# Some Aspects of Feeding Ecology of the Lesser Sand Plover *Charadrius mongolus* in Three Different Zones in the Kadalundy Estuary, Kerala, South India

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**Abstract:** The study on feeding ecology of the Lesser Sand Plover (LSP) at Kadalundy estuary from July 2007 to December 2008, revealed that there were 13 species of crustaceans and 16 species of polychaete worms identified in the study area of which all identified small crab species(4 species) and polychaete worms (4 species) were consumed by LSPs. The highest number of crustacean species was found in mangroves (11 species). In contrast the highest species number of polychaete worms (13 species) was seen in the mudflats while no polychaete worm was identified in the sandy beds. Of the Crustaceans, *Sesarma quadrata* and *Ocypoda* sp. occurred in all the habitats. Sampling polychaete worms undertaken once a month showed that the number peaked at 39 in December 2008 in mudflats. Using direct observations once a week, the number of feeding birds was at its highest in December and January. Pearson correlation test showed significant relationship between the number of polychaete worms and feeding LSPs both at mudflats and mangroves ($p<0.05$) and the Scheffe univariate test (ANOVA) showed significant differences between the three habitat zones ($p<0.01$). The highest number of average total pecks at prey was seen at mudflats (82.1 in the morning and 128.0 in the afternoon). Out of 128 pecks, 61.6 were for crustaceans and 12.9 for polychaete worms.

***Keywords:*** Crabs, Kadalundy estuary, Lesser Sand Plover, Polychaete worm.

## INTRODUCTION

The diet of shorebirds consists of crustaceans, polychaete worms, insect larvae, aquatic insects, *etc.* (Smith 1991). Shorebirds detect prey by visual and tactile sensory mechanism exhibiting a wide range of feeding styles such as pecking, probing, stabbing, sweeping, and ploughing (Ntiamoa-Baidu *et al*. 1998). Plovers feed in the highly characteristic stop-run-peck manner, detecting prey visually rather than by touch (Pienkowski 1981, 1983).

Little is known about food and feeding ecology of the Lesser Sand Plover *Charadrius mongolus* (LSP hereafter), even in the Western Palearctic (Cramp & Simmons 1983, Monke & Seeling 2009).The breeding diet of this species includes many beetles, weevils, fly larvae, stalk worms and crabs. During the non-breeding season this species takes insects, crustaceans (such as crabs and amphipods), molluscs (particularly bivalves) and polychaete worms (del Hoyo *et al.* 1996 in BirdLife International 2009). The LSP forages either individually or in scattered flocks on wet intertidal flats, usually away from the water's edge (Smith 1991). They prefer to forage on tidal mudflats, particularly in the soft mud between the tides. But they may also forage on drier mud banks. They are rarely found far inland (Tan 2001). The present study was undertaken to determine the possible prey species and foraging pattern of this species in Kadalundy estuary in order to conserve its prey species and study area.

## METHODS

The Kadalundy estuary, the confluence of Kadalundy River with the Arabian Sea in the northern Malabar coast, is one of the major wintering grounds for shorebirds and seabirds in Kerala, India. Kadalundy River is one among the 41 west flowing rivers of Kerala state. Twenty of the rivers flow directly into Lakshadweep Sea forming estuaries while the rest empty into backwaters (Sashikumar & Palot 1996). The Kadalundy River at its drainage point forms the

Kadalundy estuary that drains into the Arabian Sea. This estuary is located in Tirur Taluk of Malappuram district of Kerala and comes under the Vallikunnu Panchayat (14°49'36" &11°8'28"N and 75°49'36" & 75°51'20"E). Three square kilometres of this estuary is surrounded by hillocks. It was declared as a community wetland reserve area in 2008. On the western side of the railway track, about 8 hectares of mudflats are exposed during low tide when the water level between the busy railway line and the sea mouth recedes, which attracts many birds to the wetland. *Avicennia officinalis, A.marina, Rhizophora mucronata, Kandelia candel, Brugeria cylindrica, Acanthus ilicifolius* and *Exocecaria agallocha* are the major mangrove species found in this wetland (Radhakrishnan *etal.*2006).

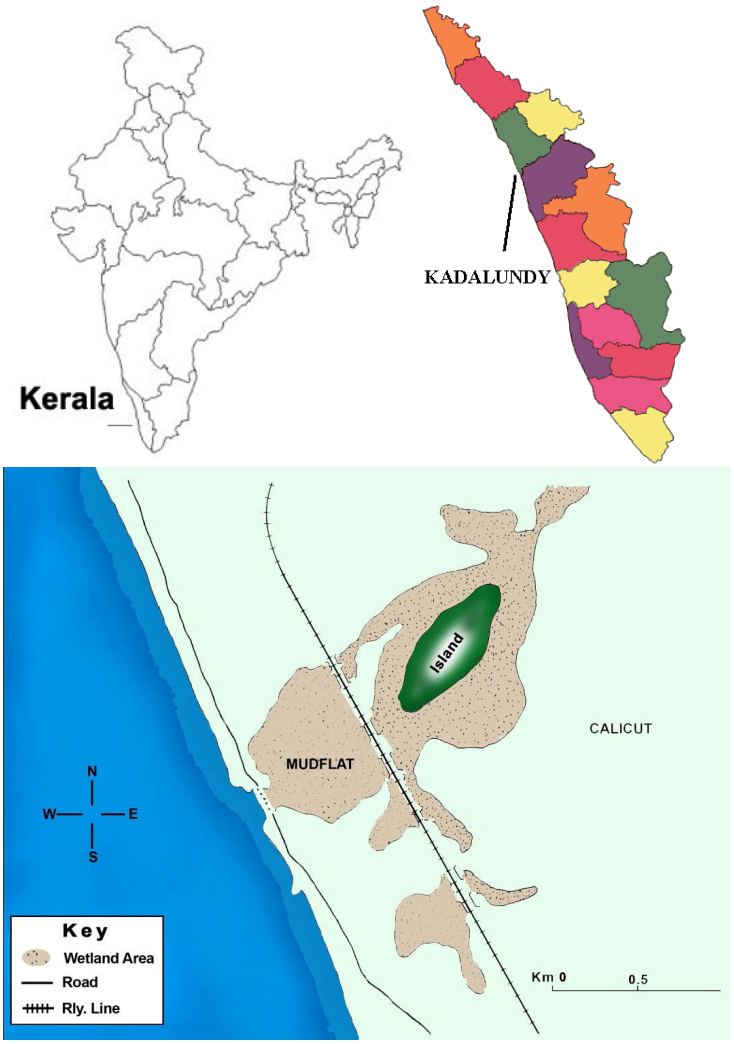


**Figure 1.** Schematic map of the study area at Kadalundy Estuary.

This study was conducted at Kadalundy estuary during an 18-month period between July 2007 and December 2008. The study area was visited once a week. The study area was divided into three scanning sectors (mudflats, mangrove and sandy zone). The mudflats, mangroves and sandy areas were 4.05 ha, 1.21 ha and 0.20 ha, respectively but the area selected for observations was mainly on the basis of concentration of migratory birds for feeding, preening and resting activities, and covered about 1.21 ha of mudflats, 0.61 ha of mangroves and 0.20 ha of sandy areas.

Bird counts were taken by both the direct count method and the block count method (Howes & Bakewell 1989) with a binocular (10×50).

Foraging behaviour was studied one day a week. On each sampling day two visits to the three habitats were undertaken starting 6:00 and 15:00 hours. On each visit, five minutes of observation and five minutes of break time were spent. Eight samples of each habitat were taken per month. Total monthly observation time can hence be calculated as:

Sampling days per month × samples per day × number of habitats × observation time: 4×2×5×3= 120 minutes/month.

In the field, feeding rate was calculated by counting number of successful pecks for capturing polychaete worms and crustaceans (modified after Khomenko 2003). Photographs were taken of prey when caught by the birds. Statistical analyses were done using the SPSS 16 program.

During each visit the temperature of air and water was recorded early in the morning (06:00 am) and during afternoon (03:30 pm) using a digital thermometer. Salinity of water was measured once a month by using Digital Salinity Meter (Basic Con / TDS / Salinity - Orion company, 115 A+ Thermo Electron Corporation) during the course of the mud sampling work.

Once a month, on low tide, five soil samples were collected from each habitat, using a 10cm-diameter metal cylinder that was plunged to a depth of 15 cm into the substrate. Samples were taken close to observation sites for foraging behaviour and chosen where there was a higher concentration of Plover excretions. The mud samples collected were washed and filtered through a sieve with 0.5 mm mesh. All organisms obtained were sorted to order and transferred to separate bottles containing 1% formalin (Wei & Chen 1991). The specimens and their photographs were identified with the help of experts. All the specimens are deposited in the General Zoology Museum at the University of Calicut, Kerala.

## RESULTS

One of the attractions of Kadalundy estuary is the Lesser Sand Plover (LSP), which is also the most abundant of the shorebird species especially during post-monsoon season (Fig. 2). Large congregations of actively feeding LSPs were found in the mudflats as well as near mangroves. LSPs were usually seen feeding in the shallow waters of mudflats along with Bar-tailed Godwit *Limosa lapponica*, Whimbrel *Numenius phaeopus*, Little Stint *Calidris minuta*, Terek Sandpiper *Xenus cinereus*, Kentish Plover *Charadrius alexandrinus*, Greater Sand Plover *Charadrius leschenaultii*, Sanderling *Calidris alba*, Pacific Golden Plover *Pluvialis fulva*, Common Redshank *Tringa totanus*, Common Greenshank *Tringa nebularia*, Curlew Sandpiper *Calidris ferruginea*, Ruddy Turnstone *Arenaria interpres* and Black-winged Stilt *Himantopus himantopus*.

The invertebrate fauna in the Kadalundy Estuary is dominated mainly by polychaete worms and crustaceans. A total of 16 species of polychaete worms and 13 species of crustaceans were identified in the three different zones of the study area (Table 1).The highest number of crustacean species was found in mangroves (11 species) followed by mudflats (9 species) and the lowest in the sandy habitat (5 species). Of the crustaceans, *Sesarma quadrata* and *Ocypoda* sp. occurred in all the habitats. In contrast the highest species number of polychaete worms was recorded in the mudflats (13 polychaete species) followed by mangroves (10 polychaete species), while no polychaete worm was identified in the sandy beds. Of the polychaete worms sampled, *Dendronereis aestuarina*, *D. arborifera*, *Ancystrrosyllis constitrica, Glycera alba*, *G. convoluta, G. longipinnis* and *Paraheteromastus tenuis* were found both in the mudflats and mangroves.

**Table 1.** Occurrence of crabs and polychaete worms in the Kadalundy Estuary during August 2007 to December 2008. += occurred, -= not occurred.

| Species | Mudflats | Mangroves | Sandy |
|---|---|---|---|
| **CRUSTACEAN** | | | |
| **Small crabs** | | | |
| *Sesarma quadrata* | + | + | + |
| *Uca annulipes* | - | + | + |
| *Dotilla myctiroides* | + | + | - |
| *Dotilla malabaricus* | + | + | - |
| *Metapograpsus messor* | - | + | - |
| *Ocypoda* sp. | + | + | + |
| **Large crabs** | | | |
| *Uca marionis* | - | - | + |
| *Metapograpsus maculatus* | - | - | + |
| **Prawns** | | | |
| *Penaeus indicus* | + | + | - |
| *Penaeus caniculatus* | + | + | - |
| *Metapenaeus monocerous* | + | + | - |
| *Metapenaeus dobsoni* | + | + | - |
| *Macrobrachium rosenbergii* | + | + | - |
| **TOTAL crustaceans** | **9** | **11** | **5** |
| | | | |
| **POLYCHAETE WORMS** | | | |
| *Perinereis cavifrons* | + | - | - |
| *Perinereis nuntia* | + | - | - |
| *Perinereis vancurica* | + | - | - |
| *Nereis chilikensis* | + | - | - |
| *Nereis capensis* | + | - | - |
| *Nereis cricognatha* | + | - | - |
| *Dendronereis aestuarina* | + | + | - |
| *Dendronereis arborifera* | + | + | - |
| *Ancystrrosyllis constitrica* | + | + | - |
| *Marphysa gravelyi* | - | + | - |
| *Marphysa macintoshi* | - | + | - |
| *Marphysa stagulum* | - | + | - |
| *Glycera alba* | + | + | - |
| *Glycera convoluta* | + | + | - |
| *Glycera longipinnis* | + | + | - |
| *Paraheteromastus tenuis* | + | + | - |
| **Total Polychaete worms** | **13** | **10** | **0** |

Identified invertebrate prey in the diet of the LSP were small size crustacean species (namely *Dotilla malabaricus, D. myctiroides, Uca annulipes* and *Sesarma quadrata*) and polychaete worms (namely *Marphysa gravelyi*, *Nereis chilikensis*, *N. capensis* and *Perinereis cavifrons*). However the number of polychaete worms had fluctuated over the study period with an increase in October and a peak in December in mudflats. This number then decreases steadily by May (Table 2). This trend was similar to the number of feeding LSPs at both air temperatures measured (Table 3).

Using direct observations, the number of LSPs feeding was lowest in May and highest in December and January (Figs. 2–4). Between December and February, LSPs showed intensive feeding on mudflats and near mangroves. The mornings appeared to be the preferred feeding time (coincides mostly with lower air temperature). The Scheffe univariate test (one-way ANOVA) showed significant difference between the Number of polychaete worms in the different study zones ($p$<0.01).Pearson correlation test showed significant relationship between the number of polychaete worms and feeding LSPs both at mudflats and mangroves (for mudflats, $r$=0.697 at minimum temperature ($p$<0.01) and $r$=0.469 at maximum temperature ($p$<0.05); for mangroves, $r$=0.911 at minimum temperature and $r$=0.592 at maximum temperature ($p$<0.01 for both). There was also a significant relationship between the number of polychaetes and the salinity of water ($r$= 0.716, $N$=18, $p$<0.01). However no significant relationship could be found between polychaete numbers and water temperature ($r$=0.232, N=18, $p$>0.05).

Although all the three habitats of mudflats, mangroves and sand flats form the feeding grounds for LSPs, the highest number of peck at prey was seen at mudflats (82.1 in the morning and 128.0 in the afternoon; Fig. 3). The mangrove area was as the second preferred feeding ground with average peck numbers of 54.4 in the morning and 86.4 in the afternoon, respectively (Table 4).

Regarding the number of pecks at crabs, in mudflats there was 61.6 pecks in the afternoon and 37.2 pecks in the morning whereas in mangroves, 26.8 pecks in the morning and 36.9 pecks in the afternoon (Table 4). Also a similar pattern was found for peck numbers at polychaete worms, ranging from 7.8 in the morning and 12.9 at afternoon in mudflats, and similarly 6.0 pecks in the morning and 10.8 pecks in the afternoon in mangroves.

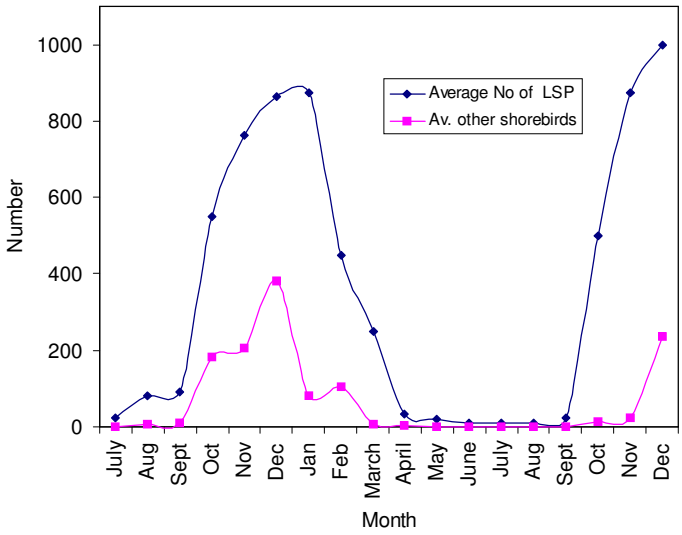


**Figure 2.** Relative abundance of LSP against other migratory shorebirds at Kadalundy estuary (July 2007 – Dec 2008).

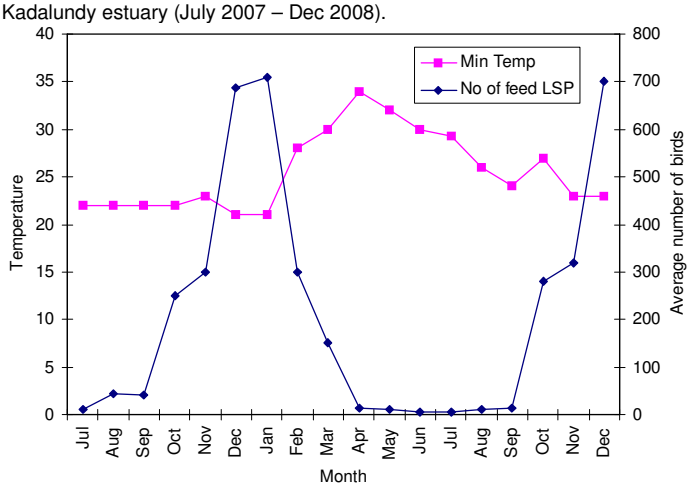


**Figure 3.** Number of feeding birds (through direct observation and block observation) at minimum temperature at Kadalundy estuary once a week and two times per day in the mornings between July 2007 and December 2008.

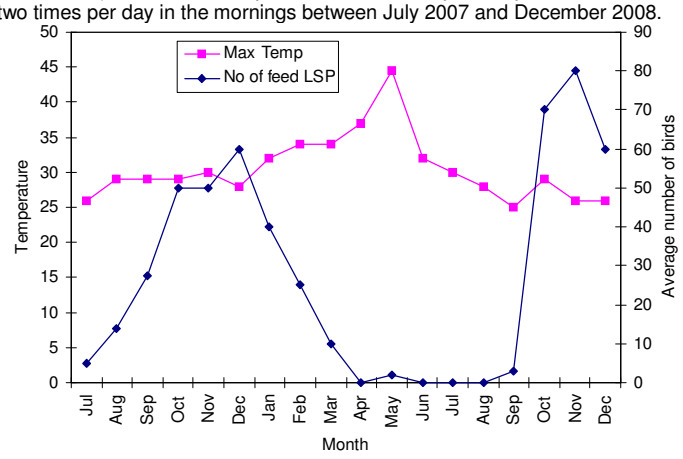


**Figure 4.** Number of birds at maximum temperature at Kadalundy Estuary between July 2007 and December 2008.

**Table 2.** Number of polychaete worms obtained once a month in the different study zones from July 2007 to December 2008.

| Months | Mudflats | Mangroves | Sandy | Total no. of polychaetes |
|---|---|---|---|---|
| **July 07** | 1 | 1 | 0 | 2 |
| **Aug 07** | 1 | 1 | 0 | 2 |
| **Sep 07** | 2 | 4 | 0 | 6 |
| **Oct 07** | 12 | 6 | 0 | 18 |
| **Nov 07** | 16 | 13 | 0 | 32 |
| **Dec 07** | 32 | 26 | 0 | 58 |
| **Jan 08** | 31 | 22 | 0 | 53 |
| **Feb 08** | 24 | 18 | 0 | 42 |
| **Mar 08** | 20 | 8 | 0 | 28 |
| **Apr 08** | 14 | 18 | 0 | 32 |
| **May 08** | 10 | 16 | 0 | 26 |
| **Jun 08** | 2 | 3 | 0 | 5 |
| **July 08** | 4 | 3 | 0 | 7 |
| **Aug 08** | 0 | 5 | 0 | 5 |
| **Sep 08** | 6 | 2 | 0 | 8 |
| **Oct 08** | 17 | 11 | 0 | 28 |
| **Nov 08** | 13 | 15 | 0 | 28 |
| **Dec 08** | 39 | 12 | 0 | 51 |

**Table 3.** Environmental parameters once a month in the different study zones from July 2007 to December 2008.

| Months | Salinity (ppt) | Water Temp. (°C) | Min. air temp. | Max. air temp. | No. of feeding LSPs at min. air temp. | No. of feeding LSP s at max. air temp. |
|---|---|---|---|---|---|---|
| **July 07** | 1.23 | 28.7 | 22 | 26 | 10 | 5 |
| **Aug 07** | 1.05 | 29.3 | 22 | 29 | 45 | 14 |
| **Sep 07** | 0.87 | 28.4 | 22 | 29 | 40 | 27 |
| **Oct 07** | 1.78 | 29.3 | 22 | 29 | 250 | 50 |
| **Nov 07** | 16.58 | 30 | 23 | 30 | 300 | 50 |
| **Dec 07** | 17.96 | 30 | 21 | 28 | 687 | 60 |
| **Jan 08** | 27.85 | 30.2 | 21 | 32 | 710 | 40 |
| **Feb 08** | 28.64 | 32.2 | 28 | 34 | 300 | 25 |
| **Mar 08** | 30.62 | 34.1 | 30 | 34 | 150 | 10 |
| **Apr 08** | 32.45 | 35.1 | 34 | 37 | 12 | 0 |
| **May 08** | 34.45 | 38 | 32 | 44.4 | 10 | 2 |
| **Jun 08** | 1.87 | 30 | 30 | 32 | 5 | 0 |
| **July 08** | 1.23 | 29 | 29.3 | 30 | 5 | 0 |
| **Aug 08** | 1.22 | 29 | 26 | 28 | 10 | 0 |
| **Sep 08** | 0.86 | 28 | 24 | 25 | 15 | 3 |
| **Oct 08** | 1.72 | 28 | 27 | 29 | 280 | 70 |
| **Nov 08** | 17.33 | 29 | 23 | 26 | 320 | 80 |
| **Dec 08** | 19.44 | 30 | 23 | 26 | 700 | 60 |

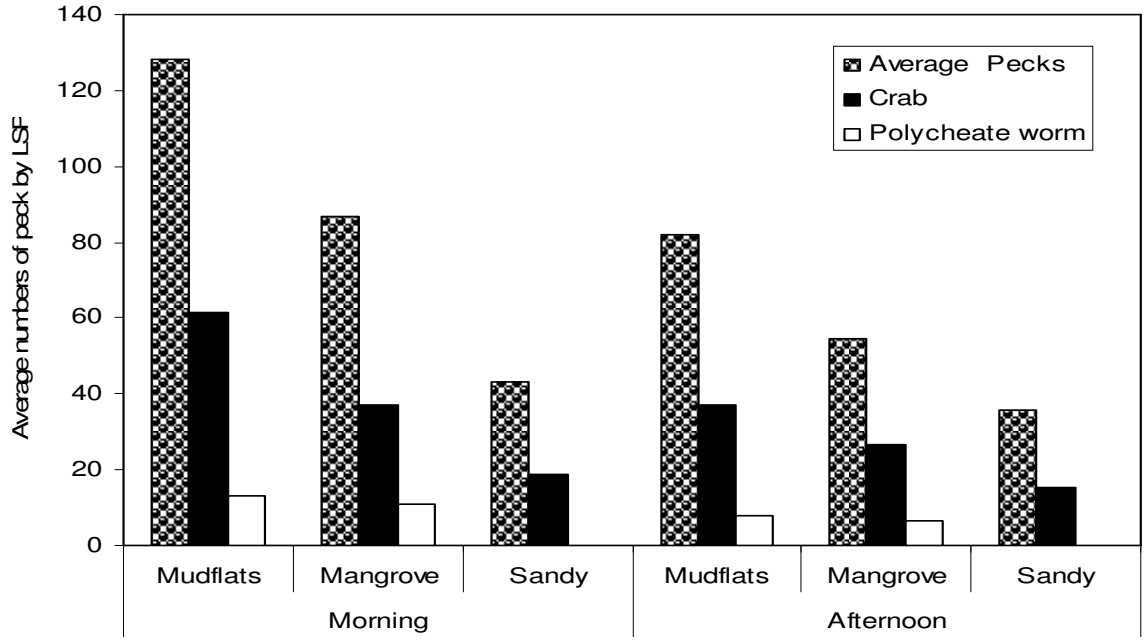


**Figure 5.** Comparison of average number of pecks made by LSP between the mornings (06:00 am) and afternoons (03:30 pm). in various habitats

**Table 4.** Average peck number at two main invertebrate taxa in field observations in the three different habitats.

| MONTHS | MANGROVE | | | MUDFLAT | | | SANDY | | | TOTAL | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Average total pecks | Average no. of crabs consumed by LSP | Average no. of polychaete worms consumed by LSP | Average total pecks | Average no. of crabs consumed by LSP | Average no. of polychaete worms consumed by LSP | Average total pecks | Average no. of crabs consumed by LSP | Average no. of polychaete worms consumed by LSP | Average total pecks | Average no. of crabs consumed by LSP | Average no. of polychaete worms consumed by LSP |
| | **Morning (per 5 minutes)** | | | | | | | | | | | |
| July 07 | 70.8 | 31.3 | 7 | 107.8 | 37.3 | 10.75 | 53.7 | 17.5 | 0 | 232.3 | 86.1 | 17.7 |
| Aug 07 | 82.3 | 29.5 | 2.5 | 72 | 30.5 | 5 | 47 | 13 | 0 | 201.3 | 73 | 7.5 |
| Sep 07 | 66 | 33 | 6.75 | 119.3 | 50.5 | 9.5 | 43.7 | 20 | 0 | 229 | 103.5 | 16.2 |
| Oct 07 | 68 | 36 | 7.5 | 120 | 52.5 | 8.5 | 40 | 20 | 0 | 228 | 108.5 | 16 |
| Nov 07 | 70 | 38 | 7.5 | 120 | 60.5 | 8.5 | 40 | 10 | 0 | 230 | 108.5 | 16 |
| Dec 07 | 100 | 62 | 20 | 150 | 76 | 15 | 70 | 40 | 0 | 320 | 178 | 35 |
| Jan 08 | 160 | 85 | 10 | 165 | 80 | 15 | 110 | 60 | 0 | 435 | 225 | 25 |
| Feb 08 | 70 | 20 | 10 | 160 | 90 | 30 | 40 | 10 | 0 | 270 | 120 | 40 |
| Mar 08 | 15 | 2 | 2 | 50 | 10 | 2 | 10 | 2 | 0 | 75 | 14 | 4 |
| Apr 08 | 5 | 2 | 1 | 5 | 2 | 1 | 5 | 1 | 0 | 15 | 5 | 2 |
| May 08 | 5 | 2 | 1 | 10 | 5 | 1 | 5 | 2 | 0 | 20 | 9 | 2 |
| Jun 08 | 5 | 1 | 0 | 5 | 1 | 0 | 5 | 1 | 0 | 15 | 3 | 0 |
| July 08 | 10 | 3 | 0 | 10 | 3 | 0 | 15 | 5 | 0 | 35 | 11 | 0 |
| Aug 08 | 5 | 1 | 0 | 5 | 1 | 0 | 5 | 1 | 0 | 15 | 3 | 0 |
| Sep 08 | 10 | 3 | 4 | 19 | 5 | 2 | 4 | 2 | 0 | 33 | 10 | 6 |
| Oct 08 | 68 | 36 | 8 | 130 | 55 | 9 | 40 | 20 | 0 | 238 | 111 | 17 |
| Nov 08 | 70 | 38 | 7.5 | 100 | 60 | 8 | 40 | 10 | 0 | 210 | 108 | 15.5 |
| Dec 08 | 100 | 60 | 20 | 130 | 50 | 15 | 70 | 40 | 0 | 300 | 150 | 35 |
| **Monthly Average** | **54.5** | **26.8** | **6.4** | **82.1** | **37.2** | **7.8** | **35.7** | **15.3** | **0** | 172.3 | 79.3 | 14.2 |
| | **Afternoon (per 5 minutes)** | | | | | | | | | | | |
| July 07 | 66.8 | 19.8 | 2.3 | 84.3 | 34.3 | 6.5 | 58.5 | 9.8 | 0 | 209.6 | 63.9 | 8.8 |
| Aug 07 | 84.5 | 29 | 5.5 | 95.5 | 38.8 | 11 | 61.8 | 23 | 0 | 241.8 | 90.8 | 16.5 |
| Sep 07 | 111 | 41.3 | 9.3 | 145.5 | 58 | 9 | 49 | 13.5 | 0 | 305.5 | 112.8 | 18.3 |
| Oct 07 | 115 | 44.5 | 9.5 | 160 | 62.5 | 9.3 | 48 | 40 | 0 | 323 | 147 | 18.8 |
| Nov 07 | 160 | 80 | 30 | 165 | 62 | 10.5 | 51 | 30 | 0 | 376 | 172 | 40.5 |
| Dec 07 | 210 | 96 | 35 | 260 | 160 | 30 | 70 | 30 | 0 | 540 | 286 | 65 |
| Jan 08 | 200 | 100 | 35 | 340 | 185 | 45 | 115 | 53 | 0 | 655 | 338 | 80 |
| Feb 08 | 80 | 30 | 10 | 330 | 180 | 40 | 100 | 10 | 0 | 510 | 220 | 50 |
| Mar 08 | 5 | 1 | 1 | 100 | 30 | 15 | 20 | 8 | 0 | 125 | 39 | 16 |
| Apr 08 | 10 | 2 | 1 | 10 | 2 | 2 | 5 | 1 | 0 | 25 | 5 | 3 |
| May 08 | 10 | 2 | 0 | 10 | 3 | 1 | 5 | 1 | 0 | 25 | 6 | 1 |
| Jun 08 | 10 | 5 | 0 | 5 | 1 | 0 | 5 | 1 | 0 | 20 | 7 | 0 |
| July 08 | 10 | 2 | 1 | 14 | 4 | 0 | 10 | 5 | 0 | 34 | 11 | 1 |
| Aug 08 | 11 | 4.5 | 2.5 | 5 | 2 | 0 | 5 | 1 | 0 | 21 | 7.5 | 2.5 |
| Sep 08 | 100 | 40 | 7 | 10 | 4 | 2 | 12 | 1.5 | 0 | 122 | 45.5 | 9 |
| Oct 08 | 115 | 44 | 8 | 140 | 60 | 10 | 50 | 40 | 0 | 305 | 144 | 18 |
| Nov 08 | 150 | 80 | 30 | 160 | 52 | 10.5 | 50 | 30 | 0 | 360 | 162 | 40.5 |
| Dec 08 | 111.3 | 43.8 | 7.5 | 270 | 170 | 30 | 60 | 40 | 0 | 441.3 | 253.8 | 37.5 |
| **Monthly Average** | **86.6** | **36.9** | **10.81** | **128.0** | **61.6** | **12.9** | **43.1** | **18.8** | **0** | 257.7 | 117.3 | 23.7 |

**Figure 6.** Two of most consumed prey crab species by LSPs at Kadalundy Estuary: *Dotilla myctiroides* (left) and *Dotilla malabaricus* (right).

**Figure 7.** Deep feeding of LSP at Kadalundy estuary.

## DISCUSSION

The main groups of invertebrate fauna at Kadalundy are crustaceans and polychaete worms. These were present mainly in the mudflats and near mangroves, and were preferred habitats for LSP. Polychaete worms were entirely absent in sandy area. This fact might suggest a reason why birds feed less in the sandy zone compared to the other zones. LSPs mainly preferred two species of crabs (*Dotilla myctiroides*, *D. malabaricus* (Fig. 6)) than other species, probably due to their smaller carapace size (less than 8 mm), which agrees with the observations made by Kai Jing *et al*. (2006) during their studies on foraging shorebirds. In winter quarters, LSPs have taken, marine worms, and molluscs whereas in breeding season they fed on beetles, fly larvae, scorpion-fly and some plant seeds (Cramp & Simmons 1983).

LSPs are considered to be surface feeders, *i.e.* penetrating the surface by less than one quarter of the bill length (Kai Jing *et al*. 2006). But in Kadalundy, deep feeding was also observed, *i.e.* birds were seen to plunge their entire beak into the muddy substrate (Fig. 7). In LSPs, pecking and probing are the main methods for visual and tactile foraging respectively. A similar observation was made by Baker & Baker (1973) during their study on shorebirds especially plovers. LSPs walked slower when feeding on worms, and only made quick short runs when feeding on crabs and other prey species, which is similar to what has been observed in Common Redshank (Speakman & Bryant 1993). But Marchant & Higgins (1993) have made no distinction in feeding behaviour and just mentioned that plovers always make short, quick runs, with abrupt stops to lunge at the ground or to look for prey.

In coastal areas, the feeding cycle of shorebirds is highly influenced by tidal cycles. The amount of available feeding space fluctuates with tidal rhythm. When the mudflats are exposed to feeding during the low tide, the feeding rate is high which then gradually gets reduced, probably due to the fluctuation of prey species. During the hot hours of the day, most of the LSPs were seen resting on the sandy beds. Uthaman & Namasivayan (1991) have made similar observations on gulls and terns in Kadalundy. The feeding behavior of LSP in our study may be due to the decrease in the number of prey species at the surface when they bury due to moving to deeper areas at higher temperatures. Large crab species, such as *Metapograpsus maculates* (*c.* 21 mm carapace length) and *Uca marionis* found in the sandy area, were not fed upon by LSP, but curlew species were seen feeding on them. This observation is supported by Kai Jing *et al*. (2006). LSPs form huge congregations near mangroves frequently, even during high tide in the post- monsoon season, perhaps due to rich availability of crab species *viz. Metapograpsus messor* (seen only in mangrove habitat) and *S. quadrata*.

The preference for mudflats and mangroves in the study area by LSP may be due to prey detectability as well. Prey species can be easily detected there than in harder sandier substrates. Mouritsen & Jensen (1992) demonstrated that sediment penetrability improves probability of detecting buried prey in Dunlins *Calidris alpina*.

## CONCLUSION

The results have revealed some of the possible prey species and the foraging strategies of the Lesser Sand Plover, which may help in better management of the preys in order to maintain

Kadalundy estuary as a stopover site for migrating and wintering shorebird species. Conservation of mudflats also helps to conserve the all prey species which indirectly conserve all migratory shorebirds. Human disturbance, sewage disposal, illegal sand mining, House Crow disturbance, coastal Highway Bridge, chasing by Jackals and Brahminy Kites are major threats for migratory shorebirds. Of these, illegal sand mining is the main threat for prey species of the LSP and other shorebirds. As Kadalundy is an important stopover for birds migrating through the west coast of India (Uthaman & Namashivayam 1991), all these problems are threatening factors for the migratory birds, a situation predicted to worsen in the near future. Waste dumping is the main problem in the mudflats a preferred habitat of LSPs and raising awareness among the locals is solution for this habitat.

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