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Pivotal reasons for the decline of the shorebirds in Kadalundi-Vallikkunnu Community Reserve, a key stop-over site in the west coast of India

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ABSTRACT

The past decade witnessed a massive alteration and loss of natural intertidal habitats that are of prime importance to large numbers of migrant shorebirds, especially at Kadalundi-Vallikkunnu Community Reserve (KVCR), first community reserve in Kerala, the west coast of India. It is also an international important stop-over site for shorebirds in the Central Asian Flyway (CAF). Eight hectares of mudflat - exposed during low tides- offer potential foraging ground for several hundreds of wintering and resident waterbirds, particularly shorebirds. During a span of ten-year period study from 2005 to 2014, we constantly monitored the key factors for the decline of diversity of shorebirds in KVCR and identified the following reasons for decline of shorebird populations *viz*., incursion of mangroves, changes in sediment quality, expansion of sand bed and shrinkage of mudflats, decreasing thickness of mudflats, and indiscriminate total ban on husk retting. Being this is an example or model study under Central Asian Flyway, every restoration biologists should monitor the habitat keeping in mind the pivotal reasons of the concerned habitat change, and provide information and technical assistance on habitat protection and restoration to government, conservation biologists, and policy makers so as to protect natural environment as well as livelihood of layman around the community reserve. Our suggestion is to derive a fine strategic management plan, which is to be devised through an array of multi disciplinary research, so as to restore and conserve the habitat - Kadalundi-Vallikkunnu Community Reserve, the west coast of India considering its unique ecosystem services and functions.

Key words: community reserve; decline; habitat restoration; husk retting; mangroves; mudflats; sand bed; sediment quality; Shorebirds

INTRODUCTION

The past century has seen massive alteration and loss of natural intertidal habitats that are of prime importance to large numbers of migrant shorebirds during the non breeding season at wintering and stopover sites (Masero and Pérez-Hurtado, 2001). Intertidal flats represented an important component for avian diversity and endangered or rare species in coastal wetlands. Intertidal habitats are the most important area for migrant shorebirds across the world during the winter (MDIFW, 2000). Migratory shorebirds require open habitat such as tidal flats and salt-marshes for foraging (Wells and Mundkur, 1996). The mudflats offer potential foraging grounds for wintering migrant shorebirds in the west coast of India (Aarif *et al*., 2011, 2014; Aarif and Prasadan, 2014).

The study area, Kadalundi-Vallikkunnu Community Reserve (KVCR - 11°7′28″– 11°8′01″N and 75°49′36″–75°50′20″E) is located at the bar mouth of Kadalundi River that drains into the Arabian Sea on the west coast of Kerala, India. Before entering the sea, the river divides into two channels encircling a small island (Figure 1). The raised sandbars on the western and southern sides of the island separate the lagoon from the sea (Uthaman and Namasivayan, 1991). Apart from scattered patches of mangroves, the estuary is bordered by coconut groves and human habitation. Around eight hectares of mudflat - exposed during low tides-offer potential foraging ground for several hundreds of wintering and resident waterbirds, particularly shorebirds. The area provides significant socio-economic and livelihood services (fishing, oyster farming and sand mining) for the people living around the estuary.

Kadalundi-Vallikkunnu Community Reserve (KVCR) is one of the most important wintering and stop-over ground in Central Asian Flyway (CAF). A total of 110 species of waterbirds, including 53 migrants have been recorded in KVCR. Among the shorebirds the most abundant species is Lesser Sand Plover - *Charadrius mongolus* (observed up to 4% of global population). Among the shorebirds species assessed, eight species (44 %) exhibited significant declining trends. Total annual shorebird counts decreased significantly during the seven year period 2005 to 2012 (ANOVA, F=3.63, p=0.001). Shannon's index & Gini-Simpson's index values varied from 0.79 to 1.27 and 0.28 to 0.53 respectively and richness varied between 17 and 26 species with significant fluctuations occurred during these years with a declining trend (Aarif *et al*., 2014). The present study designed, on the basis of former study, to identify

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Figure 1. Map of study area

the crucial factors for the decline of diversity of shorebirds in the KVCR. Finally, unearthed the major reasons for the decline of biodiversity of KVCR are (1) incursion of mangroves, (2) changes in sediment quality, (3) Expansion of sand bed and shrinkage of mudflats, (4) decreasing the thickness of mudflats, and (5) indiscriminate total ban on husk retting.

Incursion of mangroves

Even though mudflats and mangroves are closely situated, they are the two unique ecosystems. KVCR study area has both mudflats and mangroves. Close observation on the proliferation of mangroves in the past several years revealed that the proliferation of mangroves slowly wiped away the mudflats, the primary foraging ground of migratory shorebirds. Lesser Sand Plovers are the most dominant migrant shorebirds that intensively feed on the mudflats (Aarif, 2009). Migratory shorebirds require open habitat such as tidal flats and salt-marshes for foraging (Augustinus, 1995). Using a combined methodology of photogrammetric survey and Global Positioning System (GPS) measured the mangrove incursion and found exceeded 30%. The incursion of mangroves in KVCR resulted in reduction in the area of open mudflats (Figure 2). The mangroves had been planted on intertidal flats in earlier days to enlarge the area of mangrove forest. Although mangrove forest is important to coastal ecology and community security, it is necessary to evaluate each site proposed for mangrove replanting based on the importance of the habitats to migratory waterbirds. If unscientifically the mangrove planting proceeds on intertidal flats without consideration of waterbird habitat requirements, it is inevitable that important waterbird habitats will be vanished in coming years. The present observation of incursion of mangroves towards mudflats very strongly supports the study by Zou *et al*. (2006).

The expansion of mangroves into shorebird feeding habitats, due to sea-level rise and increased sedimentation, are the significant recent problems. Seaward invasion of mangroves onto tidal mudflats as a result of excessive sedimentation caused by poor watershed management is affecting shorebird feeding areas. Next to this, the accumulation of mangroves onto tidal mudflats is thought to be a result of increased silt loads and nutrient levels due to uncontrolled development and soil erosion in upstream catchment areas. Mangroves follow such fertile areas of mud accretion, and their establishment in such environments may lead to a reduction in the extent of open tidal flat habitat available to shorebirds (Augustinus, 1995).

Changes in sediment quality

The sediment quality analysis, during the study period from 2010 to 2012, showed that the proportion of clay, silt, coarse and fine sand varies with habitats. The top sediment was sampled using a steel cylinder (15cm length X 20cm diameter) and analyzed to determine grain size, silt/clay content. The highest value of clay (29.17%) and silt (23.16%) were observed in shallow mudflats followed by shallow mangroves (18.22 and 13.76%), mudflats (14.2 and 18.2%) and mangroves (7.58 and 10.62%) and the lowest value of clay and silt were observed in the sand beach (1.52 and 5.97%). The highest value of fine sand were observed at sand beach (86.72%), followed by mangroves (63.26%), mudflats and shallow mangroves (54.65 and 51.91% respectively), and least at shallow mudflats (30.48%). Whereas in the case of coarse sand, the highest value observed again at mangroves (18.54%), then at shallow mudflats and shallow mangroves (17.19 and 16.11% respectively) and thereafter at mudflats (13.03%) and least at sand beach (5.79%). Mangrove sediment is rich in fine sand followed by coarse sand, silt and clay. Major proportion of sediments in all habitats is shared by fine sand.

The sediment quality is one of the vital factors controlling the benthic life (Parsons *et al*., 1984, Merilainen, 1998, Islam *et al*., 2013). The organic matter in surface sediments is an important source of food for benthic fauna (Sanders, 1958, Gray, 1974, Pearson and Rosenberg, 1978, Lopez and Levinton, 1987, Snelgrove and Butman, 1994). Sarda *et al.* (1995) found that the grain size and organic content of soil defined distinct species assemblages. Otani *et al*. (2010) indicated that distribution of macrobenthos could be explained by the classification of physical characteristics of sediment in tidal flats. The main environmental factors affecting the distribution of macrobenthic animals reported by many researchers are organic matter, salinity and sediment characteristics, especially mud or clay content (Parsons *et al*., 1984, Macfarlane and Booth, 2001, Musale and Desai, 2010, Islam *et al*., 2013). Thompson and Lowe (2004) showed the changes in benthic species composition and abundances are often linked to the interaction of fine sediments, organic material, and chemical contaminants. The change in sediment quality affects the quality and quantity of macro as well as micro benthic life forms and this will in turn control foraging of shorebirds. Thus, the changes in sediment texture is also a crucial factor to determine the fate of abundance and congregation of shorebirds at KVCR (Finn, 2009, Kuwae *et al*., 2010).

Figure 2. Initial stage of sand bed formation

Expansion of sand bed and shrinkage of mudflats

The intertidal zones of tropical and subtropical areas are supporting a rich diversity of flora and fauna on regional and global scales (Syamjith and Ramani, 2014). In the present study, it was noticed that the small sand bed with less height, which were very close to coastal highway bridge connecting Kadalundi-Vallikunnu panchayats, are gradually increasing their size and height. Further to this, it was also noticed the decrease in size of the mudflats (Figure 3). In the year 2012- 2013 the mudflats was eight hectares but now it is less than eight hectares. The expansion of sand bed and shrinkage of mudflats were measured using a combination of photogrammetric survey and GPS. Although the emergence of sand banks become more prominent from 2008, but now increasing the level of sand bed over the years which starts to swallow the nutrient mudflats in the study area, the mudflats are most important potential foraging grounds for migrant shorebirds and that can be attributed to the shrinking of the mudflats and that in turn causes the declining of the diversity of the shorebirds. The diversity of the prey abundance has also showed in declining trends during the study period from 2010 to 2014 (Aarif *et al*., 2014).

Decreasing the thickness of mudflats

The mudflats thickness has been decreasing over the years (ie. 2010 to 2014) which mean the gradual hardening of mud. The thickness of mudflats were measured using 2 meter steel rod having a diameter of 2 centimeter and checked three times around 10-20 points especially during the first week of January, June and September on the mudflats mainly on the basis of congregation of migrant shorebirds for foraging (Figure 4). During 1980's the thickness of mudflats was more than 180cm (*Sri* Ramakkuttichan, personal communication), in those period they were engaged actively in husk retting on the mudflats. The thickness of mudflats during the study was observed in declining trends at Kadalundi-Vallikkunnu Community Reserve. For example, in January, 2010 the thickness of mudflats was 54.11cm, whereas 45.22cm in the year 2011, and declined from 38.16cm to 31.22cm in the year 2012 to 2013 and finally reached at 29.29cm in September, 2014.

Figure 3. Present stage of sand bed formation

Figure 4. Remnants of husk

Kuwae *et al*. (2010) opined that the sediment hardness is an environmental constraint for shorebirds and the study suggested for conservation and restoration of soft bottom intertidal habitats, such as mudflats, particularly critical for probing shorebirds. Any structural modification of soft sediment feeding flats that reduces the substrate penetrability may inhibit successful foraging and detrimental to the shorebirds. There are several causes of the structural modification that may reduce the substrate penetrability of intertidal flats. Compactions of sediments, dumping of debris *etc.* are the causes of structural modification (Finn, 2009).

Indiscriminate total ban on husk retting

Coconut husk retting is the basic process involved in the manufacture of coir. Retting is a curing process, decomposition of the tissues surrounding the vegetable fibers, during which coconut husks are kept in an environment of freshwater or saline water that encourages the pectinolytic action of naturally occurring microbes - bacteria, fungi and yeasts. This action partially decomposes the husk's pulp, allowing it to be separated into coir fibers and a residue called coir pith. The retting process, coconut husks are immersed in retting ponds for about 6 to 10 months, to yield golden yellow coir fibers to make high quality coir products. Coir retting was the most lucrative income generating activity, the source of livelihood for millions, for the area (Rajan and Abraham, 2007).

Figure 5. Shorebirds feeding on remnants of husk

The studies on shorebird diets from diverse locations indicated that polychaetes are one of the primary prey items taken by shorebirds while foraging (Halliday *et al*., 1982, Weber and Haig, 1997, Iwamatsu *et al*., 2007, Duijns *et al*., 2013). Earlier studies in KVCR showed that polychaetes and crabs are important food items of shorebirds (Aarif, 2009) and other waterbirds (Kurup, 1991). Among the benthic community, polychaetes are reported to dominate the retting zone (Figure 5) followed by mollusks (Nirmala *et al*., 2002). Few species of polycheates such as *Paraheteromastus tenius, Perinereis cavifrons* and *Prinospio polybranchiata* were abundant in the retting zone (Nirmala *et al*., 2002). These species are found to be benefitted from the polluted retting zone and are treated as indicators of pollution however the above species could not be observed during the present study. Kurup (1991) reported *Pereneries cavfrons* as dominant species among the polychaetes in KVCR however it was observed seldom during the present study. The present study recorded 19 species of polychaetes, of which most common species are *Ceratonereis burmensis* Monoro, *Namalycastis sp.*, *Heteromastus filiformis* and those were not observed during earlier studies (Kurup, 1991, Nirmala *et al*., 2002). Polychaetes were sampled and processed following the procedures described by Hsieh (1995). The polychaetes number reduced from 121 to 51 individuals per m^2 during the study period. This indicates a gradual decline of polychaetes. This change in diversity of polycheate shows some clear relation with husk retting process. As Nandan (1997) opined that certain groups – opportunistic (indicator) species - such as Rotifera, Copepod nauplii, Olichaeta, Polychaeta and Insecta were observed in plenty at the retting zone. Organic carbon and organic matter of the soil sediment were higher in the retting zones (1.19%) than that in the non-retting zones (0.79%) (Nandan, 1997). Less abundance of polychaetes at high organic carbon areas over the Indian coast has been attributed to avoidance of these organisms to higher concentration of soil sediment organic matter (Musale and Desai, 2010). However, in Calicut coast the scenario of polycheate abundance is higher in organic rich areas and this can be attributed to husk retting process, which completely alters the soil sediment structure. The husk retting in mudflats provide suitable soil sediment for this species irrespective of high organic matter. High concentration of polycheate species in the retting zones attracts shorebirds such as Pacific Golden Plover, Common Redshank, Common Greenshank, Lesser Sand Plovers, Little Stint, Dunlin *etc.* during the low tides across the years. In recent years the abundance of polycheate in the mudflats was observed in scanty and the abundance of birds declined as well. The relative role of husk retting and the abundance of shorebird is interesting link that needs to be unveiled and a sustainable green technology – closed or semi closed retting - to be devised (Vardhanan Shibu *et al*., 2013) at KVCR.

CONCLUSION

The management plan to habitat restoration should be devised through scientific studies considering the pivotal reasons of habitat change, especially on the vulnerable habitats like mangroves and mudflats. The observed shorebirds population fluctuations at Kadalundi-Vallikkunnu Community Reserve (KVCR) are mainly influenced by above mentioned factors on breeding or wintering grounds. Finally, it is worth to consider the impact and scope of husk retting in management and ecosystem functions and services of the habitat *ie.* husk retting is a boon? Restoration biologists should monitor concerned habitat (this study limited to KVCR) keeping in mind the pivotal reasons of habitat change, and provide information and technical assistance on habitat protection and restoration to government, conservation biologists, and policy makers so as to protect natural environment as well as livelihood of layman around the community reserve. Our suggestion is to derive a fine strategic management plan, which is to be devised through an array of multi disciplinary research, so as to restore and conserve the vast biodiversity at Kadalundi-Vallikkunnu Community Reserve, the west coast of India considering its unique ecosystem services and functions.

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