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## HABITAT PREFERENCE AND INFLUENCE OF SEASONS ON THE DISTRIBUTION OF AVIFAUNA IN THE WETLANDS: STATUS OF HABITAT UTILIZATION BY BIRDS IN THE KADALUNDI RESERVES, KERALA, INDIA

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### Abstract

Kadalundi Vallikunnu wetland located in Kerala holds sizeable number of birds. The species richness and diversity of birds in this wetland is documented by following line transect method during two years covering all the seasons. The three habitats documented include mudflat, mangrove and shallow water. Post monsoon season favors bird species richness than pre monsoon and monsoon seasons. Found some unique and rare species in this study. The rarefaction and Eigen value in the Principal Component Analysis revealed that mudflat has more species diversity than others. The three habitats are separated by distance of only 500 meter, the chance of habitat overlap is observed which altered the habitat preference behavior of shorebirds. This study highlighted the habitat preference of wetland birds and also the influence of some factors in their habitat selection. We observed the proliferation of mangroves into the mudflat habitat that induces habitat overlap.

**Keywords:** mudflat; shallow water; shore birds; mangrove; line transect

## **1. Introduction**

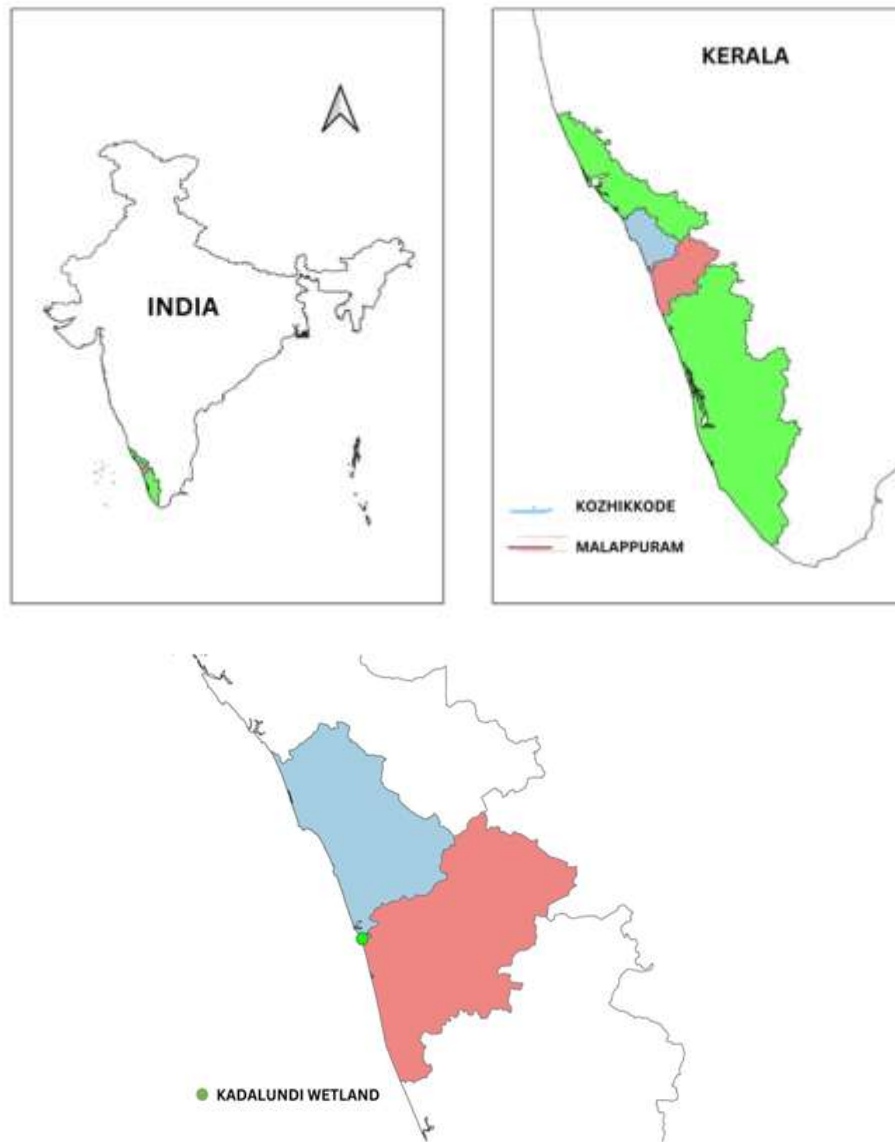
Wetlands are known for their unique ecosystems, which include various flora and fauna species adapted to wet conditions and also perform various ecological functions such as provisioning services, regulating services, cultural services and so on (Ramachandra et al., 2022). The wetlands provide nourishment and niche requirements for the avian community and also offer roosting site for many migratory birds (Balachandran, 2012).

India, a country comprised of many wetlands, lakes, and other natural conservation sites upholds the conservation significance. The wetlands in the country are account for 4.7% of the total geographical area, and are under stress due to urbanization, land use changes etc. (Bassi et al., 2014). The coastal wetlands of India are significant for many migratory birds (Sandilyan et al., 2010). Wetlands in India provide habitats for many birds (Kumar & Gupta, 2013; Bubesh Guptha et al., 2011). Apart from this, Human induced biodiversity conservation through wetlands is also a point of research as these wetlands provide a landscape for the birds (Sundar, K. G., & Kittur, S, 2013). One such coastal wetland located in southern India, which belongs to Kerala state, is the Kadalundi community reserve. This wetland is home to numerous birds and also provides a roosting site for many migratory birds. This geographical area is owned by two villagers- Kadalundi and Valikkunnu, which consist of different niches that account for biodiversity. The biodiversity of this landscape is documented which upholds the conservational significance of this ecosystem (Vinod et al., 2020)

The avian fauna found in the Kadalundi reserve has been well documented (Aarif et al., 2017; Aarif & Prasad, 2014) which highlights the importance of these habitats for birds. Eventhough these places are of conservation significance, the anthropological disturbances, geographical alterations have affected the biodiversity. The formation of sandbars has an impact on the mangrove ecosystem in the Kadalundi reserve (Bindu & Jayapal, G. 2016). Though many modifications altered the species composition, in the current geographical pattern also, this ecosystem can uphold a sizeable number of bird species. This study is focusing on the avifauna distribution in three different ecosystems found within this community reserve, as this area witnessed multiple types of geographical patterns, which also included human dominated areas. We also focused on the effect of seasons on species accumulation in three different habitats.

Study area:

The Kadalundi Vallikkunu reserve located in Tirur taluk, Malappuram district, Kerala (Figure 1). The Kadalundi River flows into the Arabian sea. The study was carried out in three major ecosystems – mudflat, mangrove and shallow water. These ecosystems are separated by only a distance of 500 meters among them. A comparison is made between these ecosystems in terms of bird distribution.



**Figure 1:** Study area Kadalundi Vallikkunu

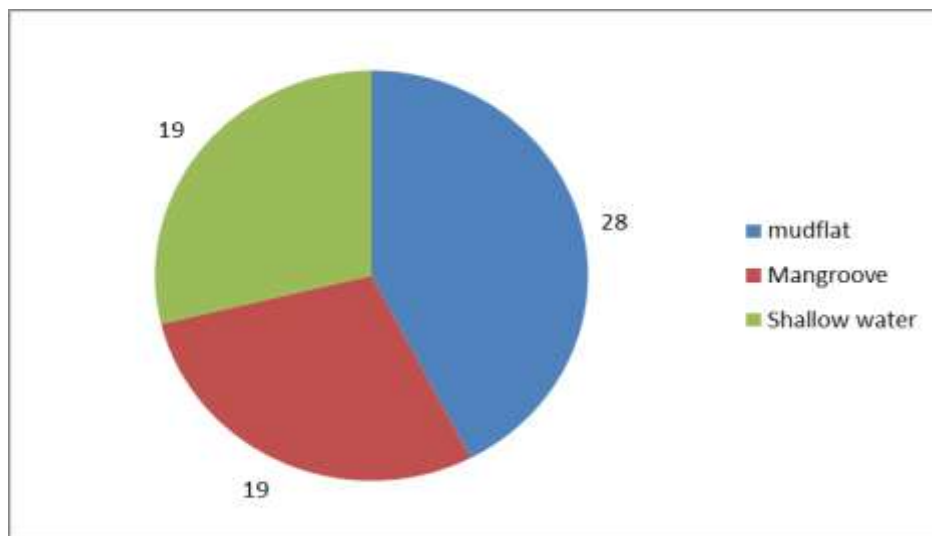


## 2. Materials and methods

Line transect method was followed (Burnham et al.,1980) (Greene & Pryde, 2012) to document the birds observed in the study sites. The survey was carried out in the morning after sunrise and the width of transect is 10 meter to both the side. The total length of transect is 500 meters. Apart from this, direct observation method is also followed. All the birds were photographed and video documentation also done by using Nikon Coolpix 1000 camera also used binoculars 50x40 dimensions to observe the birds. The survey lasted for two years during 2020 December to December2022 covering three seasons- pre monsoon, monsoon and post monsoon. The survey time was in the morning during low tide condition since the mudflats are mostly exposed for the birds. The birds were identified using field guides (Grimmett et al.,2016). All the statistical data analysis done by using Microsoft excel 2011 version, R software and PAST software.

## 3. Results

From the three selected ecosystems, 28 species of birds were observed though difference was there in their habitat preference. Species richness was more in mudflat as compared to other ecosystems (figure2)



**Figure 2:** Species distribution in three ecosystems

Seasonal variation is also documented to determine which season supports birdlife more. The survey period lasted for two years, which is broadly divided into three seasons- pre-monsoon

(March, April and May), monsoon (June to September) and post monsoon season (October to December). The influence of season in bird distribution is depicted as the following

The SHE analysis of three seasons estimated, in which the Shannon diversity obtained is depicted in table 1. The Shannon index highlights that irrespective of the season, birds are dominant in the mudflat as compared to shallow water and mangrove.

**Table 1:** Shannon diversity of the selected habitats in three seasons

Season	Mudflat	Mangrove	Shallow water
Pre monsoon	2.5	2.1	2.5
Monsoon	2.4	2.2	1.9
Post monsoon	2.5	2.3	2.4

The diversity, distribution and habitat use by the avian fauna in all the seasons is estimated. Seasonal wise distribution of birds in each study sites is described.

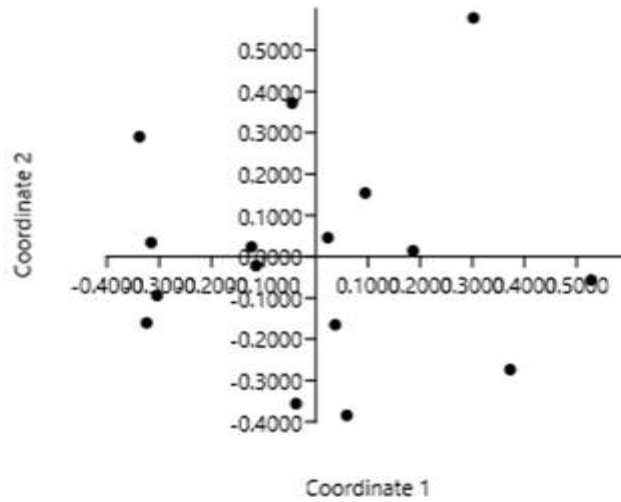
**Pre monsoon**

The pre monsoon period comprises March, April and May. The estimated beta diversity of the three ecosystems (table 2) highlights that 17% of species are dissimilar among the three study sites or 83% of the three habitats comprises similar species, which is further supported by the principal component analysis.

**Table 2:** beta diversity of three ecosystem in pre monsoon season

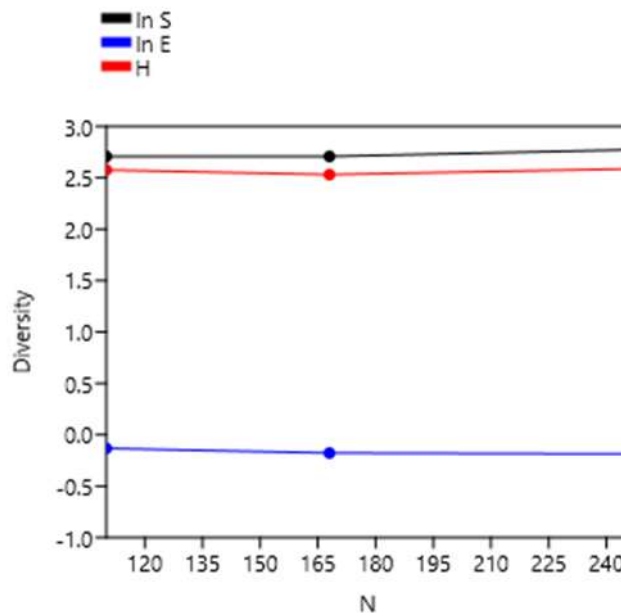
Beta diversity	Whittaker	0.170
	Williams	0.06

The beta diversity result is further supported by the principal component analysis (Figure 3) in which the eigen value obtained shows that mudflat has more variance than other ecosystems indicating mudflat has more number diverse species.



**Figure 3:** PCOA analysis of three ecosystems in pre monsoon

To analyze how the species are distributed throughout the ecosystems, the SHE graph plotted (Figure 4).



**Figure 4:** SHE analysis of three ecosystems in pre monsoon

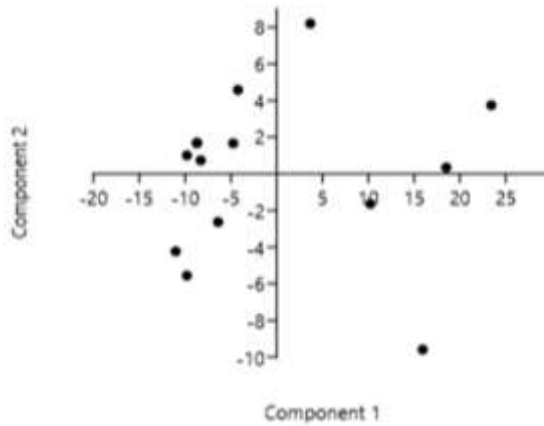
In this graph, the evenness value obtained (lnE) reveals that in the mudflat ecosystem, the species are distributed in a more balanced way than others and are showing no dominance of species over each other whereas in the mangrove ecosystem, a moderately balanced species distribution, and in shallow water the species are not distributed evenly as compared to others.

Monsoon

When we surveyed during the monsoon season, very few species were distributed in the three ecosystems. The beta Whittaker diversity (Table 3) signifies 13% of species are dissimilar or there is no significant difference in the diversity among the three ecosystems, which is further supported by the principal component analysis (Figure 5)

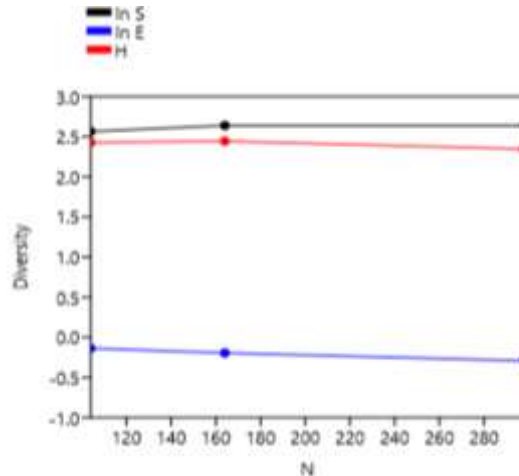
**Table 3:** Beta diversity of three ecosystems in monsoon season

Beta diversity	Whittaker	0.13514
	Williams	0.071429



**Figure 5:** Principal component analysis in monsoon

The SHE analysis revealed that in the mudflat, the species are tend to distributed in a balanced manner than other two as similar to the pre monsoon season (Figure 6)



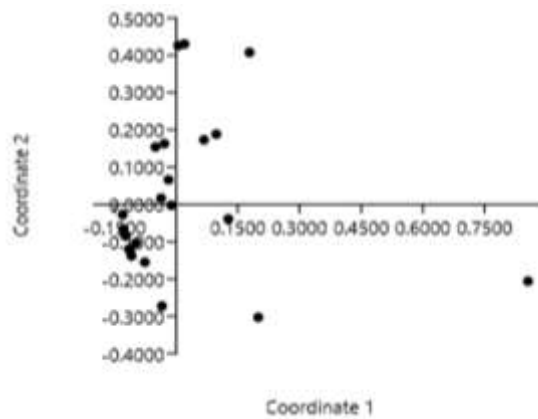
**Figure 6:** SHE analysis in monsoon season

Post monsoon

The beta diversity value showed the dominance of mudflat ecosystem (36%) than other ecosystems in species diversity (Table 4). The post monsoon season favors more birds and mudflat is preferred more by avifauna than the other two ecosystems, which is further confirmed by the Principal component analysis (Figure 7).

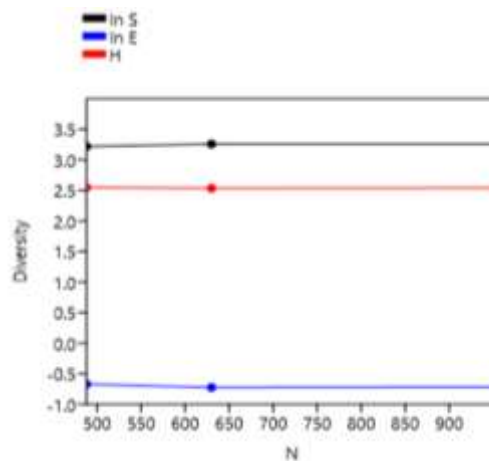
**Table 4:** beta diversity of three ecosystems in post monsoon

Beta diversity	Whittaker	0.36842
	Williams	0.038462



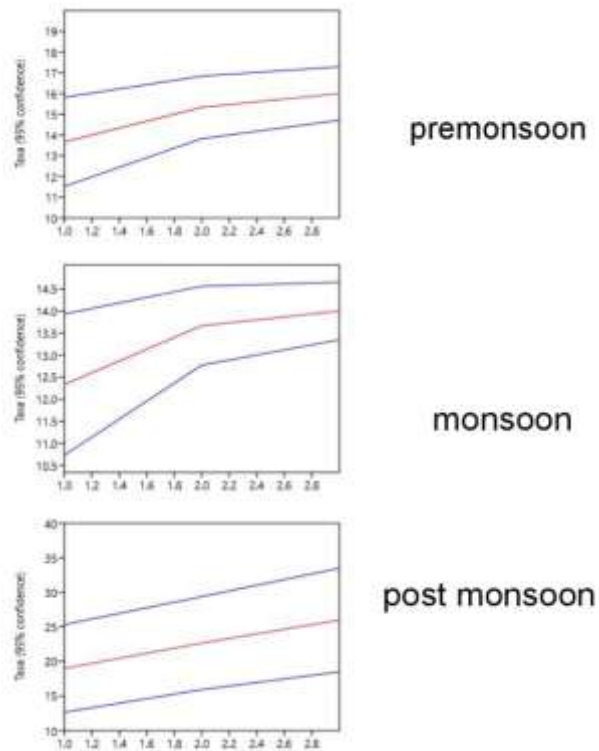
**Figure 7:** Principal component analysis in post monsoon

To detect the evenness or how the species are distributed in the selected habitats, SHE analysis is plotted (Figure 8) indicates the species are evenly distributed in mudflat and shallow water whereas in mangrove, a dominance of some species is observed.



**Figure 8:** SHE analysis in post monsoon season

The rarefaction curve plotted in all the seasons reveals that highest species richness was found in the post monsoon season and also indicates more studies during the post monsoon season may result in additional species occurrence. In pre monsoon and monsoon seasons, sufficient studies have been done to obtain the species richness as the curve is flattening (Figure 9).

**Figure 9:** rarefaction curves of all the seasons**4. Discussion**

Though the wetlands provides suitable habitat for many avian species (Zakaria & Rajpar, 2013), their distribution and habitat preference may varies among individuals. The studies in the wetland initially were focused only on the bird distribution (McKinney et al., 2011) More attention was given only to the species diversity in many landscapes (Sulaiman et al., 2015). whereas, in recent times, more attention s given on the habitat use as well as habitat preference by the coexisting bird species in these wetlands (Martin, T. E, 1996; Pimm & Rosenzweig, 1981). In the context of this, we focused on the habitat preference of the wetland birds in this reserve. The habitat preference of the birds is influenced by the change in landscape.

The Kadalundi River flows through the hearts of Kadalundi and Vallikkunu reserve which also have human settlements. This wetland performs many ecological functions and home to

numerous flora and fauna, which also emphasize on ecotourism (Pavithran a. p et al., 2017). A portion of this area has been declared as bird sanctuary where occurrence of migrant birds is frequent. This study showed the distribution of birds in three habitats found in this landscape. Though they are distributed in all the habitats, mudflat is the preferred habitat over the other two for the avian fauna. Found more common species in all the habitats, but their foraging time is longer in the mudflat habitat.

This habitat provides more niche requirements than other two for the birds as it become a favorite spot for the migrant birds since the area witnessed the presence of polychaetes, shrimps, prawns, small crabs, aquatic insects and some small fishes on which these birds are feeding. We documented the presence of rare and unique species in this study such as red knot, bar tailed Godwin and Eurasian oyster catcher. The post monsoon season favors more species abundance than pre monsoon and monsoon seasons. A study in another wetland of Kerala, which is near to this reserve, found 57 species of birds, in which most number of species found in the post monsoon months (Aarif & Basheer, 2012). The post monsoon season provides a suitable environment for the species to flourish in all habitats. It is interesting to note that, in pre monsoon, the shallow water ecosystem has more Shannon diversity than post monsoon and monsoon. It may be due to less availability of water so that the land is exposed for the birds to extend their niche. More migrant birds are recorded during the post monsoon season in all the habitats. The arrival of sea gull birds during the post monsoon season in this wetland has been observed (Ansari & Akshad, 2017)

Rarefaction curves predict extent of work completed. In pre monsoon and monsoon season, the rarefaction curve reveals that additional sampling may not yield new species and the sampled time period has captured almost all the available species, whereas in the post monsoon season, a chance of documenting more species of birds is found, which further discloses that the post monsoon season can provide a niche for a large number of species. Additionally, the negative evenness value indicates more species distribution in the mudflat area, which is supported by the Eigen value in the Principal Component Analysis. The Eigenvalue represents the degree of variance among the three ecosystems. More variance is recorded in the mudflat area, which highlights the species diversity of this habitat more than others.

These three habitats are separated by a distance of 500 meter between them and the chance of niche overlap is very prominent. We observed distribution of common species in all these habitats and also the dominance of mangrove over the mudflat.

A gradual proliferation of mangrove over the mudflat area is negatively affecting some unique birds in the wetlands such as lesser sand plover, greater sand plover, whimbrels, red shank and green shank. The feeding guild structure of these birds is altered by the dominance of mangrove as these birds are primarily feeding on the preys available in the mudflats. Since their habitat preference is depend on their foraging structure, the shrinkage of mudflat becoming a serious concern on the distribution of these birds in this wetland. A previous study documented more number of birds in this wetland (Aarif et al., 2017) while this study showcased only a limited number of species. The shrinkage of mudflat due to the expansion of mangrove over mudflat altered the habitat preference of birds. Our findings are further supported by a study in this habitat that also point out the same effect by the mangroves (Aarif & Musammilu, 2018). Though mangroves provides niche for many species (Faridah-Hanum et al., 2014), the habitat preference of some unique shore birds in the wetlands got reformed by mangroves. When this proliferation continues, less availability of shore birds may report from this wetland as there may be no suitable mudflat habitat for these birds. One of the shore birds, which is very frequent in the post monsoon in this wetland, feeds on invertebrates available in the mudflat (Aarif, 2009). Apart from this, we also observed the shore birds spent more time in the sand sea shore which is only two kilometers away from this wetland. Shore birds choose sandy sea shore as their foraging site due to the depletion of mudflat and proliferation of mangroves. In the future, as the proliferation of mangroves continues, it influences the habitat preference by the shore birds that overturn the species diversity of this wetlands, as study in wetland highlighted that the habitat preference and also the diversity of birds are affected by multiple factors such as micro climates, vegetation type such as submerged plant, grasses, shrubs are also altering the species distribution in the wetlands (Rajpar & Zakaria, 2011).on the other side, the proliferation of mangroves are affected by the sand bar formation in this landscape (Bindu, K. B & Jayapal, G, 2016) ,which may again alter the fauna in future.

## **5. Conclusion**

The Kadalundi wetland, has witnessed many birds, that includes shore birds and winter visitors, but their habitat preference are different. Mudflat witnessed a greater number of species where birds spent more time to forage. The mangrove ecosystem also supports moderate bird species. The shallow water area fluctuated by the amount of water also a favorite area for the birds. Seasonal variations also influence the species distribution, as we observed a higher number of species in the monsoon season. As there is a chance of habitat overlap, the existence of sea shore birds in this wetland may be reduced by this scenario. In the previous studies, high species richness of shore birds was observed which is due to the exposure of mudflat that provides a foraging land for these birds. Whereas this study observed a limited number of species as the area witnessed habitat overlap by the mangroves over the mudflat, which significantly reduced the foraging space for these species. the shore birds find their foraging time more in the sandy sea shore which is two kilometers away from this wetland. In the future, a chance of alteration in the bird diversity may happen due to mangrove proliferation. This study provides an insight to the fact that habitat alterations modify the species composition in an ecosystem. This study also favors the effect of mangroves on the species distribution as well as on the micro soil composition, microhabitat alterations that also directly modify the species distribution in a landscape.

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