Shorebird in West and East Coast of India

Subjects: Ecology

Contributor: A. P. Rashiba , K. Jishnu , H. Byju , C. T. Shifa , Jasmine Anand , K. Vichithra , Yanjie Xu , Aymen Nefla , Sabir Bin Muzaffar , K. M. Aarif , K. A. Rubeena

Shorebirds constitute a highly diverse group of migrant species that require a high amount of energy in association with their long-distance migration. They are documented in nearly all shorelines of the world except Antarctica. The seasonal migration of shorebirds is an important biological event, characterized by long-distance travel among breeding, stopover and wintering sites driven by seasonal influences on resources.

shorebirds east coast west coast conservation

1. Species Diversity, Abundance and Population Trends of Shorebirds on the West Coast

The west coast of India has been recognized as the important wintering ground for many shorebird species in the CAF, but the documentation on the diversity, abundance and spatiotemporal pattern of shorebirds from the west coast of India is scanty [1][2][3][4][5]. A total of 30 species of shorebirds belonging to the Charadriidae and Scolopacidae families were reported from Byet Dwarka Island, Gujarat [6]. Also, 12 species of shorebirds, including migrant, resident and resident migrant, have been recorded from Thane creek including the Black-tailedGodwit (*Limosa limosa*), Eurasian Curlew (*Numenius arquata*), Common Redshank, Marsh Sandpiper, Wood Sandpiper, Common Sandpiper *(Actitis hypoleucos*), Little Stint, Little Ringed Plover (*C. dubius*), Kentish Plover (*C. alexandrinus*), Lesser Sand Plover, Black-Winged Stilt (*Himantopus himantopus*) and Pied Avocet (*Recurvirostra avosetta*). Of all the 12 species recorded, Lesser Sand Plovers were not dominant in the region. Thane Creek is a productive habitat for shorebirds, but it is severely contaminated with garbage from both domestic and industrial sources [7].

The coastal zone of Sindhudurg district, Maharashtra, is of international importance for shorebirds and 31 species of migratory shorebirds and five species of resident shorebirds were recorded from there [3]. One Endangered species, the Great Knot (*C. tenuirostris*) and five near-threatened species, the Eurasian Oystercatcher (*Haematopus ostralegus*), Eurasian Curlew, Curlew Sandpiper, Black-tailed Godwit and Bar-tailed Godwit (*L. lapponica*) were recorded. Lesser Sand Plover, Common Sandpiper and Kentish Plover accounted for 72% of Sindhudurg's shorebird population. Besides them, the other most common species were the Common Redshank, Common Greenshank and Greater Sand Plover (*C. leschenaultia*). The Broad-Billed Sandpiper (*Limicola falcinellus*) and Eurasian Oystercatcher were found only in beach habitats, whereas the Great Knot was observed only on mudflats [3].

In a report that check-listed 35 species of migratory shorebirds along the various habitats of Goa, the Great Knot has been enlisted as endangered and eight species have been enlisted as near threatened under the IUCN Red List, which include the Great Thick-knee (*Esacus recurvirostris*), Eurasian Oystercatcher, Eurasian Curlew, Bar-tailed Godwit, Black-tailed Godwit, Curlew Sandpiper, Buff-breasted Sandpiper (*C. subruficollis*) and Asian Dowitcher (*Limnodromus semipalmatus*) [8].

Kadalundi-Vallikkunnu Community Reserve (KVCR) is a coastal wetland comprising patches of mudflats, mangroves and sand beaches located in south western India from where diverse avian fauna has been reported [9] and a small population of Lesser Sand Plover, Whimbrel (*N. phaeopus*) and Common Redshank were recorded to be over-summering in the habitat [4]. The most abundant species recorded in KVCR is the Lesser Sand Plover, which constitutes about 4% of the global population [10][11]. Endangered shorebirds like the Great Knot; vulnerable species like the Eurasian Oystercatcher; and near-threatened species like Curlew Sandpiper, Bar-tailedGodwit, Black-tailedGodwit and Eurasian Curlew have been recorded from this important site [10]. However, an increase in relative humidity, air and water temperature and salinity over years resulted in a decrease in prey abundance, which in turn adversely affected the abundance of shorebirds and caused their departure delay [9].

In a study conducted in the Kole wetlands of Thrissur (Kanjany, Parappur, Chettupuzha and Enamavu), Kerala, from November 1998 to April 2001, 34 wader species were recorded out of which 20 belonged to shorebird species. A high abundance of Wood Sandpiper, Little Stint, Little Ringed Plover, Curlew Sandpiper, Common Sandpiper and Eurasian Curlew were observed at Kanjany. Among these, Wood Sandpipers were dominant, followed by Little Stint [12]. The highest number of Curlew Sandpipers was observed during December and January whereas a higher number of Eurasian Curlews was observed from November to December. Common Sandpipers were very low in the first and third years but in the second year, a high number of Common Sandpipers were observed, especially during the month of December. The highest number of Little Ringed Plovers and Little Stints were recorded in the month of November and Wood Sandpipers were observed during November and December [12]. This can be attributed to the fact that the abundance of shorebirds is at its peak during December and January, that is, post the south west monsoon periods on the west coast of India. Soon after the south west monsoon, the area becomes ideal foraging and roosting grounds for these migrant shorebirds as the prey availability and accessibility will be higher and the availability of exposed mudflats during low tides also supports them.

Out of a total of 39 species of shorebirds, 34 migrant species were reported from Changaram wetland in Kerala from 2018 to 2019 [5]. Most of the species were observed during the returning period of migration and they included IUCN enlisted endangered, Great Knot and near-threatened shorebird species such as the Black-tailed Godwit, Curlew Sandpiper, Eurasian Curlew. As per the study, 14 species of shorebirds were categorized as dominant and regular winter visitors, three were classified as unusual and the remaining 22 as rare. The Black-tailed Godwit, the most dominant species, attained its peak count in April, and the Wood Sandpiper, the second most dominant species, reached its peak count in May [5]. At Changaram wetlands, an agriculture system called Pokaalli is practiced, where paddy and shrimp/fish culture is practiced alternatively in the same wetlands, that is, paddy culture from May to October and shrimp/fish culture from November to April. At the end of April, after fish culture, the water is drained out completely from the wetlands, which leads to the exposure of mudflats rich in invertebrate

fauna which in turn attracts the migratory shorebirds like the Black-tailed Godwit and Wood Sandpiper and serves as foraging grounds for them [5].

Each wintering ground studied reveals its own characteristic patterns in terms of species diversity and abundance of shorebirds. It could be an outcome of the macro and micro level habitat characteristics that need to be further investigated. To treat these wintering grounds with unerring conservation strategies such studies need to be conducted in depth. The species composition of shorebirds was found to vary across sites and months and is largely influenced by the heterogeneity of estuarine habitat, seasonality, and anthropogenic pressure [3][5][9][12]. In Sindhudurg district, Maharashtra, the winter season was characterized by significant richness and abundance of shorebirds, especially in the mudflats (73% of the birds counted in Sindhudurg district were encountered on mudflats) and the abundance values declined slowly from February to May [3].

Shorebirds such as Plovers, Sandpipers, Stints, Greenshanks and Redshanks were observed arriving along the Sindhudurg coast from August and continued until October. Populations of wintering shorebirds such as Plovers, Sandpipers, Greenshanks and Redshanks reached their peak during the November to February period. Consequently, almost all shorebirds, except a few over-summering individuals (Lesser Sand Plover, Greater Sand Plover, Common Redshank, Common Greenshank, Whimbrel and Common Sandpiper) departed to the breeding grounds toward the end of May.

In KVCR, a significant relationship between the number of polychaetes and feeding Lesser Sand Plovers was documented at mudflats with their population at its peak during December [13]. Even though shorebirds prefer mudflats to mangroves and sandy beaches, a declining trend in the number of birds using mudflats, mangroves and shallow-water habitats at KVCR was reported whereas the number of shorebirds using sandy areas increased significantly (**Figure 1**) [10][14].

Figure 1. Lesser Sand Plover (*C. mongolus*), Sanderling (*C. alba*) and Ruddy Turnstone (*A. interpres*) at Puthiyappa beach in the west coast of India—Photo courtesy: C.T. Shifa.

Long-term dynamic population studies on shorebirds have not been carried out anywhere on the west coast except at KVCR. A significant decline in the shorebird abundance in the KVCR wetland was reported from 2005 to 2019 [9]. Further, the overall count of shorebirds has declined catastrophically over the last 10 years [9]. The abundance of Pacific Golden Plovers, Lesser Sand Plovers, Greater Sand Plovers, Kentish Plovers, Little Stints and Terek Sandpipers (*Xenus cinereus*) was observed to be declining significantly over the years. All these decline in numbers and shifts in habitat use were attributed to high predator pressure. Hence it is evident that apart from abiotic factors, biotic factors also play a major role in determining shorebird abundance, species diversity and distribution.

The west coast of India is more productive than the east coast [15][16]. However, the studies of shorebirds on the West Coast are far fewer than those on the East Coast [3][5][9][10]. Therefore, there is an urgent need to develop robust conservation plans for shorebirds and to encourage in-depth studies on them along the West Coast.

Distribution Pattern of Shorebirds on the West Coast

The west coast of India extends from the Gulf of Cambay (Gulf of Khambhat) in the north to Cape Comorin (Kanyakumari) in the south, which touches six states such as Gujarat, Maharashtra, Goa, Karnataka, Kerala and Tamil Nadu. The west coast of India is copious with a variety of habitats such as sandy beaches, mudflats, mangroves, salt pan and tidal flats, which are preferred by shorebirds [17]. However, the studies on the distribution pattern of migrating shorebirds along the west coast are minimal. The records available regarding their distribution along the west coast are from Sindhudurg, Thane creek, Kadalundi-Vallikkunnu Community Reserve and Kole wetlands as mentioned earlier.

Gujarat, which has the longest coastline on India's west coast (about 1650 km), serves as an important stop-over and wintering grounds for many resident and migrant shorebirds [17][18][19]. Narara Island and Rozybundar coast in the Gulf of Kachchh have been recorded as important foraging and roosting sites for shorebirds, especially for Crab Plover, Eurasian Curlew, Black-tailed Godwit and Pied Avocet [20]. The Rozybundar coast was recorded with the lowest concentration of these species, which is believed to be due to higher anthropogenic pressure. Although the number of Eurasian Oystercatchers recorded in India has varied considerably over years, a constant and substantial proportion of the species has been observed from Byet Dwarka Island [6]. Shorebirds have also been observed from Jamnagar, which is further to the east of Byet Dwarka Island, however, the number of species found in Jamnagar was lower than that of Byet Dwarka Island [21].

The Maharashtrian Coast, which includes Mahul-Sewri Creek, Thane Creek wetlands and Navi Mumbai, is a well-known and significant wintering ground for migratory shorebirds because of its wide mudflats and shallow tidal beaches [18]. A small patch of mangrove ecosystem and mudflat of Thane has been found nurturing a number of shorebird populations. Further, the dominance of shorebirds along the rocky and sand beach shores of Akshi and

Revdandanda (Maharashtra Coast) has also been reported [22]. These coasts shelter a large variety of gastropods and bivalves, which form the major prey for shorebirds and also have a uniform, gradual slope of the continental shelf, which enables smooth landing and provides favorable foraging grounds for shorebirds. The beaches, sandy mudflats, and mangroves of the Sindhudurg coast in Maharashtra have been identified as crucial wintering and stopover sites for many migrant shorebirds. Of the shorebird species observed there, 68% used the coast as their wintering site and 32% used the coast as a migratory stop-over site [3].

The coastal belt of Goa, which extends about 133 km, with its sandy bays, beaches, rocky headlands, saltpans and saline and freshwater marshes, coastal mangroves, creeks and estuaries [23] provide foraging ground for many migratory shorebirds including some endangered and near threatened species under IUCN Red List.

The Kole wetland, which is located below the sea level, is known for paddy cultivation and serves as important wintering and stop-over grounds for many transcontinental migrant shorebirds, in Kerala [12]. Along the entire west coast, KVCR in Kerala has been extensively studied for population and abundance of shorebirds and it is the most significant wintering and stop-over site for many migrant shorebirds where the shorebirds reach their maximum count at low rainfall periods [1][10].

Changaram wetlands, one of the least explored Pokaalli agro-ecosystem in central Kerala, is attracting migratory shorebirds in recent years [5]. From there, 33 species have been identified as winter visitors, two species, the Kentish Plover and Great Thick-knee, were recorded as local migrants and four species were listed as residents but non-breeding individuals. As migratory shorebirds use such fragile habitats as their crucial wintering and stop-over grounds, these habitats also need to be protected.

The distribution and abundance of shorebirds are highly supported on the west coast by various factors when compared to the east coast. Because of the high levels of sand and sandy silts, the sediments on the west coast have a loose texture, which is favorable for the dwelling of macrobenthic polychaetes [16]. These polychaetes, being the key prey items for the foraging shorebirds, attract more diverse species and numbers of migratory or locally moving and resident species of shorebirds [13][24][25][26][27].

2. Species Diversity, Abundance and Population Trends of Shorebirds on the East Coast

The eastern coast of India stretches northward along the Coromandel Coast to West Bengal. Its width ranges from 80 to 100 km, which is more extensive and broader than its western counterpart. It is an aggradational plain and is characterized by sea beaches, lagoons and offshore bars. Dominant shorebird groups recorded from the west coast are Plovers followed by the Common Greenshank and Common Redshank [1] while those of the east coast are Little Stint, Black-tailed Godwit, Bar-tailed Godwit and Curlew Sandpiper (**Figure 2**) [28][29]. This is due to the narrow intertidal mudflats dominated by sand at the west and muddy substrate at the east [30].

Figure 2. Mixed flock of Curlew Sandpiper (*C. ferruginea*), Lesser Sand Plover (*C. mongolus*), Greater Sand Plover (*C. leschenaultia*) and Ruddy Turnstone (*A. interpres*) observed at Gulf of Mannar at the east coast of India —Photo courtesy H. Byju.

The diversity and abundance of shorebirds in the Sundarbans, a protected biosphere, is marked by the records of critically endangered Spoon-Billed Sandpipers [31][32][33][34][35][36] and a total of 4000 small shorebirds [32], the most abundant species being Lesser Sand Plover, followed by Kentish Plover, Common Redshank and Greater Sand Plover. Three notable species recorded include the Eurasian Curlew, the Great Thick-Knee (both are near-threatened) and the Eurasian Oystercatcher [37]. Further, 37 species of shorebirds were listed from West Bengal from 2018 December to August 2020 [38].

A total of 800,000 birds were reported from Chilika lake during 2002–03, the Black-tailed Godwit (48,000 numbers) being the predominant species [39]. Large breeding colonies of Black-Winged Stilt along with Oriental Pratincole (*Glareola maldivarum*) and Kentish Plover occur in much greater numbers. The Presence of Spoon-Billed Sandpipers and Asian Dowitchers, though in small numbers (10–15) [40], in the checklist of birds enhances the importance of Chilika Lake. During a winter survey, nearly 3000 Black-tailed Godwits were recorded [41] from Bhitarkanika, Odisha.

Out of 49 species of migrant shorebirds in India, 34 were reported at Pulicat Lake [28]. A total of 88 species of water birds have been recorded from Pulicat Bird Sanctuary [42], of which shore birds represented a major portion.

In Vedaranyam, a swamp of the Point Calimere, 47 species of shorebirds have been recorded, the commonest being Lesser Sand Plover, Marsh Sandpiper, Little Stint and Curlew Sandpiper. The population of Little Stint during

the peak season reaches 25,000 and that of each of the other three species is approximately 15,000 [43]. Up to four Spoon-Billed Sandpipers were recorded annually until 2004 [44] and the endangered Nordmann's Greenshank (*T. guttifer*) has also been recorded at Point Calimere [18].

A study reported 27 species of shorebirds at Pichavaram in 2021 [45], in which the Little Stint showed the highest density and the Bar-tailed Godwit showed the lowest density. Gulf of Mannar (GoM), a marine biosphere reserve, is known for the populations of shorebirds such as Eurasian Oystercatcher, Grey Plover, Lesser Sand Plover, Greater Sand Plover, Bar-tailed Godwit, Eurasian Curlew and Crab Plovers who prefer sand flats [46]. The avifaunal distribution of all 21 islands of GoM has been documented recently [47]. The population of most of the abundant species recorded during the 1990s had significantly reduced, which can be attributed to the degradation of habitat, especially in the Manoli islands [48][49]. Red Knot *C. canutus* (a regular winter visitor), Great Knot (rare bird), Crab Plovers and Bar-tailed Godwit (in hundreds) Sanderling (regular common winter migrant) are the main attractions of this site [46][50][51]. The Kentish Plover and Indian Thick-Knee (*Burhinus indicus*) use the Mandapam area as their breeding site [52]. The Gulf of Mannar lies within the passage of many migrants such as Black-tailed Godwit and Broad-Billed Sandpiper. Hence this site forms an extremely important link for migrant shorebirds along with Chilika Lake in Orissa and Point Calimere in Tamil Nadu on the east coast of India.

Coastal zones are efficiently utilized by avian fauna for millennia and many shorebird species are now threatened. Therefore, systematically monitoring the dynamics of shorebirds and their habitats over long-term periods is important for improving management strategies for their effective conservation [53][54]. Understanding the long-term habitat changes through systematic demographic monitoring [55] that helps in the statistical analysis of shorebird populations underpins conservation management [56]. The Gulf of Mannar [46], Point Calimere [43], Pichavaram [29], Pulicat Lake [28], and Chilika Lake [57] are significant stopover and wintering grounds for migrating shorebirds on India's east coast. Out of the 49 species of migrating shorebirds recorded in India [58], 34 are found on the east coast [28][59].

Lesser Sand Plover, Little Stint, Common Greenshank, Marsh Sandpiper, Common Redshank, Pacific Golden Plover and Eurasian Curlew are among the first to arrive (sometimes as early as July) while, Wood Sandpipers and Common Sandpipers can be seen by the end of August and Grey Plover, Little Ringed Plover, Spotted Redshank (*T. erythropus*), Curlew Sandpiper, Ruff and other species can be found in September, and Black-tailed Godwit and Pied Avocet can be found in October. The mudflats host the highest population of shorebirds in Chilika Lake because Nalabana Island is exposed there from December to May during the dry season. Small and medium-sized shorebirds, which are rare until December, reach their peak in late January. From November to March, big and long-legged Black-tailed Godwits have been observed in significant numbers [40] mostly using the Mangalajodi area as a foraging ground [60].

The Lesser Sand Plovers reach their highest populations at Nalabana Island on Chilika Lake in January and February. Ruffs, Little Stints, and Curlew Sandpipers are common shorebirds in this area. Throughout the year, very few individual Whimbrels were observed. Rare winter migrants include the Bar-tailed Godwit and Green Sandpiper (*T. ochropus*), the latter of which is typically seen in small puddles around Chilika Lake's Parikud,

Mangalajodi and Gurubai regions. The Broad-billed Sandpiper is an occasional winter visitor and the uncommon winter visitors include the Terek Sandpiper, Temminck's Stint, Asian Dowitcher and Ruddy Turnstone. The Greater Sand Plover is an uncommon and irregular migrant, whereas Dunlin (*C. alpina*) and Pied Avocets are regular winter visitors [60].

Many shorebirds that were previously recorded from Chilika are no longer there. The last authenticated record of the critically endangered Spoon-billed Sandpiper was a bird that was ringed in 1981. Eurasian Oystercatcher and Common Ringed Plover (*C. hiaticula*) were not present after 2000, and there were no recent records of Sanderling [60] but they were sighted in 2012.

The migration season typically begins at Pulicat Lake on the east coast in the first week of August, and it lasts until the second week of April to the first week of May. Lesser Sand Plover, Black-tailed Godwit, Whimbrel, Common Redshank, Common Greenshank, Wood Sandpiper, Common Sandpiper, Little Stint and Ruff are the first species to arrive in August while Grey Plovers, Curlew Sandpiper and Red-necked Phalarope (*Phalaropus lobatus*) arrive in September and Marsh Sandpiper and Temminck's Stint arrive by the northeast monsoon (October). It is in January when shorebird populations are at their highest [28]. Lesser Sand Plover, Black-tailed Godwit, Little Stint, Curlew Sandpiper and Ruff are the most prevalent shorebirds in this area [40].

With a few records at Point Calimere [61], Pulicat [62] and Kolkata [63], the Great Knot was previously considered a "rare winter visitor" to the east coast of India [63]. The migratory and sighting records at Chilika shows that it is an uncommon and regular visitor here. Similarly, Long-toed Stint (*Calidris subminuta*) used to be regular and uncommon [63], recorded from Assam, Bihar and Andaman Islands. However, another study [52] revised the status to "rare winter visitor" as one bird was ringed at the Gulf of Mannar and 13 birds at Point Calimere. Another species to be mentioned is the Red Knot, a regular winter visitor to Point Calimere and the Gulf of Mannar [64][65]. The recent ringing records in Chilika further confirm the extension of its wintering range along the east coast [60]. Recent sightings were also reported from the Pallikaranai wetlands of Chennai and Kanyakumari saltpans [60].

Among the shorebirds wintering at the Gulf of Mannar, Lesser Sand Plover, Curlew Sandpiper and Little Stint were common in all the six habitats studied during 1985–1988 and their numbers exceeded over 1000 in all the selected study sites. The dominance of these three species was seen in all of the coastal wetlands studied by the BNHS, including the key east coast sites of Point Calimere, Kaliveli, Pulicat and Chilika [64]. The reduction of these three species in all of those wetlands is similar to all wetlands along the east coast and is in line with the global trend of decline in the shorebird population. However, the proportion of the decline in the Gulf of Mannar is significant when compared to other locations [49].

Distribution Pattern of Shorebirds on the East Coast

Large stretches of intertidal regions, mangroves, sea grasses, coral islands, coastal swamps, mudflats, lagoons, and other similar ecosystems can be found throughout the east coast. However, there are some amazing shorebird populations along the beaches, as seen at Chilika Lake and Bhitarkanika in Orissa, Pulicat Lake in Tamil Nadu and

Andhra Pradesh, Point Calimere and Gulf of Mannar in Tamil Nadu, and Sundarbans (IBA) in West Bengal. Shorebirds were also observed from different regions of the east coast such as Thanjavur, Chennai, Ramanathapuram, Nagapattinam, Pondicherry, Karaikal and Kolleru Lake [66]. The studies of bird ringing by BNHS at Point Calimere had thrown light on the migratory paths of many shorebird species to and from the east coast. The records available regarding their distribution along the east coast are from Sundarbans, Chilika Lake, Bhitarkanika, Point Calimere, Pichavaram, Kaliveli and the Gulf of Mannar as mentioned earlier.

The Sundarbans, a protected biosphere, is the largest single tract of tidal mangrove forests and vast saline mudflats in the world, covering over 9360 sq. km (the Indian area 4264 sq. km). Besides having records of many wintering shorebirds, Sundarbans is an important breeding site for the Great thick-Knee [67]. It is a key wintering site for shorebirds of which at least nine species occur in numbers exceeding the internationally recognized 1% threshold for site importance. Extrapolation to all areas of suitable habitat suggests that the total population was 40,000 shorebirds [32]. Almost 80% of the recorded species were Arctic breeding long-distance migrants such as Little Stint and Curlew Sandpiper. Recently an Oriental Plover (*C. veredus*) was also recorded here [38].

The largest brackish water wetland in India, the Chilika Lake, is an important wintering ground for shorebirds on the east coast. The various habitats in the Lake include marshes, mudflats, freshwater pools and areas of open water with varying depths and salinity. It is the largest wintering ground for migratory waterfowl in India [60]. The lake has been included in Ramsar sites. The Nalabana Island on Chilika Lake primarily serves as a staging area for the smaller shorebirds during the springtime northward migration [40] as it gets exposed only in December. For the small shorebirds, the lake serves mainly as a staging area during the northward migration in spring. Black-tailed Godwits are present in good numbers from November to March. The Asian Dowitcher is also recorded in a few numbers [40].

Bhitarkanika, Odisha, situated in the delta formed by Brahmani and Baitarani rivers, has one of the finest patches of mangroves and a coastline of 35 sq. km. The vast stretches of intertidal zones along the Gahirmatha coast attract shorebirds and are known for a large population of Black-tailed Godwits [41].

Pulicat Lake on the Andhra Pradesh-Tamil Nadu border is an extensive brackish to saline lagoon with associated marshes covering an area of 720 sq. km [68]. Most of the shorebirds are distributed over the extensive mudflats along the Sriharikota-Sullurpet Road near Tada in the southwestern part of the lagoon. It is an important wetland for migratory shorebirds and is identified as a coastal flyway used by a number of pelagic and coastal migrants linking Point Calimere, Tamil Nadu and Chilika, Odisha.

Point Calimere (Vedaranyam Swamp) at the Bay of Bengal seaboard of Thanjavur is another important wintering quarters for shorebirds, with the great Vedaranyam swamp of Point Calimere, stretching for about 48 km from east to west, parallel to the Palk strait that connects India and Sri Lanka and separated by a sandbank, harbors a large number of shorebirds [69]. The commonest shorebirds are Lesser Sand Plover, Marsh Sandpiper, Little Stint and Curlew Sandpiper. The saltpans near the Sanctuary and Siruthalaikadu are areas where a good congregation of migrating shorebirds was found.

Another vital stopover site on the east coast of Southern India is Pichavaram Mangrove Forest. It is situated along the CAF routes of migratory shorebirds and it provides sufficient nutrients for the shorebirds [43][45].

References

1. Aarif, K.M.; Muzaffar, S.B.; Babu, S.; Prasadan, P.K. Shorebird assemblages respond to anthropogenic stress by altering habitat use in a wetland in India. Biodivers. Conserv. 2014, 23, 727–740.
2. Aarif, K.M.; Sara, K.; Aymen, N.; Sama, A. Over-summering abundance, species composition, and habitat use patterns at a globally important site for migratory shorebirds. J. Ornithol. 2020, 132, 165–172.
3. Rao, B.; Santhanakrishnan, B.; Quadros, G. Spatial and Temporal Patterns of Shorebird Assemblages in Select Estuaries along India's West Coast. Ornithol. Sci. 2022, 21, 199–213.
4. Aarif, K.M.; Prasadan, P.K.; Santhanakrishnan, B. Conservation significance of the Kadalundi-Vallikkunnu Community Reserve. Curr. Sci. 2011, 101, 717–718.
5. Jasmine, A.; Byju, H.; Nefla, A.; Abhijith, S.; Aarif, K.M. Conservation significance of Changaram wetlands—A key wintering site for migratory shorebirds and other waterbirds in the west coast of Kerala. J. Threat. Taxa, 2022; in press.
6. Urfi, A.J. Waders and other wetland birds on Byet Dwarka Island, Gulf of Kutch, western India. Wader Study Group Bull. 2002, 99, 31–34.
7. Chaudhari-Pachpande, S.; Pejaver, M.K. A preliminary study on the birds of Thane Creek, Maharashtra, India. J. Threat. Taxa 2016, 8, 8797–8803.
8. Baidya, P.; Bhagat, M. A checklist of the birds of Goa, India. Indian Birds 2018, 14, 1–31.
9. Aarif, K.M.; Nefla, A.; Nasser, M.; Prasadan, P.K.; Athira, T.R.; Muzaffar, S.B. Multiple environmental factors and prey depletion determine declines in abundance and timing of departure in migratory shorebirds in the west coast of India. Glob. Ecol. Conserv. 2021, 26, e01518.
10. Aarif, K.M.; Prasadan, P.K.; Hameed, A.S.V.; Ravindran, R. Avian fauna of kadalundi-vallikkunnu community reserve, west coast of india. Stilt 2017, 71, 25–32.
11. Aarif, K.M.; Mussammilu, K.K. Pivotal reasons for the declining of shorebirds in Kadalundi-Vallikkunnnu Community Reserve, a key stop-over site in the West Coast of India. Asian J. Conserv. Biol. 2018, 7, 46–50.
12. Jayson, E. Ecology of Wetland Birds in the Kole Lands of Kerala; KFRI Research Report No. 244; Kerala Forest Research Institute: Peechi, India, 2002; pp. 15–42.

13. Aarif, K.M. Some Aspects of Feeding Ecology of Lesser Sand Plover in Three Different Zones in the Kadalundi Estuary, Kerala, South India. Podoces 2009, 4, 100–107.
14. Aarif, K.M. Ecology and Foraging Behavior of Some Migrant Shorebirds in the Kadalundi-Vallikkunnu Community Reserve, West Coast of India. Ph.D. Thesis, Kannur University, Kannur, India, 2014; 219p.
15. Nair, R.P.V. Primary productivity in the Indian seas. Bull. Cent. Mar. Fish. Res. Inst. 1970, 22, 29–35.
16. Musale, A.S.; Desai, D.V. Distribution and abundance of macrobenthic polychaetes along the South Indian coast. Environ. Monit. Assess. 2011, 178, 423–436.
17. Khacher, L. The birds of Gujarat—A Salim Ali centenary overview. J. Bombay Nat. Hist. Soc. 1996, 93, 331–373.
18. Islam, M.Z.; Rahmani, A.R. Important Bird Areas in India: Priority Sites for Conservation; Bombay Natural History Society: Mumbai, India; Bird Life International: Cambridge, UK, 2004; pp. 1–1200.
19. Munjpara, S.; Joshi, K.; Joshi, J.; Kamboj, R.D.; Salvi, H. Status of Extra-Limits Migrating Avifauna and their Stopover in the Gulf of Kachchh, Gujarat. Res. Rev. J. Life Sci. 2019, 9, 34–41.
20. Bhuva, V.J.; Soni, V.C. Wintering Population of Four Migratory Species of Waders in the Gulf of Kachchh and Human Pressures. Wader Study Group Bull. 1998, 86, 48–51.
21. Vala, D.; Parmar, H.; Dal, P.; Parihar, A.; Parmar, D.; Parihar, V.; Khandla, Y. Diversity and distribution of birds in Jamnagar, Gujarat, India. Int. J. Fauna Biol. 2020, 7, 35–43.
22. Kurve, P.N. Habitat-dependent avifaunal diversity along the coastline of Raigad district, Maharashtra, India. Int. J. Fauna Biol. 2017, 4, 1–6.
23. Abdulali, H. The birds of Goa. J. Bombay Nat. Hist. 1980, 76, 507–510.
24. Halliday, J.B.; Curtis, D.J.; Thompson, D.B.A.; Bignal, E.M.; Smyth, J.C. The abundance and feeding distribution of Clyde Estuary shorebirds. Scott. Birds 1982, 12, 65–72.
25. Iwamatsu, S.; Suzuki, A.; Sato, M. Nereid Polychaetes as the Major Diet of Migratory Shorebirds on the Estuarine Tidal Flats at Fujimae -Higata in Japan. J. Zool. Sci. 2007, 24, 676–685.
26. Duijns, S.; Hidayati, N.A.; Piersma, T. Bar-tailed Godwits Limosa lapponica eat polychaete worms wherever they winter in Europe. Bird Study 2013, 60, 509–517.
27. Sivaperuman, C.; Jayson, E.A. Population fluctuations of shore birds in the Kole wetlands, Kerala, India. Ann. For. 2012, 20, 129–144.
28. Kannan, V.; Pandiyan, J. Shorebirds (Charadriidae) of Pulicat Lake, India with special reference to conservation. J. Zool. 2012, 7, 178–191.

29. Sampath, K.; Krishnamurthy, K. Shorebirds of the Pichavaram mangroves, TamilNadu, India. Wader Study Group Bull. 1990, 58, 24–27.
30. Kathiresan, K. Mangrove forests of India. Curr. Sci. 2018, 114, 976–981.
31. Thompson, P.M.; Harvey, W.G.; Johnson, D.L.; Millin, D.J.; Rashid, S.M.A.; Scott, D.A.; Stanford, C.; Woolner, J.D. Recent notable bird records from Bangladesh. Forktail 1993, 9, 13–44.
32. Zockler, C.; Balachandran, S.; Bunting, G.C.; Fanck, M.; Kashiwagi, M.; Lappo, E.G.; Maheswaran, G.; Sharma, A.; Syroechkovski, E.E.; Webb, K. The Indian Sundebans: An important wintering site for Siberian waders. Wader Study Group Bull. 2005, 108, 42–46.
33. Sharma, A. First records of Spoon-billed sandpiper, Calidris pygmeus in the Indian Sundarbans delta, West Bengal. Forktail 2003, 19, 136–137.
34. Zockler, C.; Bunting, G.C. Bangladesh 2006 Expedition Report; Unpublished Report to the Deutshe Ornitologen Gesellschaft (D-OG); Arcoana Ecological Consulting: Cambrigde, UK, 2006.
35. Bird, J.P.; Lees, A.C.; Chowdhury, S.U.; Martin, R.; Ul Haque, E. A survey of the critically Endangered spoon-billed sandpiper, Eurynorhynchus pygmeus in Bangladesh and key future research and conservation recommendations. Forktail 2010, 26, 1–8.
36. Chowdhury, S.U.; Foysal, M.; Das, D.K.; Mohsanina, S.; Diyan, M.A.A.; Alam, A.B.M.S. Seasonal occurrence and site use by shorebirds at Sonadia Island, Cox‘s Bazar, Bangladesh. Wader Study Group Bull. 2011, 118, 77–81.
37. Chowdhury, S.; Diyan, M.; Zöckler, C.; Foysal, M.; Lemke, H. A survey of shorebirds in the sundarbans of Bangladesh. Stilt 2014, 66, 10–13.
38. Payra, A. Avifauna of adjoining coastal areas of Purba Medinipur district, southern West Bengal, India: Additional records and updated list. Cuad. De Biodivers. 2020, 59, 1–24.
39. Balachandran, S.; Rahmani, A.R.; Sathyaselavam, P. Habitat Evaluation of Chilika Lake with Special Reference to Birds as Bio-Indicators. Final Report (2001–2005); Bombay Natural History Society: Mumbai, India, 2005.
40. Balachandran, S. The decline in wader populations along the east coast of India with special reference to Point Calimere, south-east India. In Waterbirds Around the World; Boere, G.C., Galbraith, C.A., Stroud, D.A., Eds.; The Stationery Office: Edinburgh, UK, 2006; pp. 296–301.
41. Pandav, B. Birds of Bhitarkanika Mangroves, eastern India. Forktail 1997, 12, 9–20.
42. Rao, P.; Mohapatra, K.K. Occurrence of the knot (Calidris canuta) from Andhra Pradesh. J. Bombay Nat. His. Soc. 1993, 90, 509.
43. Sampath, K.; Krishnamurthy, K. Shorebirds of the salt ponds at the Greater Vedaranyam Salt Swamps, Tamil Nadu, India. Stilt 1989, 15, 20–23.

44. CMS (Convention on the Conservation of Migratory Species). The Agreement on the Conservation of African-Eurasian Migratory Waterbirds. Report. 2008. Available online: https://www.cms.int/en/publication/conference-parties-proceedings-9th-meeting (accessed on 5 September 2022).
45. Jagadheesan, R.; Pandiyan, J. Seasonal Variations of Small Wading Birds in the Pichavaram Mangrove Forest, India. Curr. World Environ. 2021, 16, 399–407.
46. Balachandran, S. Shorebirds of the Gulf of Mannar Marine National Park, Tamil Nadu. J. Bombay Nat. Hist. Soc. 1995, 92, 303–313.
47. Byju, H.; Raveendran, N.; Ravichandran, S. Distribution of avifauna in twenty-one islands of the Gulf of Mannar Biosphere Reserve, South East India. J. Threat. Taxa, 2022; in press.
48. Byju, H. Interesting foraging behaviour of Crab Plover in Manali Island, Gulf of Mannar, India. Bird-o-soar #63. Zoos Print 2020, 35, 25–28.
49. Byju, H.; Balachandran, S.; Ravichandran, S. Long-term population trends of migratory shorebirds—A case study from Manoli Island, the Gulf of Mannar Biosphere Reserve, India. Ornis Svec. 2022; in press.
50. Cross, S.S.R.T.; Mohanraj, T.; Shanmugavel, S. Diversity and distribution of shore birds in the Tuticorin coastal area of Gulf of Mannar. Adv. Appl. Sci. Res. 2015, 6, 45–49.
51. Asha, P.S.; Diwakar, H.; Sivanesh, K.V. Habitat depended on coastal and avian faunal characteristics of Tuticorin, Gulf of Mannar. J. Exp. Zool. India 2019, 22, 209–214.
52. Balachandran, S. Studies on the Coastal Birds of Mandapam and the Neighbouring Islands (Peninsular India). Ph.D. Thesis, Annamalai University, Annamalai Nagar, India, 1990.
53. Hanski, I.; Gilpin, M.E. Metapopulation Biology: Ecology, Genetics and Evolution; Academic Press: San Diego, CA, USA, 1997.
54. Preiszner, B.; Csörgő, T. Habitat preference of Sylviidae warblers in a fragmented wetland. Acta Zool. Acad. Sci. Hung. 2008, 54 (Suppl. 1), 111–122.
55. Monaghan, P.; Uttley, J.D.; Burns, M.D.; Thaine, C.; Blackwood, J. The relationship between food supply, reproductive effort and breeding success in Arctic Terns Sterna paradisaea. J. Anim. Ecol. 1989, 58, 261–274.
56. Robinson, R.A.; Clark, N.A.; Lanctot, R.; Nebel, S.; Harrington, B.; Clark, J.A.; Gill, J.A.; Meltofte, H.; Rogers, D.I.; Rogers, K.G.; et al. Long term demographic monitoring of wader populations in non-breeding areas. Wader Study Group Bull. 2005, 106, 17–29.
57. Hussain, S.A.; Mohapatra, K.K.; Ali, S. Avifauna Profile of Chilika Lake. A case of Conservation. Technical Report 4. J. Bombay Nat. Hist. 1984, 1–67.

58. Davidson, N.C. Status of wader populations on the Central/South Asain Flyway. Wader Study Group Bull. 2003, 101–102, 14–15.
59. Sandilyan, S.; Thiyagesan, K.; Nagarajan, K. Major decline in species-richness of waterbirds in the Pichavaram mangrove wetlands, southern India. Wader Study Group Bull. 2010, 117, 91–98.
60. Balachandran, S.; Sathiya Selvam, P.; Sudarasan, P. Bird Atlas of Chilika; Bombay Natural History Society: Mumbai, India; Chilika Development Authority: Bhubaneswar, India, 2009; pp. 1–325.
61. Ali, S.; Hussain, S.A. Studies on the movement and population structure of Indian Avifauna. Annual Report 1. J. Bombay Nat. Hist 1987, 1–47.
62. Mohapatra, K.K.; Rao, P. Some wader records from coastal Andhra Pradesh. J. Bombay Nat. His. Soc. 1993, 89, 250–251.
63. Ali, S.; Ripley, S.D. Compact Handbook of the Birds of India and Pakistan Together with Those of Bangladesh, Nepal, Bhutan, and Sri Lanka, 2nd ed.; Oxford University Press: Bombay, India, 1983.
64. Balachandran, S. Bird Migration Studies in India, (1980–1992); 5pr. II, 3 pr. II, 1–142; Bombay Natural History Society: Mumbai, India, 1998; pp. 1–177.
65. Cramp, S.; Simmons, K.E.L. The Birds of the Western Palaearctic; Oxford University Press: Oxford, UK, 1983; Volume 3, pp. 1–452.
66. Balachandran, S.; Tuhina, K.; Ranjith, M. Indian Bird Migration Atlas; Bombay Natural History Society: Mumbai, India; Oxford University Press: New Delhi, India, 2018; pp. 1–216.
67. Siddiqui, P.J.; Farooq, S.; Shafique, S.; Farooqi, Z. Conservation and management of biodiversity in Pakistan through the establishment of marine protected areas. Ocean Coast. Manag. 2008, 51, 377–382.
68. Prater, B.L.; David, R.B.; John, H.O. New sampler for shallow-water benthic macroinvertebrates. The Progressive Fish-Culturist. 1977, 39, 57–58.
69. Ali, S. Point Calimere as a refuge for wintering shorebirds. J. Bombay Nat. Hist. Soc. 1963, 60, 458–460.