khad | 30 | 1.0414 | 0.5842 | Submerged | Diving | little grebe | 7 | |
| 1479 | 16-03-2025 | T6 | Gaj Khad | 30 | 1.0414 | 0.5842 | Submerged | Diving | little cormorant | 2 | |
| 1480 | 16-03-2025 | T6 | Gaj Khad | 60 | 2.1336 | 0.7874 | Submerged | Diving | little cormorant | 6 | |
| 1481 | 16-03-2025 | T7 | Gaj Khad | 0 | 0 | 0 | Emergent | Picking from mud | Red wattled lapwing | 2 | |
| 1482 | 16-03-2025 | T7 | Gaj Khad | 0 | 0 | 0 | Terrestrial | Grazing | Bar-headed Goose | 43 | |
| 1483 | 16-03-2025 | T7 | Gaj Khad | 30 | 1.4224 | 0.5334 | Submerged | Diving | Eurasian coot | 5 | |
| 1484 | 16-03-2025 | T8 | Gaj Khad | 0 | 0 | 0 | Terrestrial | Grazing | Bar-headed Goose | 25 | |
| 1485 | 16-03-2025 | T8 | Gaj Khad | 0 | 0 | 0 | Emergent | Picking from mud | Black winged stilt | 3 | |
| 1486 | 16-03-2025 | T8 | Gaj Khad | 0 | 0 | 0 | Emergent | Picking from mud | little ringed plover | 1 | |
| 1487 | 16-03-2025 | T8 | Gaj Khad | 30 | 0.9906 | 0.445 | Submerged | Diving | Eurasian coot | 2 | |
| 1488 | 16-03-2025 | T8 | Gaj Khad | 30 | 0.9906 | 0.445 | Submerged | Upending | Northern shoveler | 3 | |
| 1489 | 16-03-2025 | T9 | Gaj Khad | 0 | 0 | 0 | Emergent | Picking from mud | Grey heron | 1 | |
| 1490 | 16-03-2025 | T9 | Gaj Khad | 0 | 0 | 0 | Emergent | Picking from mud | little egret | 2 | |
| 1491 | 16-03-2025 | T9 | Gaj Khad | 0 | 0 | 0 | Emergent | Picking from mud | Black winged stilt | 1 | |