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Research Article

TEMPORAL VARIATIONS OF SHOREBIRDS AND BENTHIC COMMUNITY, TRADITIONAL SALTPANS OF EAST COAST OF SOUTHERN INDIA

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ABSTRACT

Seasonally the saltpans are acting as alternate foraging habitats for shorebirds. We have estimated the density of shorebirds and benthic organisms from November 2012 to October 2013. The birds were estimated by total count and the invertebrates were sampled at 20 cm depth which used for foraging by shorebirds. Totally 44 water birds /shorebirds were recorded, in which the Little Stint was the maximum density than the other species recorded among the months in different saltpans. Maximum bird density was recorded during the month of January 2013 and minimum density was noted during the month of October 2013. There was a positive relationship between the density of bird species and benthic organisms ($P<0.05$). From this study, it is inferred that the management of saltpans at coastal wetlands, is a significant approach to the conservation of birds especially migratory shorebirds.

Key words: Saltpans, shorebirds, invertebrate prey, spatial variations and conservation.

INTRODUCTION

Natural and artificial coastal wetlands tend to be highly productive and are a vital habitat for waterbirds/shorebirds (Velasquez, 1992; Masero *et al.,* 2000), which are very sensitive to habitat change (Alexander *et al.,* 1996). In recent decades, many coastal wetlands have been damaged or altered, resulting in major impacts on shorebird populations (Goss-Custard *et al*., 1977a, b; Goss-Custard and Moser, 1988). Artificial wetlands such as saltpans can provide important foraging habitats for shorebirds as alternate foraging habitat, (Pe´rez-Hurtado and Hortas, 1991). Salt production via the circulation of sea water through a system of ponds in saltpans is an ancient activity in the world (Britton and Johnson, 1987). Saltpans are extensive, man-made hyper saline habitats that are of great importance for migratory shorebirds owing to the high productivity and predictability in time and space, as well as their shallow depth (Britton and Johnson 1987). But, current scenario, lots of saltpans have been abandoned or transformed into other uses, leading to the loss of their shorebird and invertebrate populations (Masero, 2003).

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In India, Tamil Nadu, seasonally the salt extraction is one of the major professions of the coastal areas and there are more than 12,000 hectares are under salt extraction. The saltpans represent 16% of the surface area of the coastal area, and are an important feeding and roosting area for shorebirds. Aquatic invertebrates in saltpans represent abundant prey for shorebirds (Velasquez, 1992), although there are relatively few invertebrate taxa owing to the extreme salinities. Amongst these taxa, chironomid larvae are particularly important for several shorebirds (Velasquez, 1992; Pe´rez-Hurtado *et al.*, 1997). During the migration periods and in winter seasons, several flocks of shorebirds can regularly be observed in saltpans (Pandiyan *et al.*, 2013). In addition, the present study areas of the saltpans are located adjacent to Point Calimere Wildlife and Bird Sanctuary which is one of the important bird areas and the only RAMSAR site located in Tamil Nadu. Although they attract good number of shorebirds, they do not get any protection. Based on the above said information we have studied the densities of water birds/shorebirds and invertebrates prey items in the saltpans of east coast of Kodikkarai region, Tamilnadu, Southern India to know the significance of saltpans on shorebird population.

MATERIALS AND METHODS

Study area

The study was carried out in the Kodikkarai saltpans of the east coast of Tamilnadu, southern India. The saltpans in the study area comprised 930 ha. and divided into five different saltpan areas viz., (Camplast (250 ha. $10^0$19.678'N, $79^0$49.809'E), Kovilthalvu (190 ha. $10^0$20.793'N, $79^0$48.163'E), Nandupallam (170 ha. $10^0$20. 394'N, $79^0$50.714'E), Nedunthittu (160 ha. $10^0$20.520'N, $79^0$50.203'E) and Pushkarani (160 ha. $10^0$20.444'N, $79^0$48.989'E). These saltpans are located on the east coast of India near an important water bird wintering area: Point Calimere Wildlife Sanctuary, which is the only RAMSAR site located in Tamilnadu (Figure 1). The saltpans primarily comprise of reservoir ponds (which are mainly used to store sea water), Evaporation ponds (which are mainly used for increasing the salinity of the water) and crystallization ponds (these are true saltpans in which the sea water crystallizes into salt particles), which differ mainly in their salinity, vegetation and water levels. The salinity of the first (reservoir) pond type is very similar to that of the marine environment (35-38%), whereas in the last pond type (crystallization ponds) it reaches more than 250%. This region is subjected to the northeast monsoon, with most of the rainfall occurring during October–December. However, in the past decade, rainfall has declined remarkably and, in recent years, most rainfalls are over a period of 2–3 weeks. In fact, these study areas are important and are acting as stopover sites for the migratory birds during their migratory periods (Sampath and Krishnamoorthy 1989 and Pandiyan *et al.*, 2010).

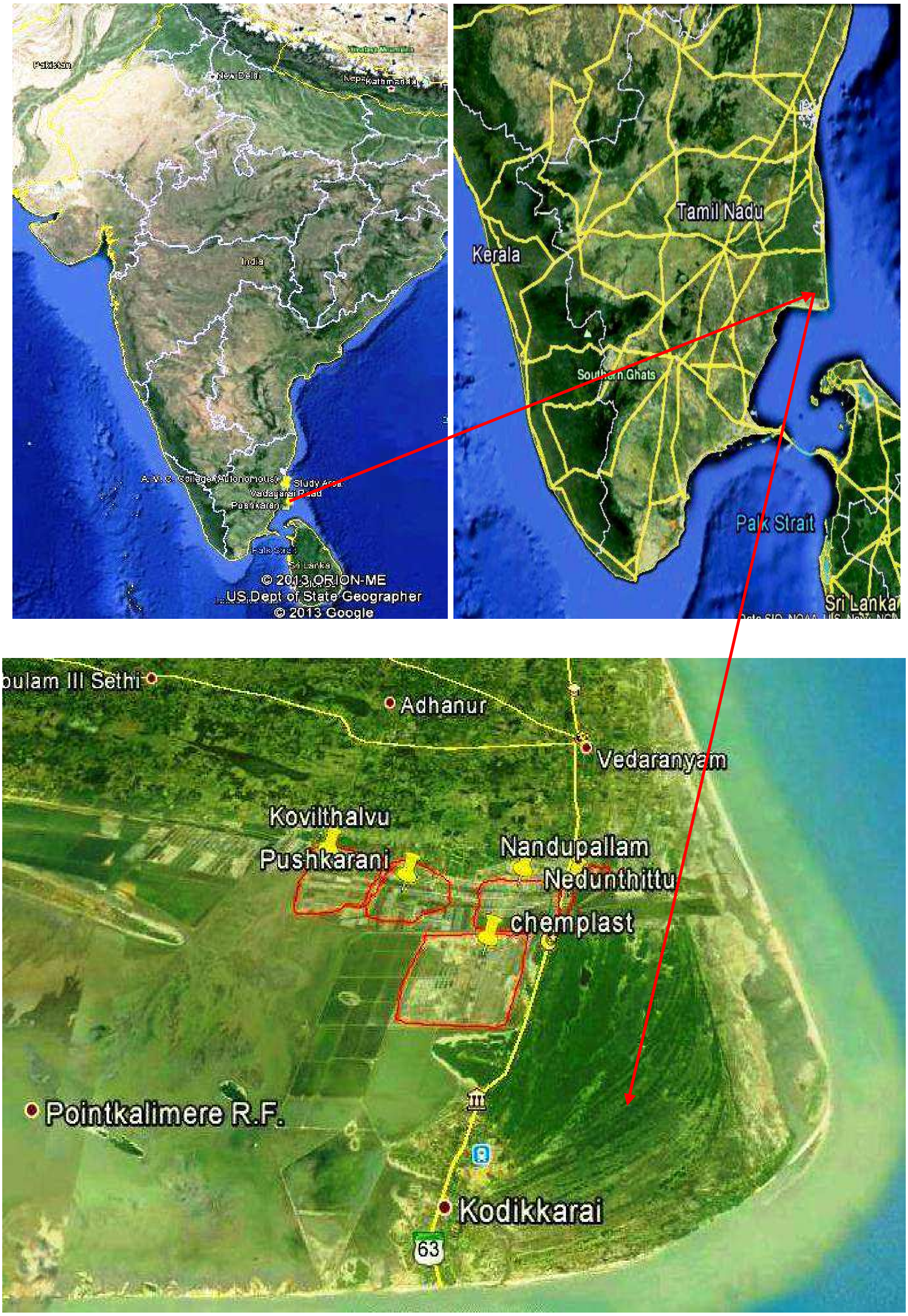

Figure 1. Map showing the saltpan areas of Kodikkarai, Tamilnadu.

Methodology

Shorebird count

Since all the saltpans appeared relatively homogenous, the study area was divided into five different areas, and its name was based on their nearby location to categorize the spatial variations of bird and benthic organisms' densities. Birds were counted with 7 × 50 binocular and 20 x 60 spotting scope from vantage points on the saltpans. Birds were counted individually using the 'direct count' method which gave a total count of birds in each area (Yates and Goss-Custard, 1991 and Nagarajan and Thiyagesan 1996). On each day, we carried out two counts of 3.00 h duration and as far as possible, counts were undertaken on clear and sunny days to minimize bias arising from variation in weather. All the study areas were entirely open and had very scanty vegetation so birds could be seen and counted without difficulty. During the census, we were always aware of any arrival or departure of flocks of birds in the areas to be counted to avoid missing or duplicating records. The birds were not particularly disturbed by our counts and in fact they tolerate our presence very reasonably.

Benthic fauna sampling

In the selected salt pan areas the benthos were sampled twice in a month, selecting two points at random and laid 1x1 m^2 quadrates, in each quadrate six core samples were collected from a depth of 5 cm with a 20 cm^2 core sampler. Smaller samples were taken at the saltpans in order to reduce laboratory processing time and hence to increase the number of samples we could process. Previous studies on benthos had shown the benthic fauna to be extremely abundant and dominated by small animals, so only small cores were required to capture enough animals for analytical purposes. At most sites it would not have been possible to take considerably deeper cores, because the sediment in these saltpans is very hard due to saltpan activities so at least 10 cm deep at some sites were considered. However, benthic animals buried more than 5 cm below the surface are beyond the reach of the bill tips of the most common shorebird species (Red-necked Stint, bill length 16-22 mm; Curlew Sandpiper *Calidris ferruginea*, bill length 32-43 mm; and Sharp-tailed Sandpiper *Calidris acuminata*, bill length 22-27 mm; bill measurements from Higgins and Davies (1996). Moreover, observations on these species had shown that these species rarely probe deeply into the mud, usually taking prey from the top centimetre or so of the sediment (Loyn *et al.* 2002). The samples were filtered with 0.5, 0.3 and 0.1 mm sieves, and the organisms in them were counted and identified. Unidentified organisms were preserved in 95% alcohol, than they were brought to the laboratory for identification with standardized references.

Data analysis

Shorebird density was calculated as number per hectare for each area. Species richness was calculated by the number of shorebird species recorded in the salt pans (Verner 1985), and species diversity was calculated by using the Shannon-Wiener Index (H': Shannon and Wiener 1949). Individual bird density was calculated as number per hectare for each saltpan area in each month. Shorebirds were observed at all levels, including evaporation ponds. The General Linear Molde (GLM) was applied to the density of benthic organisms between months and saltpan areas. The GLM was also applied for the bird species between the months and saltpan areas. All the statistics were run by using SPSS. Results of the analyses were interpreted using standard statistical procedures (Sokal and Rohlf 1995).

RESULTS

Bird density

Totally 44 species water birds/shorebirds were recorded, in which the Little stint was the maximum density than the other species recorded in different saltpans from November 2012 to October 2013 (Table 1). Maximum bird density was recorded during the month of January 2013 and minimum density was noted during the month of October 2013 (Table 1 and Figure 2).

Benthic faunal density

Highest chironomid larvae density estimated during the month of November 2012 (364.1 ± 84.2 No./M^2) than the other months. The lowest density was noted during the month of March 2013 i.e. (88.7 ± 25.9 No./M^2) (Figure 3). The density of chironomid larvae showed significant difference among the months $P<0.05$.

Relationship between bird density and benthic organisms' density

The results of the present study showed that there was a positive relationship between the bird densities and benthic organism's density ($P<0.001$. Highest bird density noted during the month of November 2012 (6.18/Ha) and lowest during the month of April and June 2013 with the value of (0.04//Ha). Similarly in the case of benthic organisms showed the same trends i.e. highest density was noted for the month of November 2012 (381 No./M^2) and lowest during the month of April 2013 (101.2 No/M^2).

Table 1. Overall Density of waterbirds/ shorebirds (No./Ha.) recorded at Five different Salt Pans Kodikkarai, Tamilnadu, from November 2012 to October 2013 (Values are Mean±SD1).

S. No.	Species Name	Months 2012-2013								
		Nov-12	Jan-13	Feb-13	Mar-13	Apr-13	Jun-13	Aug-13	Sep-13	Oct-13
1	Common kingfisher	0.25 ± 0.06	0.25 ± 0.03	0	0	0	0	0	0	0
2	White breasted kingfisher	0.25 ± 0.06	0.62 ± 0.26	0	0	0	0	0	0	0
3	Pied kingfisher	9.7 ± 5.6	1.38 ± 0.56	0	0	0	0	0	0	0
4	Common redshank	125.0 ± 51.4	19.0 ± 11.25	0	0.60 ± 0.40	0	0	0	0	0
5	Broad bellied sandpiper	57.2 ± 14.25	0	0	0	0	0	0	0	0
6	Common greenshank	22.7 ± 10.5	10.5 ± 5.99	0	0	0	0	0	0	0
7	Common sandpiper	73.2 ± 34.5	33.75 ± 9.7	10.7 ± 9.20	1.40 ± 0.67	0	0	0	0	0
8	Curlew sandpiper	4.7 ± 2.9	3.0 ± 2.7	0	0	0	1.0 ± 0.25	5.2±0.9		
9	Dunlin	0	4.0 ± 2.62	0	0	0	0	0	0	0
10	Eurasian curlew	0	0	0	1.2 ± 0.24	0	0	0	0	0
11	Green sandpiper	26.0 ± 20.17	4.88 ± 2.51	0	0	0	0	0	0	0
12	Marsh sandpiper	54.5 ± 35.17	9.8 ± 4.24	0.71 ± 0.47	0	0	0	0	0	0
13	Little stint	457.2 ± 228.2	210.7 ± 57.05	166.2 ± 58.19	5.2 ± 2.13	0	0	0	0	0
14	Spotted redshank	7.50 ± 4.97	2.12 ± 1.28	0	0	0	0	0	0	0
15	Temminks stint	0	12.0 ± 8.46	14.1 ± 10.69	0	0	0	0	0	0
16	Tereck sandpiper	0	0.6 ± 0.07	0	0	0	0	0	0	0
17	Whimbrel	1.0 ± 0.25	0	0	0	0	0	0	0	0

S. No.	Species Name	Months 2012-2013								
		Nov-12	Jan-13	Feb-13	Mar-13	Apr-13	Jun-13	Aug-13	Sep-13	Oct-13
18	Wood sandpiper	14.25 ± 6.7	1.6 ± 1.10	0.29 ± 0.28	0	0	0	0	0	0
19	Common ringed plover	0	138.0 ± 0.73	0	0	0	0	3.12±0.32	0	0
20	Kentish plover	0	0	1.29 ± 0.18	0	0	0	0	0	0
21	Lesser sand plover	97.0 ± 90.13	0.62 ± 0.07	0	0	0.67 ± 0.66	2.0 ± 0.5	2.0 ± 0.5	2.0 ± 0.5	2.0 ± 0.5
22	Little ringed plover	132.0 ± 46.61	66.0 ± 18.56	32.2 ± 21.64	2.4 ± 0.81	1.0 ± 0.33	0	0	0	0
23	Pacific golden plover	0.50 ± 0.12	0	0	0	0	0	0	0	0
24	Redwattled lapwing	0	0.12 ± 0.01	0	0	0	0	0	0	0
25	Black0winged stilt	1.75 ± 1.18	5.87 ± 3.19	0	0	0.67 ± 0.66	0.5 ± 0.12	0.5 ± 0.12	0.5 ± 0.12	0.5 ± 0.12
26	Brown headed gull	0	2.0 ± 0.25	0	0	0	0	0	0	0
27	Heuglins gull	19.0 ± 14.81	13.5 ± 13.2	0	0	0	0	0	0	0
28	Yellow legged gull	0	19.3 ± 18.8	0	0	0	0	0	0	0
29	Caspian tern	6.0 ± 2.58	4.0 ± 1.68	1.29 ± 0.18	2.0 ± 1.09	0	0	0	0	0
30	Common tern	8.0 ± 4.88	0.75 ± 0.09	0	0	0	0	0	0	0
31	Gullbilled tern	4.7 ± 3.3	4.5 ± 3.17	0	0	0	0	0	0	0
32	Little tern	0	4.0 ± 1.36	0	0.2 ± 0.04	0	0	0	0	0
33	Whiskered tern	6.7 ± 4.02	4.6 ± 2.29	0.1 ± 0.01	2.8 ± 0.56	0	0	0	0	0
34	White bellied sea eagle	0	0.25 ± 0.16	0	0	0	0	0	0	0
35	Little cormorant	0	0.75 ± 0.41	0	0	0	0	3.0±0.75	0	0
36	Great egret	5.0 ± 2.4	1.7 ± 0.64	0	0	0	0	0	0	0
37	Intermediate egret	4.0 ± 3.08	2.2 ± 0.75	0	1.2 ± 0.24	0.3 ± 0.1	0	0.5 ± 0.12	0	0
38	Little egret	15.5 ± 9.91	8.12 ± 1.24	4.1 ± 2.85	6.4 ± 2.6	3.0 ± 1.0	2.5 ± 0.50	2.5 ± 0.50	6.2 ± 0.2	8.1 ± 0.20

S. No	Species Name	Months 2012-2013								
		Nov-12	Jan-13	Feb-13	Mar-13	Apr-13	Jun-13	Aug-13	Sep-13	Oct-13
34	White bellied sea eagle	0	0.25 ± 0.16	0	0	0	0	0	0	0
35	Little cormorant	0	0.75 ± 0.41	0	0	0	0	3.0±0.75	0	0
36	Great egret	5.0 ± 2.4	1.7 ± 0.64	0	0	0	0	0	0	0
34	White bellied sea eagle	0	0.25 ± 0.16	0	0	0	0	0	0	0
35	Little cormorant	0	0.75 ± 0.41	0	0	0	0	3.0±0.75	0	0
37	Intermediate egret	4.0 ± 3.08	2.2 ± 0.75	0	1.2 ± 0.24	0.3 ± 0.1	0	0.5 ± 0.12	0	0
38	Little egret	15.5 ± 9.91	8.12 ± 1.24	4.1 ± 2.85	6.4 ± 2.6	3.0 ± 1.0	2.5 ± 0.50	2.5 ± 0.50	6.2 ± 0.2	8.1 ± 0.20
39	Cattle egret	0	0.38 ± 0.26	0	0	0	0	3.0±0.15	0.9 ±01	0
40	Grey heron	0	0.25 ± 0.06	0	0	0	0	0	0	0
41	Indian pond heron	2.5 ± 1.89	1.8 ± 0.69	0	0	0.3 ± 0.1	0.25 ± 0.06	0.25 ± 0.06	0.25 ± 0.06	0.25 ± 0.06
42	Yellow bittern	0	0.13 ± 0.12	0	0	0	0	0	0	0
43	Greater flamingo	9.0 ± 2.25	1.5 ± 0.18	0	0	0	0	0	0	0
44	Painted stork	2.7 ± 1.60	2.6 ± 1.23	0.8 ± 0.11	3.8 ± 2.5	2.0 ± 0.67	0.5 ± 0.12	0	2.1±0.9	8.91±1.4

(0) indicates the absence of species.

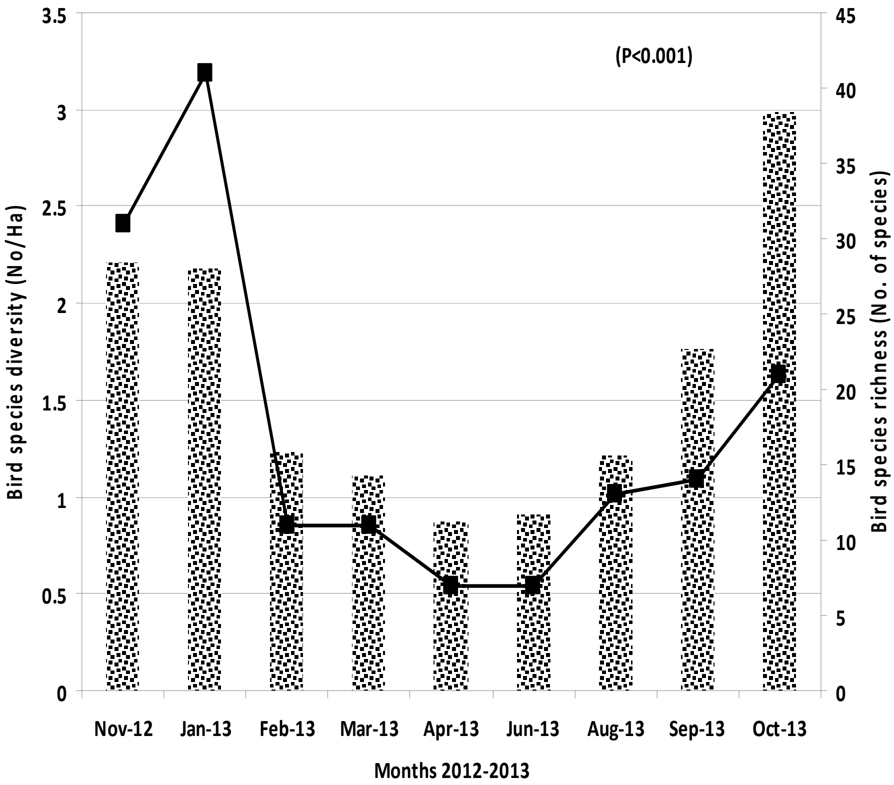

Figure 2. Waterbirds/shorebirds diversity (H') and bird species richness (No. of species), recorded from November 2012 and October 2013, Kodikkarai region, Tamilnadu, Southern India.

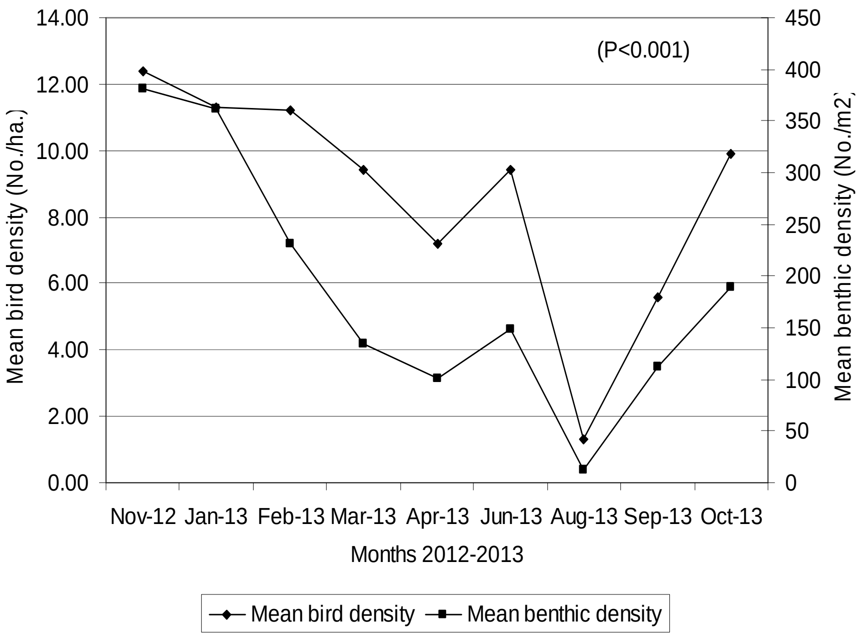

Figure 3. Mean waterbirds/shorebirds density (No./ha.) and benthic organism density (No/m^2), recorded from November 2012 and October 2013, Kodikkarai region, Tamilnadu, southern India.

DISCUSSION

As the winter progressed, significantly more shorebirds were observed using the saltpans, with the greatest densities being documented in January, 2013. The shorebirds' temporal proportion showed that winter was the migration season with more numerous shorebirds (Skewes, 2003). Certain shorebirds viz., Little Stint was the dominant species in our study. Highest density was observed during winter or monsoon season than the other season, probably because of better accessibility to food. Therefore it seems that during winter season supports the largest numbers of shorebirds during the southward migration. Shorebirds strongly depend on estuarine intertidal flats during migration and wintering periods and so are particularly vulnerable to such impacts, whose importance will depend on the availability of alternative feeding habitats (Goss-Custard *et al.*, 1977a). In addition to that the temporal changes in bird density also occur because of localized movements of shorebirds (Pienkowski and Evans 1984). Local movements may be synchronous with time factor, thus extending foraging time (Connor *et al.* 1980). Additionally, bird density can vary with daily movement of some species to feed in alternate fields (Townshend, 1981).

On the other hand the density and distribution of shorebirds in a wetland ecosystem during winter is purely depends on availability of prey density (Goss-Custard *et al.*, 1977a and Pandiyan, *et al.*, 2006). Due to the alteration of coastal ecosystem the waterbirds and shorebirds are shifting their feeding grounds into some other habitats such as saltpans (Rehfisch, 1994 and Pandiyan, *et al.*, 2010). The saltpans generate a higher availability of chironomid prey, and which provide a preferred habitat for waders/shorebirds. The extent to which a high production of chironomid larvae is translated into a good foraging habitat for shorebirds depends largely on appropriate management of water levels (Velasquez, 1992; Rehfisch, 1994). Shorebirds were dominated in our study than the other bird species studied in the saltpans. Smaller shorebird species are those that are most limited in the depth range where they can feed, and also those most dependent on alternative, artificial habitats such as saltpans since their low body mass and high metabolic rate requires them to feed practically all day round (Goss-Custard *et al*., 1977b; Fasola and Canova, 1993). We concluded that saltpans, can be used as an alternative habitat by larger species during winter and southward migration. We also reinforce the need to manage the saltpans as key habitats and vital ecosystem for shorebirds.

CONCLUSIONS

This study supports the idea that salt pans are valuable buffer wetlands habitat for migrating shorebirds as alternate feeding habitats. Salt pans will become more critical to shorebirds as natural feeding habitats progressively decrease on coastal wetlands. But we need a proper management of saltpans with well established coastal regulation zone act, which will save the coastal ecosystem. Finally we enforce that the Government should take some kind of responsibility to regulate the saltpans practices to sustain migratory shorebird population.

CONFLICT OF INTERESTS

The authors declare that there are no conflicts of interests associated with this article.

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