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Bombay Natural History Society

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Monitoring and Mitigating the Impacts of Mumbai Trans-Harbour Link on Flamingos and Other Avifauna and Formulating a Conservation Blueprint for the Sewri–Nhava Seascape

October 2017 to September 2018

First Year Report



BOMBAY NATURAL HISTORY SOCIETY
2018

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First Year Report

**Submitted to
Mangrove and Marine Biodiversity Conservation Foundation of
Maharashtra**

Submitted by



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**BOMBAY NATURAL HISTORY SOCIETY
2018**

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1. Introduction

Mumbai is located in the Konkan Plains of the northern Western Ghats. Due to its key geographic position and abundant natural resources, Mumbai has always been a centre of development since the colonial period. It is the financial capital of the nation, and the ninth most populous city in the world, with the current population at 26.6 million (UN 2012). The Mumbai Metropolitan Region Development Authority (MMRDA), the planning authority for Mumbai Metropolitan Region (MMR), has predicted in its 40-year concept plan that the city would have 44 million inhabitants spread over 1050 sq. km by 2052, which is almost double the present area 603 sq. km (Kamdar 2014). This means there will be tremendous pressure on the already shrunken natural habitats, especially mangroves, coastal mudflats and remnant patches of the natural forests, which will eventually impact the biodiversity (Nagendra et al. 2012). Given the coastal features of the city, the disappearance of the mangroves and mudflats may leave the city not only vulnerable to local environmental issues such as floods, toxic run offs, siltation and reduction in the ground water, but also to global disasters such as cyclone, tsunamis and sea level rise due to global climate change (Kleppel et al. 2006).

Alongside the environmental concerns Mumbai also faces the inevitable need for development. The Mumbai Trans Harbour Link (MTHL), the 22-km bridge connecting Southern Mumbai (at Sewri) with Southern Navi Mumbai (at Nhava Sheva), is one such developmental project that is set to bring Mumbai closer to its satellite city. The alignment passes over Sewri Mudflat, which is a home to a wide variety of bird species, including migratory, and is identified as an Important Bird Area (IBA) by the Indian Bird Conservation Network (IBCN, Rahmani et al. 2016). In addition, Thane Creek up to Vashi has been declared as the Thane Creek Flamingo Sanctuary in 2018. The intertidal mudflats in the creek harbour a large population of waterbirds including ducks, waders and 12–15% of the south Asian population of Lesser Flamingo *Pheonicopterus minor*, a Near Threatened species (Vijayan et al. 2008).

Habitats along this Indian coast such as creeks, mangroves, mudflats, salt marshes and wetlands harbour rich coastal and marine biodiversity. This western coast is also considered as the main wintering grounds for the waders migrating from Central or South Asia (Balachandran 2006). The MTHL project is likely to affect waterbirds of Sewri Mudflat, Thane Creek and wetlands of Navi Mumbai. Hence, MMRDA has approached BNHS to monitor/ the impacts of the bridge on flamingos and other avifauna and marine fauna, and suggest mitigation plan for the conservation of waterbirds and their habitats.

The duration of study is 10 years (2017–2027). The target taxa of examination are water birds and marine benthic fauna. In the first year of the study (October 2017 – September 2018), we focused on standardizing different quantitative methods used for the estimation of waterbirds and marine faunal abundance. Our goals for the first year were as follows:

1. To standardize wetland count surveys (WCS) for estimating abundance of birds in high tide roosting sites (wetlands).
2. To standardize transect count surveys (TCS) for estimating abundance of birds in the creek.
3. To standardize flamingo count surveys (FCS) for estimating flamingos in the creek.
4. To standardize estimation of richness and abundance and biomass of benthos in the different strata of the mudflats associated with wader species with varied beak sizes.
5. To standardize estimation of richness and abundance of planktons.

In addition to this we also carried out exploratory and pilot studies such as assessing the potential impact of bridge using behavioural studies, heavy metals deposition in the creek, and bird ringing at Panje Wetland.

2. Methodology

2.1. Study area

The study area includes Sewari region Thane Creek and wetlands (high tide roosts) in Navi Mumbai and Uran (Fig.1). Seven wetlands and mudflats of Thane Creek and Sewri were surveyed during the study. The Creek and the mudflats were divided into 40 transects and sampled for quantification of birds and marine fauna (for details of the study , please refer to chapter 2, section 2.1, Apte et al. 2018).

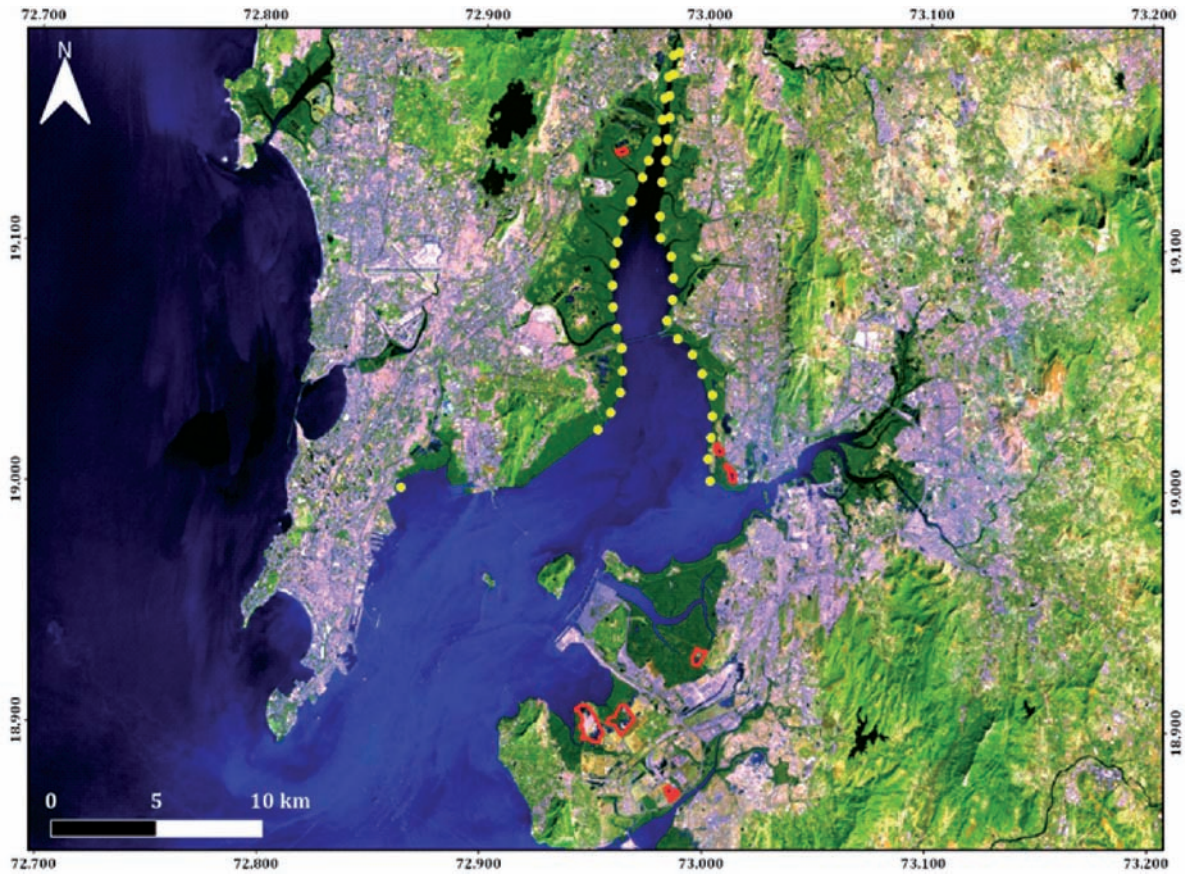


Fig.1. Land use and land cover map of study area developed using Landsat 8 satellite imagery

Land use and land cover map of study area was developed using Landsat 8 satellite imagery (January 2018; band combinations = 7, 5 and 3). Wetlands are highlighted with red polygons and the transects are with yellow circles. Forest and mangroves appear in shades of green, the darker colour indicates healthy and dense vegetation; urban areas are marked with cyan or purple; and soil markings vary from dark to light brown; moist soils are darker in colour.

2.2 Bird sampling

2.2.1. Bird counts

We used total count method for sampling birds (Bibby et al. 1998) and adopted different sampling strategies for creeks, wetlands and flamingos, viz., wetland count surveys (WCS), transect count surveys (TCS) and flamingo count surveys (FCS).

Wetland count surveys (WCS): In wetland count surveys, the observer(s) counted the species and number of individual of birds in wetlands observed two hours before and two hours after high tide. WCS were carried out during high tide when birds came out of the creek due to inundation of mudflats, in search of roosting sites.

Transect count surveys (TCS): In transect count surveys (TCS), the observer(s) counted the birds seen in 1-km transects from hand-rowed boat. TCS were conducted during low tide when the birds fed on the exposed mudflats.

Flamingo count surveys (FCS): Almost the entire stretches of Thane Creek and Sewri Mudflat were surveyed by multiple teams of researchers and assistants in hand-rowed boats to count Lesser and Greater Flamingos in one day. FCS were conducted on two consecutive days to increase reliability of the counts.

Bird sampling was carried out between February to September 2018. Wetlands were visited twice in a month, while the creek was surveyed twice from March to May 2018.

2.2.2 Bird behaviour

We conducted pilot surveys using scan and focal animal sampling (Altmann 1973) to explore the feeding behaviour of waterbirds, particularly flamingos, in response to existing and potential disturbances. In scan animal sampling, the entire flock was monitored for a minute at an interval of 15 minutes, and in focal animal sampling, the particular individual was followed in order to record its behaviour. In focal animal sampling, we made videos of 2 minute duration each of small groups of birds, and selected random individuals from the video to enlist the types of behaviour and the time they spent engaged in a particular behaviour, for the purpose of computing time budget.

2.2.3 Bird ringing

Bird ringing was conducted from August 29, 2018 to September 24, 2018 at Panje Wetland, a high tide roosting site. We used 3 wader nets (size 11.5 cm; dimensions 2m × 100m) and 2000 noose traps to capture birds for ringing. Two to three nets were deployed considering the water depth, wind direction and movement of the waders. Birds were extracted from the traps by experienced trappers and then ringed by experienced ringers in order to minimise stress and injury to birds. We followed the Indian Bird Banding Manual (Balachandran 2002) for ringing and recording the morphology and morphometry of the waders.

2.3 Benthos sampling

We sampled each transect for benthic fauna. A transect was divided into three zones (A, B and C) to examine the vertical distribution of the macrobenthic community in the intertidal zone. Our main focus for sampling the benthos was to explore its quantitative relationship with bird abundance and their feeding niche segregation. Hence, we adopted a cylindrical core, divided into 5 strata according to beak length of waders (2, 4, 8, 11, 15cm) to estimate vertical stratification in the availability of benthos (food) for the birds. In the wetlands with hard substratum, we scrapped out mud samples from the upper stratum (up to 2 or 4 cm) which had volume comparable with equivalent core strata. We grouped these transects into eight clusters based on their physical proximity and cardinal position for easy and credible interpretation.

2.4 Plankton sampling

Phytoplankton and zooplankton collections were carried out using standard nets during early morning high tides. Five stations (P1/Z1-Transect 1, P2/Z2-Transect 4, P3/Z3-Transect 8, P4/Z4-Transect 34, P5/Z5-Transect 38) were selected for this sampling. Zooplankton samples were preserved in 5% formalin and phytoplankton samples were stained with 2–3 drops of Lugol's iodine. Phytoplankton and zooplankton were more often identified up to the species level, or else assigned to higher taxonomic ranks.

2.5 Water parameter sampling

We recorded 11 water parameters likely to influence abundance of benthos using portable Henna H19829 multiparameter: pH, ORP (oxygen reduction potential), DO (dissolved oxygen), conductivity, resistivity, TDS (total dissolved solid), Sigma t (density of water at given pH), turbidity, salinity, temperature and atmospheric pressure. In the creek, sampling was carried out at the start, mid and end point of each transect while in wetlands, parameters are recorded at every 5m in 25m transect in four cardinal directions, except Panje where the wetland was divided into two parts and each sampled separately.

2.6 Data analysis

The data was analyzed and visualized in 'R' programming language version 3.4.3 (R Core Team 2017) using package 'ggplot2' (Wickham 2009) and MS-Excel 2016.

3. Preliminary Observations

3.1. Birds

A total 75 species of waterbirds belonging to 17 families were recorded during this study. The abundance, richness and composition of the waterbirds varied considerably between the creek and wetlands.

3.1.1. Wetland count survey (WCS)

In total, 69 species of waterbirds were recorded from these wetlands, of which 43 were migratory and 26 were non-migratory (residential). Among them, 25 species were waders. These wetlands showed substantial variation in species richness: Panje (50 species), Bhendkhal (40 species), NRI (38 species), TSC (33 species), Belpada and BPS (30 species), Sewri (18 species) and NSPS (5 species; Appendix 1). Similarly, abundance of birds also varied greatly (Appendix 2); for example, only 12 individuals were recorded at BPS while 11560 individuals were seen at Panje during a count. In addition to the spatial variations, these wetlands also showed considerable temporal variations in richness and abundance of the waterbirds; for example, 565 individuals (17 species) of waterbirds were observed in July 2018 whereas 11560 individuals (33 species) were recorded in September 2018 at Panje Wetland (Fig. 2).

In almost all wetlands, migratory waterbirds were exceedingly high in number than that the residential waterbirds. The former occurred in thousands at Panje NRI and BPS; in contrast, the remaining sites had numbers ranging in hundreds (Fig. 2). Interestingly, the abundance of the migratory birds had shown exceptional peaks during August–September at Panje and Belpada wetlands. It seems likely that these sites may be used as stop-over sites by wintering birds. However, more intensive WCS along with ringing of the birds from September to January would test this hypothesis credibly. On the contrary, the number of birds increased during May–June at NRI, Bhendkhal, NSPS and BPS wetlands. It could be related to the local movement of the birds between these sites, which was largely driven by fluctuating water level in the wetlands and human disturbances; e.g. landfilling of wetlands (Rahmani et al. 2017).

Flamingos were observed in all wetlands, except NSPS. The preference of Greater Flamingos for Panje, BPS, Bhendkhal and Belpada wetlands and of Lesser Flamingos for NRI and TSC wetlands was intriguing (Fig.3). The largest congregations of flamingos were seen at Panje, BPS and NRI wetlands. From June to September, Greater Flamingos were reported in large numbers; in contrast Lesser Flamingos were more abundant from March to June. It appears to be an interesting pattern and might be correlated with migration or local movement pattern of the flamingos. But considering the scarcity of information available about the breeding and migration of the flamingos, particularly in India, it may be premature to arrive at a conclusion. The intensive ringing and satellite telemetry of the flamingo population(s) in our study area would throw light on these patterns of seasonal fluctuations in their abundance.

3.1.2 Transect count survey (TCS)

In all, 63000 individuals belonging to 50 species of waterbirds (and raptors) were counted in the first survey (March–April; Appendix 1). Among them, 35 species were migratory and comprised 60200 individuals, of which 42600 were waders (20 species). We found that Little Stint was the most abundant species at 34300 individuals. It was followed by Greater (5500 individuals) and Lesser Flamingos (9400 individuals).

In the second survey (April–May), a total of 63800 individuals (46 species) were seen, of which 62900 were migratory (30 species). Among them 20 species were waders comprising 16150 individuals. Interestingly, Greater (15800) and Lesser Flamingos (29000) had increased substantially when compared to the first survey. Similarly, the highest number of Lesser Flamingos (20000) was observed at Sewri Mudflat on May 2018.

The abundance of waterbirds in Thane Creek revealed an interesting spatial pattern, i.e. peak counts were recorded at transects T1–T3 (near Ghansoli); T11–T18 (near Bhandup) and T35–T40 (near Vashi, Fig.4–6). This spatial pattern of abundance may be correlated to the food abundance – macrobenthos. Though we collected macrobenthos abundance data, it was a single temporal replicate which was not credible to explore or test this hypothesis. However, multiple temporal replicates of birds and macrobenthos abundance data would provide insight into the correlation between them.

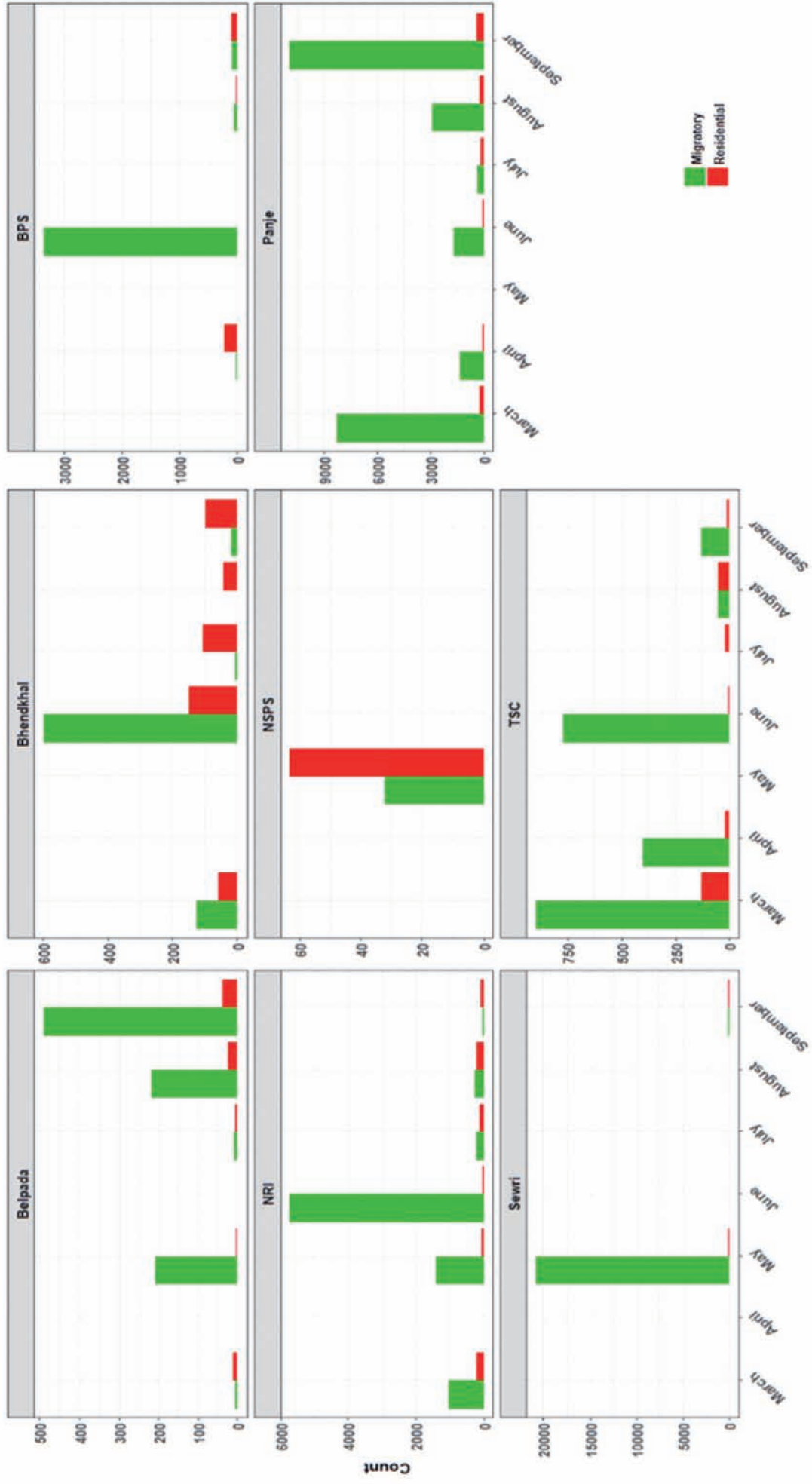


Figure 1. Seasonal variations in abundance of migratory and residential waterbirds at different wetlands.

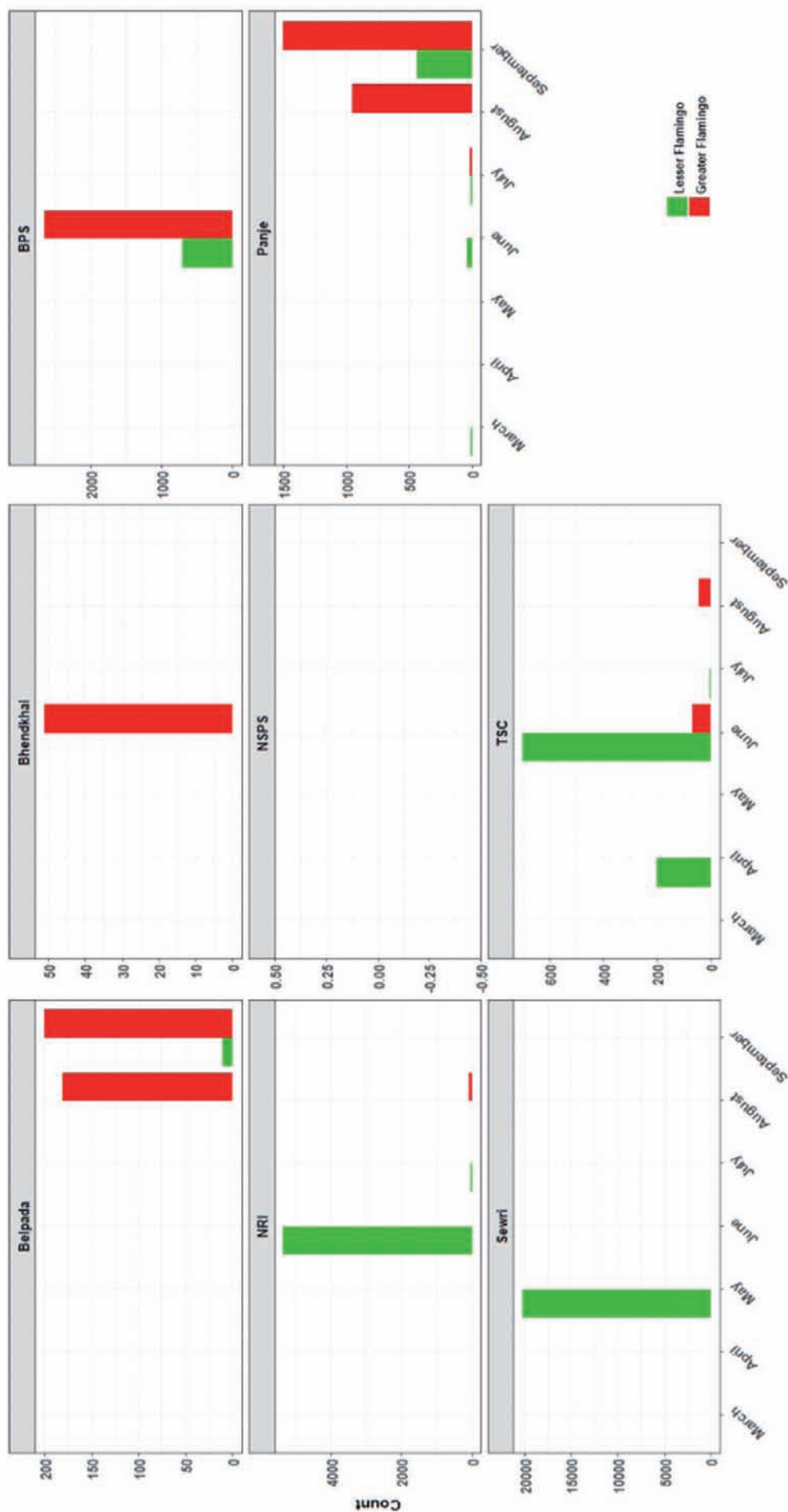


Figure 2. Seasonal variations in abundance of gGreater and Lesser fFlamingos at different wetlands.

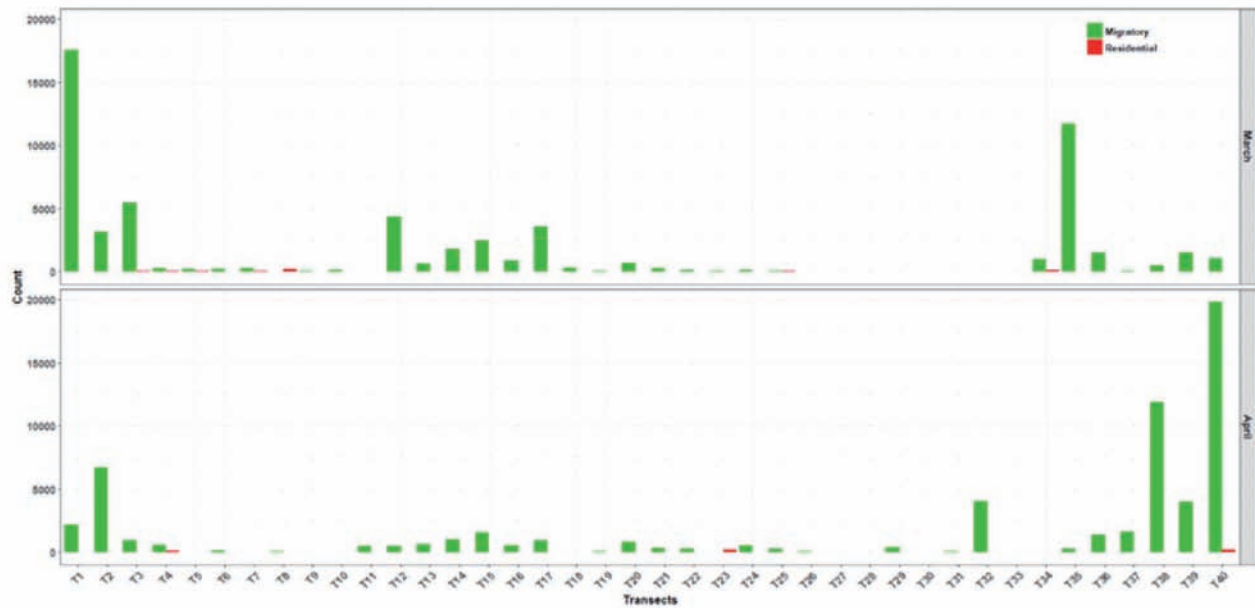


Figure 3. Abundance of migratory and residential waterbirds in Thane Creek

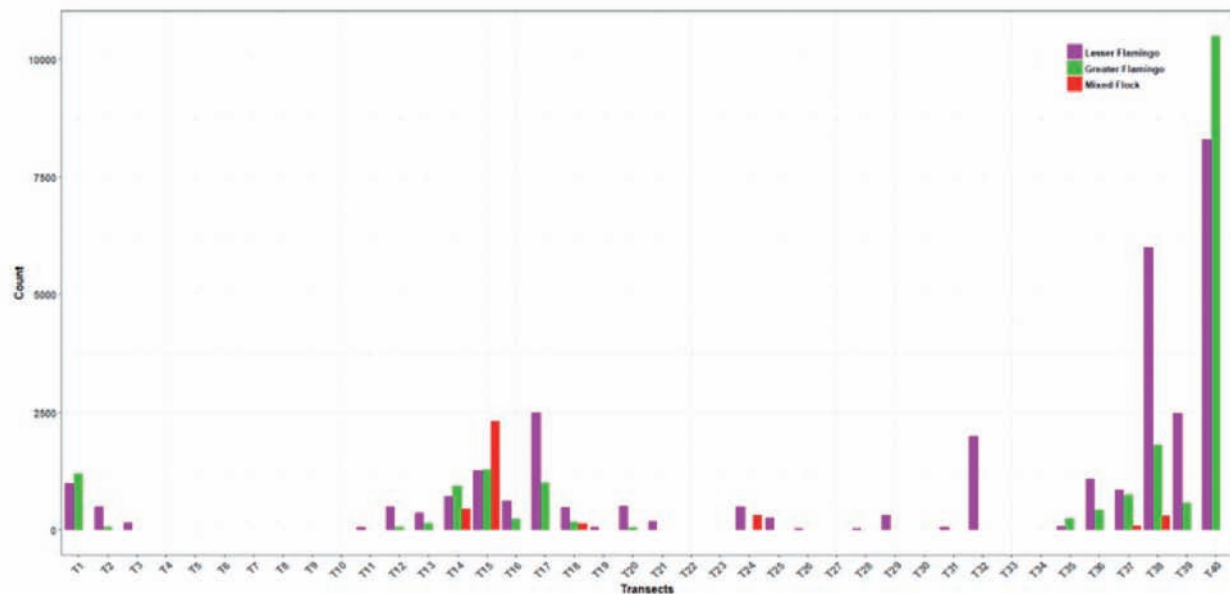


Figure 4. Abundance of Greater and Lesser Flamingos in Thane Creek

3.1.3 Flamingo count surveys (FCS)

The number of Greater Flamingos (12200) and Lesser Flamingos (19500) counted in the two-day census surveys (Flamingo Count Surveys) were lesser than recorded during TCS; the discrepancy was very high for Lesser Flamingos. We anticipated this difference because TCS needs comparatively longer period of sampling (10 days), and hence it is likely that the flamingo flocks move between transects which ultimately would result in an overestimation of their numbers. It indicates that counting waterbirds in the entire creek during a day would give more credible numbers than that of TCS.

3.1.4. Bird behaviour

We selected 10 behavioural categories of the flamingos based on preliminary sampling for further exploration: feeding, maintenance, walking, swimming, flying, standing, resting, aggression, alert or vigilance and courtship (Felicity and Baldassarre 1995, Eduardo and Baldassarre 1997, Kumssa and Bekele 2014, Bensaci et al. 2015).

3.1.5. Bird ringing

We captured and ringed 549 individuals (23 species) of waterbirds at Panje Wetland. Among them, Little Stint, Lesser Sand Plover and Curlew Sandpiper were the most abundant species (>100 individuals of each species captured; Fig.7, Table 1). They showed variations in recaptures, i.e. percentage of recapture ranged between 1% to 9%. Common



Figure 6. Abundance of waders in Thane Creek in March –April 2018

Table 1 Details of birds ringed and recaptured during ringing session

Sr. No.	Ring size	Common name	Scientific name	Individuals ringed	Recapture
1	A	Little Stint	<i>Calidris minuta</i>	152	3
2	A	Red-necked Phalarope	<i>Phalaropus lobatus</i>	1	-
3	AA	Kentish Plover	<i>Charadrius alexandrinus</i>	2	-
4	AB	Lesser Sand Plover	<i>Charadrius mongolus</i>	134	2
5	AB	Common Sandpiper	<i>Actitis hypoleucos</i>	13	-
6	AB	Curlew Sandpiper	<i>Calidris ferruginea</i>	120	3
7	AB	Broad-billed Sandpiper	<i>Limicola falcinellus</i>	8	-
8	AB	Whiskered Tern	<i>Chlidonias hybrida</i>	33	-
9	AB	Dunlin	<i>Calidris alpina</i>	18	1
10	AB	Greater Sand Plover	<i>Charadrius leschenaultii</i>	5	-
11	B	Common Redshank	<i>Tringa totanus</i>	32	3
12	B	Gull-billed Tern	<i>Gelochelidon nilotica</i>	5	-
13	B	River Tern	<i>Sterna aurantia</i>	1	-
14	B	Ruff	<i>Philomachus pugnax</i>	5	-
15	B	Whiskered Tern	<i>Chlidonias hybrida</i>	3	-
16	B	Marsh Sandpiper	<i>Tringa stagnatilis</i>	2	-
17	B	Common Greenshank	<i>Tringa nebularia</i>	2	-
18	C	Red-wattled Lapwing	<i>Vanellus indicus</i>	3	-
19	C	Grey Plover	<i>Pluvialis squatarola</i>	2	-
20	F	Eurasian Curlew	<i>Numenius arquata</i>	1	-
21	G	Glossy Ibis	<i>Plegadis falcinellus</i>	1	-
22	K	Lesser flamingo	<i>Phoenicopterus minor</i>	1	-
23	L	Greater Flamingo	<i>Phoenicopterus roseus</i>	5	-

Redshank was frequently recaptured (9%) while Lesser Sand Plover was the least recaptured species (1%). Long-term ringing of the waterbirds in the study area can provide credible and vital information about capture and recapture rates, survival probabilities, immigration and emigration rates, site fidelity and seasonal and annual variations in these parameters.

3.1.6. Threatened birds

We found eight Threatened species of waterbirds in the study area, of which, barring a few Vulnerable species, all were Near Threatened species (Appendix 3). Painted Stork, Lesser Flamingo, Black-headed Ibis, Black-tailed Godwit, Eurasian Curlew and Curlew Sandpiper were found in most sites. In contrast, Indian Skimmer and Asian Dowitcher were restricted to a fewer sites. For instance, a small flock of Indian Skimmer was seen at Panje Wetland whereas Asian Dowitcher was observed only in Thane Creek.

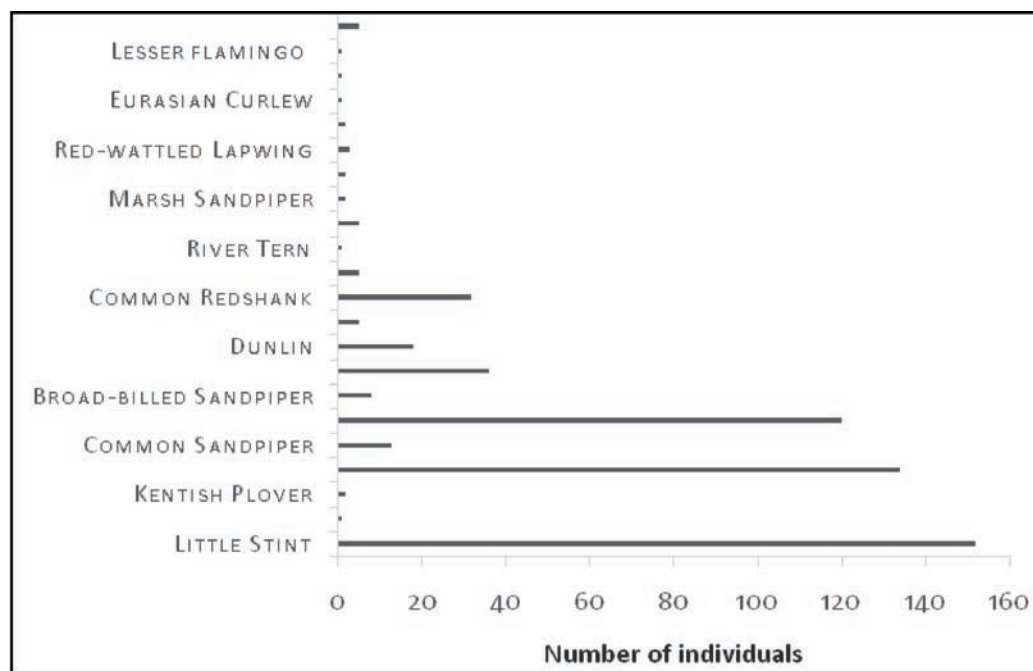


Figure 7. Number of individuals of the bird species ringed during this study

3.2. Benthos

3.2.1. Thane Creek

The Macrobenthic community along the east bank showed high biomass, abundance and faunal richness than along the west bank (Table 2). In the East Bank, EII and EIII depicted the highest macrobenthic biomass and abundance, however, highest richness was found at EIV. Among macrobenthos, Gastropoda heavily contributed to biomass and abundance which was followed by Polychaeta (Fig. 8 and 9). In the West Bank, peak biomass and abundance of macrobenthos was seen at WII (Fig.10). Amidst the macrobenthos, Polychaeta largely contributed to abundance, while Gastropoda accounted for the bulk of the biomass (Fig.11).

Faunal richness was uniform along the West Bank, except WIV with poor richness. Nemertea, Arthropoda, Sipuncula and Cnidaria were the minor groups, with low abundance. Arthropoda was found among all the clusters with the exception of WIV, which comprised Brachyura, Copepoda, Shrimp, Pycnogonida and Amphipoda. Similarly, excluding WIV, Sipunculid and Cnidaria were recorded along the entire West Bank. However, Sipunculid (EI and EIV) and Cnidaria (EI, EII, EIII) showed varied distribution along the East Bank. Nemertea was found only in the East Bank (EIII and EIV).

Overall, Zone A of East and West Banks had high faunal richness of macrobenthos compared to Zone B and C, whereas abundance of macrobenthos was highest in Zone C, except EI (Fig. 8). On the contrary, biomass of macrobenthos did not show any zonal pattern along both the banks. In strata, Polychaeta and Gastropoda were the predominant groups along both the banks.

3.2.2. Wetlands and Sewri Mudflat

Macrobenthic composition in the wetlands was mainly dominated by Gastropoda (Fig. 12 and 13). Considerable number of Polychaeta were obtained exclusively at Sewri Mudflat. However, their biomass was very low when compared to that of the Creek. Though biomass of Bivalvia was noticeable at TSC and Sewri, their abundance was low in all the wetlands. Arthropoda, mainly Amphipoda, were found at NRI.

3.3. Planktons

A total of 16 species of *phytoplankton* were recorded from 5 stations (Fig.14, Table 3). The maximum numbers of species were recorded from P1 station (10 species), followed by P4 (8 species), while P2 and P3 had 7 species. The least number of taxa were recorded from Z2 (3 taxa). Medusae (48%) was found to be the predominant group in all stations followed by Copepod (42%) and Decapod larva (5%).

Table 2. Biomass, abundance and faunal groups of macrobenthos across various clusters.a

Clusters	Transects	Biomass (g/ unit area)	Abundance (no./unit area)	Faunal groups
EI	3, 4, 5, 6, 7	0–4.56	0–475	Polychaeta, Gastropoda, Bivalvia, Arthropoda, Cnidaria
EII	1, 2, 38, 39, 40	0–9.28	0–2875	Polychaeta, Gastropoda, Bivalvia, Arthropoda, Cnidaria
EIII	33, 34, 35, 36, 37	0–6.8	0–1334	Nemertea, Polychaeta, Gastropoda, Bivalvia, Arthropoda, Cnidaria
EIV	27, 28, 29, 31, 32	0–4.23	0–216	Nemertea, Polychaeta, Gastropoda, Bivalvia, Arthropoda, Cnidaria, Sipunculid
WI	22, 23, 24, 25, 26	0–2.39	0–229	Polychaeta, Gastropoda, Bivalvia, Arthropoda, Cnidaria, Sipunculid
WII	17, 18, 19, 20, 21, 22	0–3.76	0–995	Polychaeta, Gastropoda, Bivalvia, Arthropoda, Cnidaria, Sipunculid
WIII	12, 13, 14, 15, 16	0–1.44	0–402	Polychaeta, Gastropoda, Bivalvia, Arthropoda, Cnidaria, Sipunculid
WIV	8, 9, 10, 11, 12	0–0.20	0–128	Polychaeta, Gastropoda, Bivalvia

Table 3. Percentage composition of phytoplankton in Thane Creek. P1–P5 =
Sampling stations/transects

Phytoplankton	P1	P2	P3	P4	P5	Mean
<i>Rhizosolenia setigera</i>	-	-	-	0.01	-	0.01
<i>Cylindrotheca closterium</i>	-	-	-	0.02	-	0.02
<i>Nitzschia sigma</i>	-	-	-	0.02	-	0.02
<i>Nitzschia</i> sp.	-	0.01	0.14	0.18	-	0.11
<i>Thalassiosira subtilis</i>	-	0.89	0.13	0.28	0.42	0.43
<i>Dinophysis caudata</i>	0.73	-	-	-	-	0.73
<i>Dinophysis miles</i>	1.76	0.02	-	-	-	0.89
<i>Pleurosigma normanii</i>	0.88	0.45	0.14	-	0.25	0.43
<i>Prorocentrum</i> sp.	0.73	-	-	-	-	0.73
<i>Surirella</i> sp.	1.84	-	-	-	-	1.84
<i>Ornithoceros</i> sp.	1.47	-	-	-	-	1.47
<i>Skeletonema costatus</i>	61.43	44.63	52.07	66.3	59.17	56.72
<i>Coscinodiscus granii</i>	1.03	-	-	-	-	1.03
<i>Odontella sinensis</i>	29.39	53.55	47.38	33.15	4.15	33.524
<i>Navicula</i> sp.	0.73	-	0.13	-	-	0.43
<i>Coscinodiscus</i> sp.	-	0.45	0.02	0.04	-	0.17

Table 4. Percentage composition of zooplankton in Thane Creek. Z1–Z5 = Sampling stations/transects

Zooplankton	Z1	Z2	Z3	Z4	Z5	Mean
Medusae	96.37	90.09	52.19	0.9	33.45	54.60
Polychaeta	0.32	-	-	-	0.515	0.41
Copepoda	2.57	-	43.72	96.36	50.35	48.25
Amphipoda	0.42	-	-	-	-	0.42
<i>Acetes</i> sp.	-	9.46	0.13	0.11	2.49	3.048
Decapod larva	-	-	1.53	2.39	12.3	5.40
Gastropod larva	-	-	0.21	-	-	0.21
Fish larvae	-	-	-	0.01	0.1	0.055
Nematoda	-	-	2.04	0.08	1.855	-
Isopoda	-	-	-	0.15	0.23	0.19
Aquatic insect	0.32	0.45	-	-	-	0.39

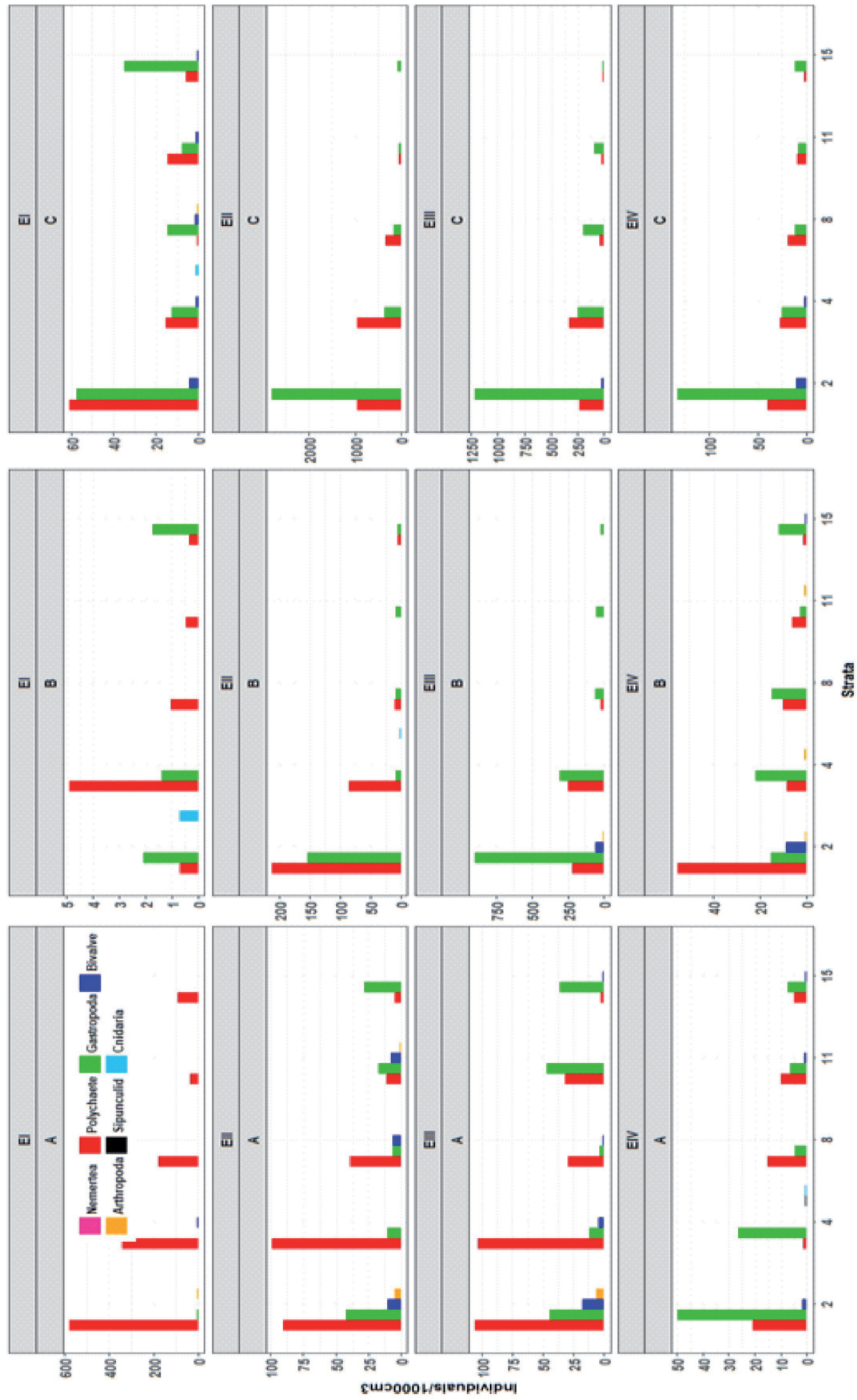


Fig.7. Abundance and richness of macrobenthic groups in different zones and strata along the East Bank.

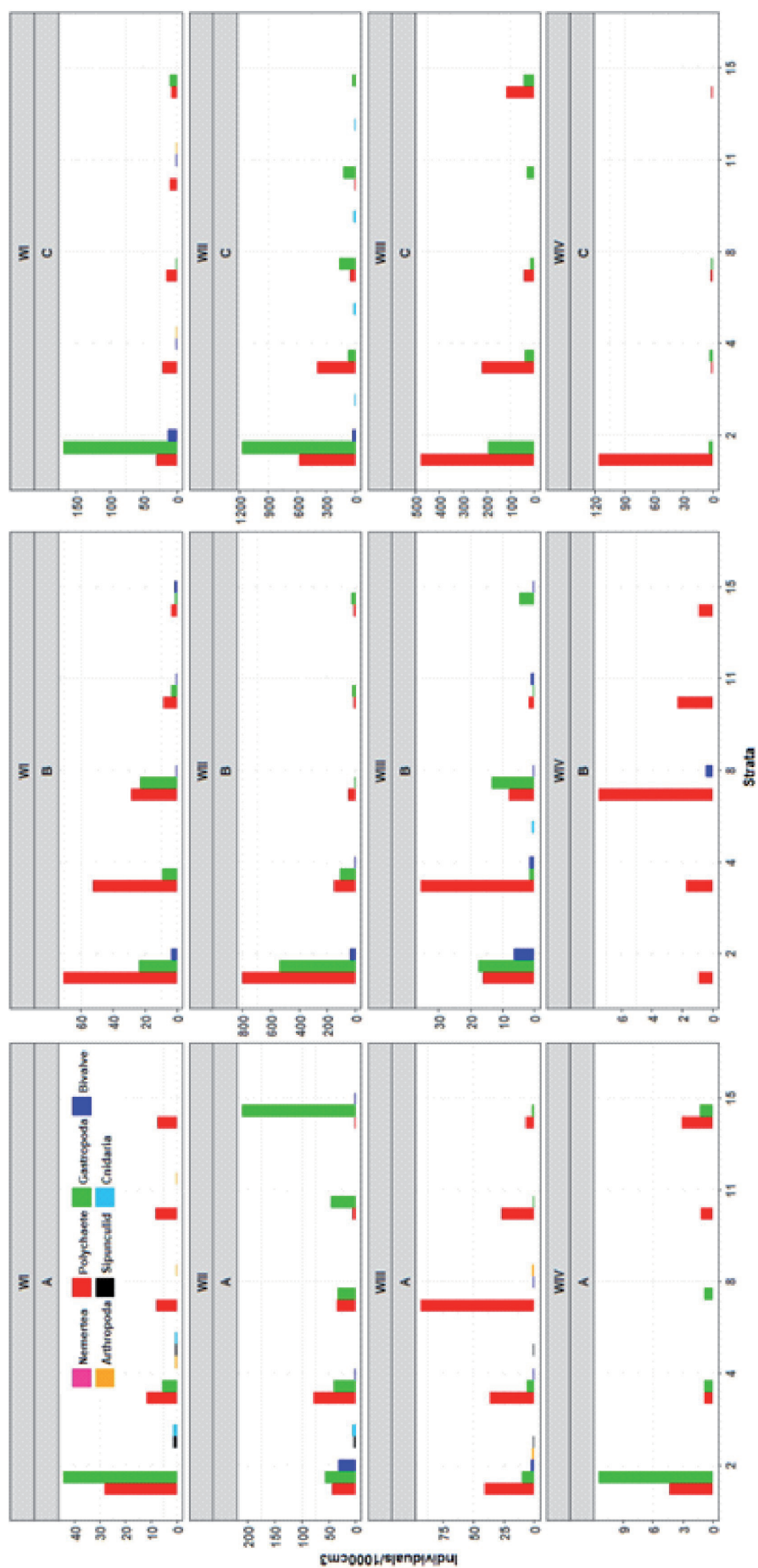


Fig.8. Abundance and richness of macrobenthic groups in different zones and strata along the West Bank

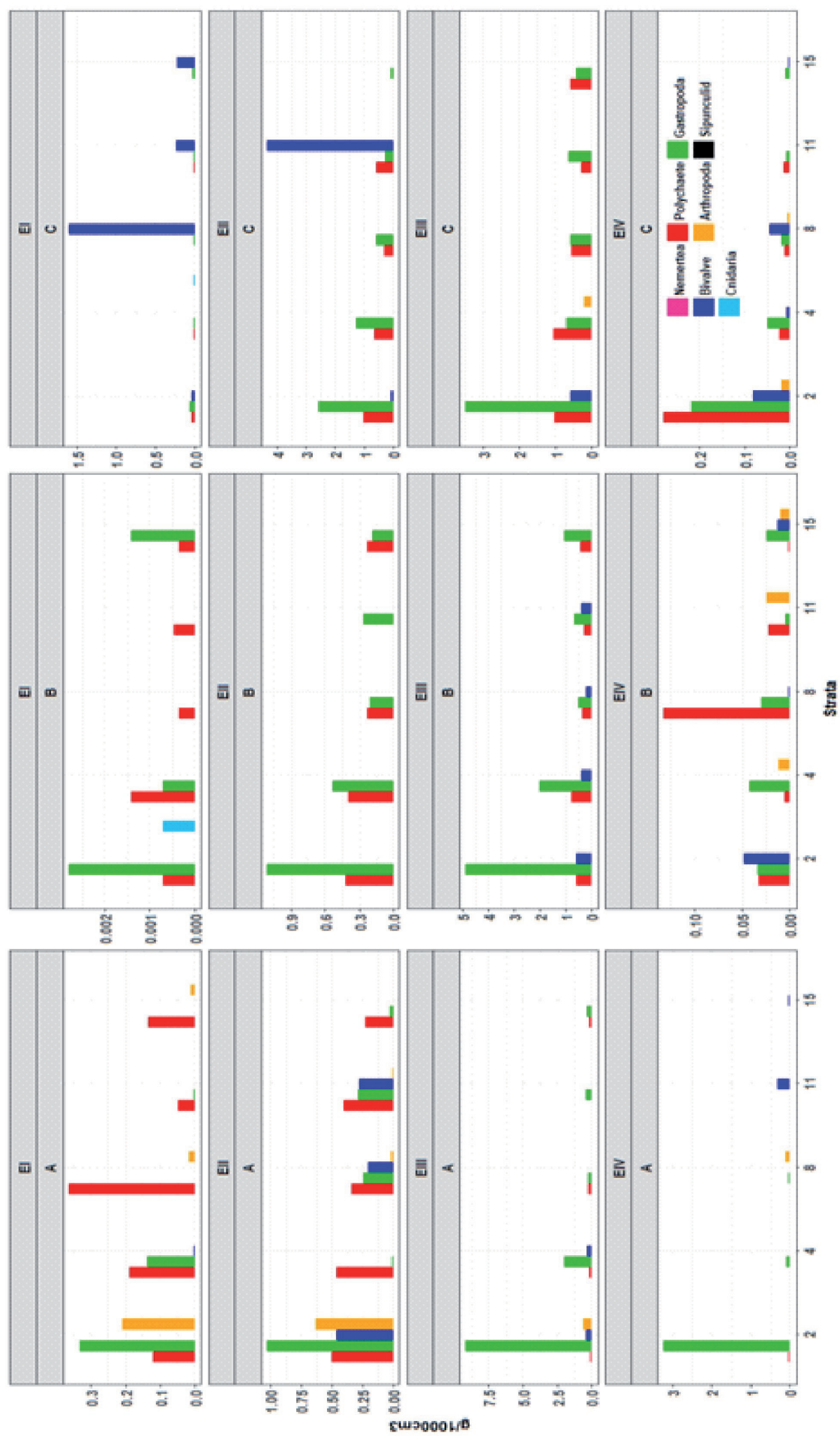


Fig.9. Biomass of macrobenthic groups in different zones and strata along the East Bank

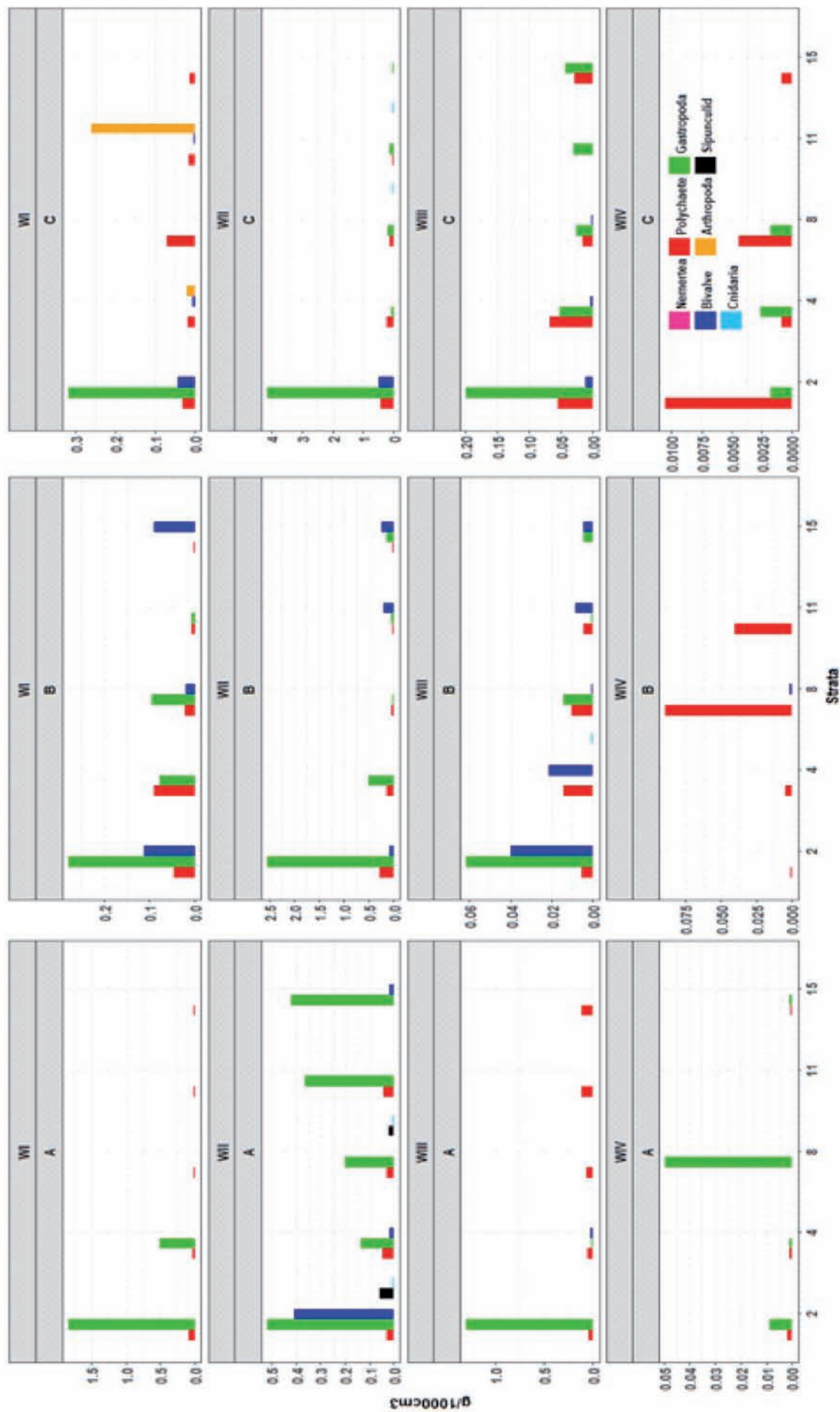


Fig.10. Biomass of macrobenthic group in different zones and strata along the West Bank

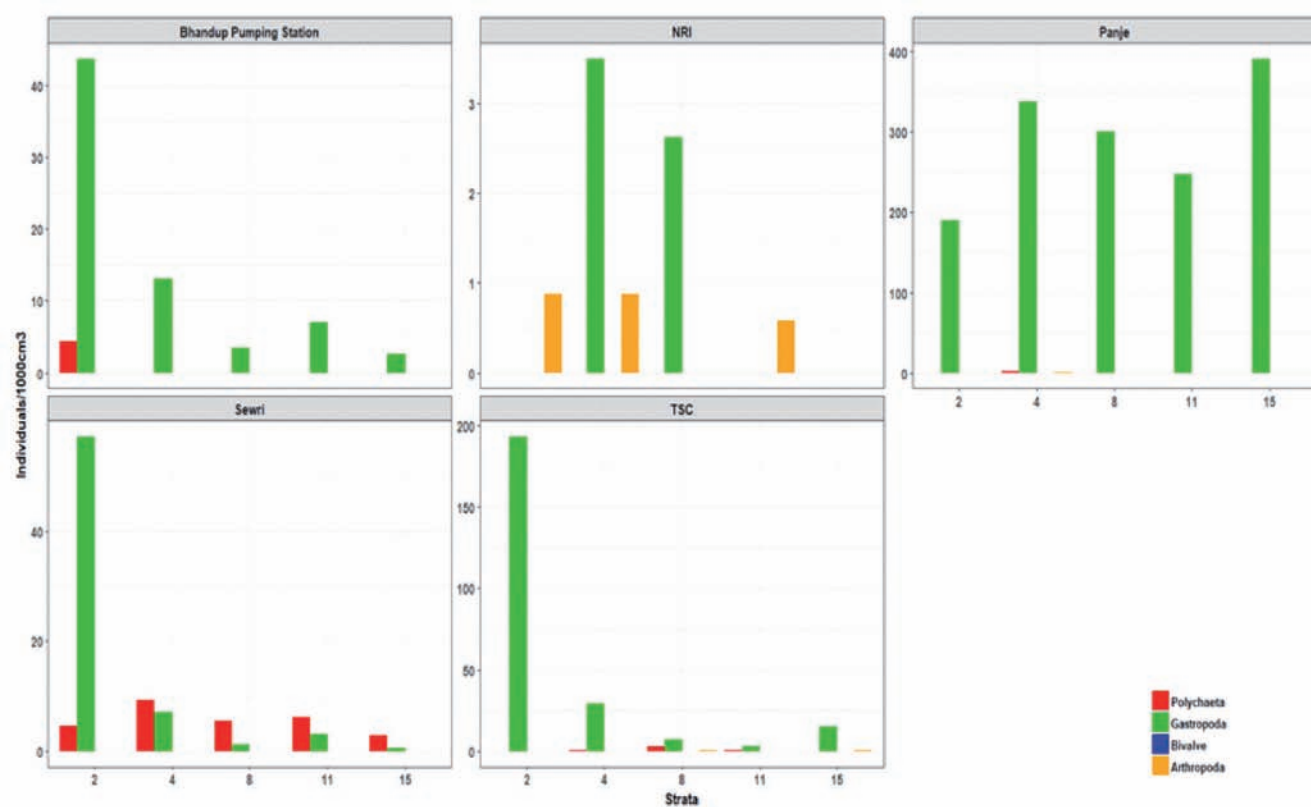


Fig.11. Abundance and richness of macrobenthic groups in various strata of the wetlands and Sewri Mudflat

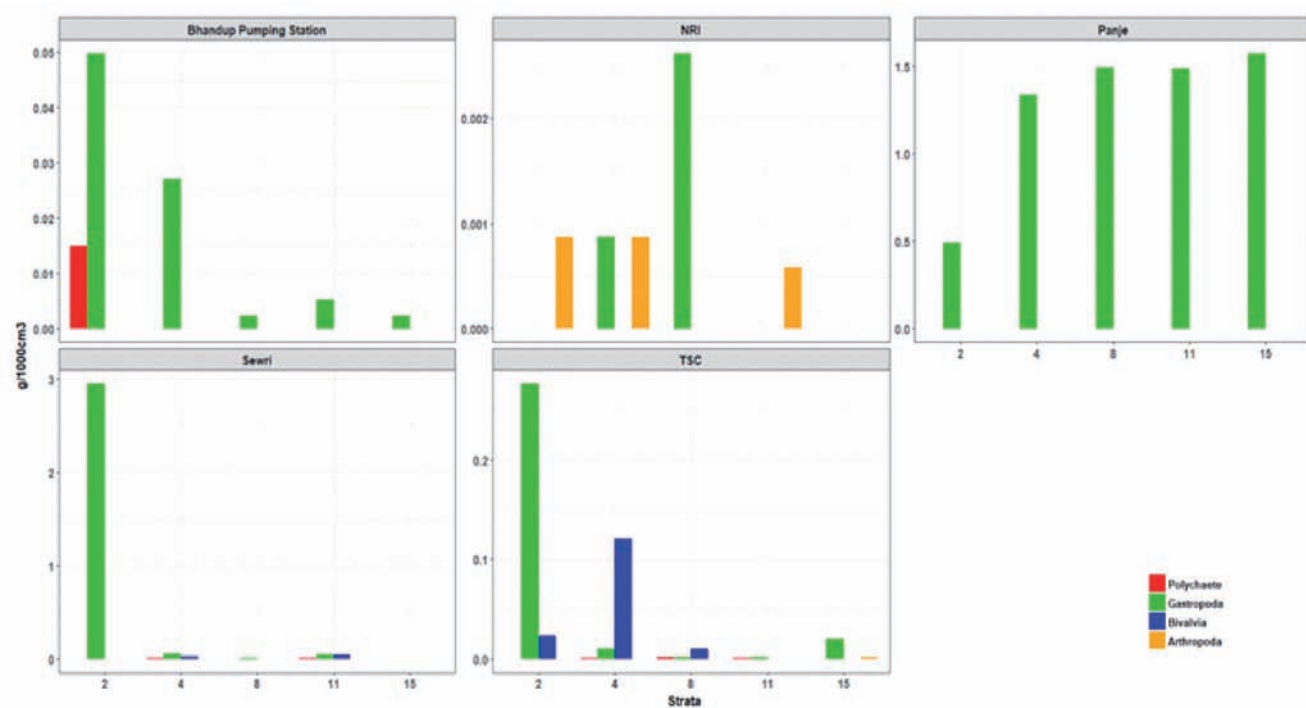


Fig.12. Biomass of macrobenthic groups in various strata of the wetlands and Sewri Mudflat

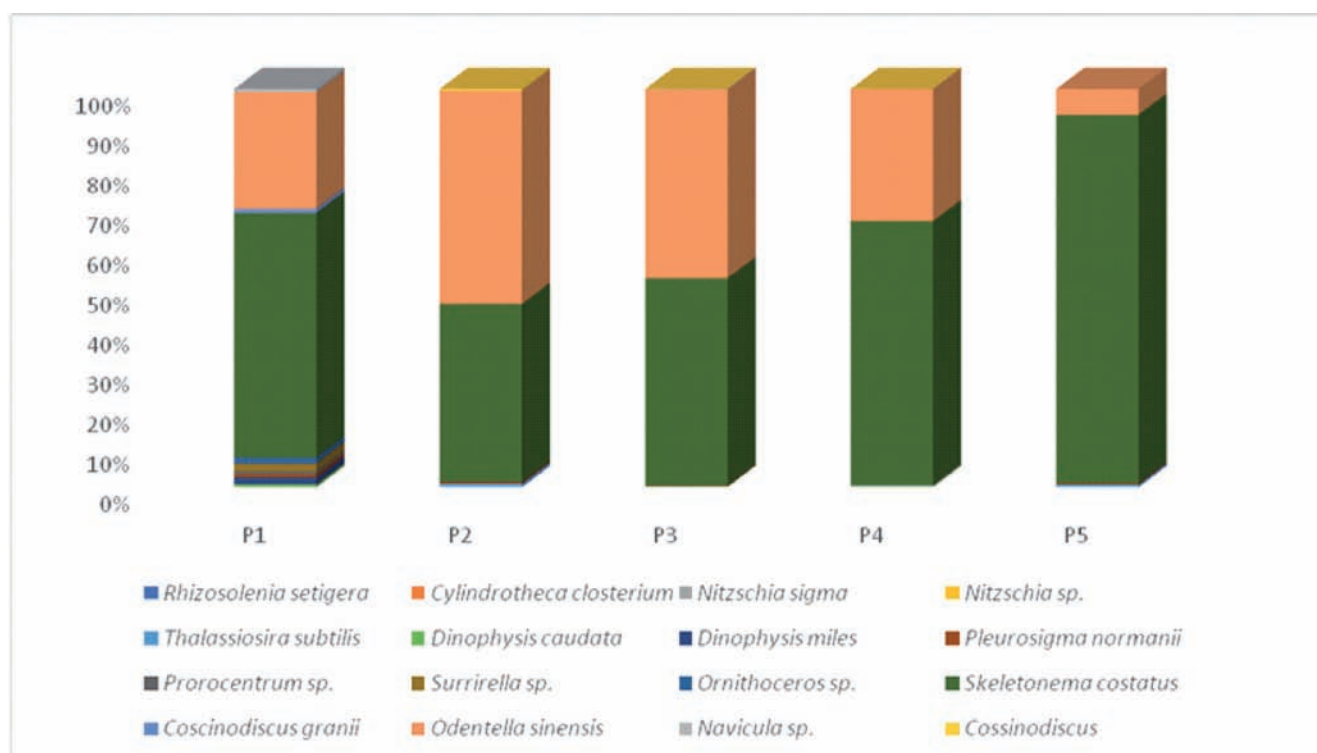


Fig.13. Percentage composition of phytoplankton in Thane Creek

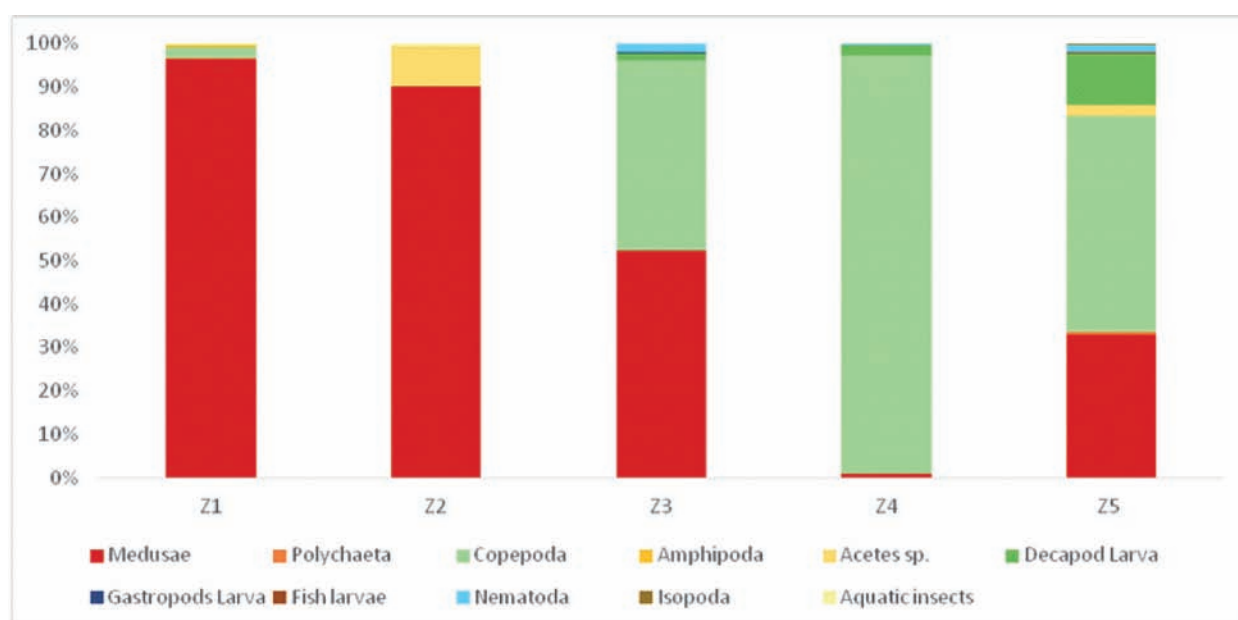


Fig.14. Percentage composition of zooplankton in Thane Creek

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Appendix 1. Checklist of birds found in study area with their IUCN status, migratory or residential nature and occurrence in different areas

SR. NO.	COMMON NAME	SCIENTIFIC NAME	IUCN CATEGORY	RESIDENTIAL/ MIGRATORY	NSPS	BHENDKHAL	BPS	BELPADA	NRI	SEWRI	PANJE	TSC	THANE CREEK
	Anatidae												
1	Lesser Whistling Duck	<i>Dendrocygna javanica</i>	LC	M	-	+	+	+	+	+	+	-	+
2	Ruddy Shelduck	<i>Tadorna ferruginea</i>	LC	M	-	+	-	-	-	-	+	-	-
3	Cotton Pygmy Goose	<i>Nettapus coromandelianus</i>	LC	M	-	-	+	-	-	-	-	-	-
4	Indian Spot-billed Duck	<i>Anas poecilorhyncha</i>	LC	R	-	+	+	+	+	-	+	+	+
5	Northern Shoveler	<i>Spatula clypeata</i>	LC	M	-	-	-	-	-	-	-	-	+
6	Garganey	<i>Anas querquedula</i>	LC	M	-	-	+	-	-	-	-	-	+
7	Common Teal	<i>Anas creva</i>	LC	M	-	-	-	-	-	-	-	-	+
	Podicipedidae												
8	Little Grebe	<i>Tachybaptus ruficollis</i>	LC	R	-	+	+	-	+	-	+	-	-
	Ciconiidae												
9	Painted Stork	<i>Mycteria leuccephala</i>	NT	R	-	+	+	+	+	+	+	+	+

Appendix 1. Checklist of birds found in study area with their IUCN status, migratory or residential nature and occurrence in different areas

SR. NO.	COMMON NAME	SCIENTIFIC NAME	IUCN CATEGORY	RESIDENTIAL/ MIGRATORY	NSPS	BHENDKHAL	BPS	BELPADA	NRI	SEWRI	PANJE	TSC	THANE CREEK
	Phoenicopteridae												
10	Greater Flamingo	<i>Phoenicopterus roseus</i>	LC	M	-	+	+	+	+	+	+	+	+
11	Lesser Flamingo	<i>Phoeniconotus minor</i>	NT	M	-	-	+	+	+	+	+	+	+
	Threskiornithidae												
12	Black-headed Ibis	<i>Threskiornis melanocephalus</i>	NT	R	-	+	+	+	-	+	+	-	+
13	Glossy Ibis	<i>Plegadis falcinellus</i>	LC	M	-	+	-	-	-	-	+	-	-
14	Eurasian Spoonbill	<i>Platalea leucorodia</i>	LC	M	-	+	+	+	-	-	+	-	-
	Ardeidae												
15	Indian Pond Heron	<i>Ardeola grayii</i>	LC	R	-	+	+	-	+	+	+	+	+
16	Grey Heron	<i>Ardea cinerea</i>	LC	R	-	+	+	+	+	-	+	+	+
17	Purple Heron	<i>Ardea purpurea</i>	LC	R	-	+	-	-	-	+	+	-	-
18	Cattle Egret	<i>Bubulcus ibis</i>	LC	R	-	+	-	-	+	-	-	-	-
19	Great Egret	<i>Casmerodius albus</i>	LC	R	-	+	+	-	-	+	+	+	+

Appendix 1. Checklist of birds found in study area with their IUCN status, migratory or residential nature and occurrence in different areas

SR. NO.	COMMON NAME	SCIENTIFIC NAME	IUCN CATEGORY	RESIDENTIAL/ MIGRATORY	NSPS	BHENDKHAL	BPS	BELPADA	NRI	SEWRI	PANJE	TSC	THANE CREEK
20	Intermediate Egret	<i>Mesophyx intermedia</i>	LC	R	+	+	+	+	+	+	+	+	+
21	Little Egret	<i>Egretta garzetta</i>	LC	R	-	+	+	+	+	+	+	+	+
22	Western Reef Egret	<i>Egretta gularis</i>	LC	R	-	+	+	+	+	+	+	-	+
	Phalacrocoracidae												
23	Little Cormorant	<i>Phalacrocorax niger</i>	LC	R	-	+	+	+	+	-	+	+	+
24	Indian Cormorant	<i>Phalacrocorax fuscicollis</i>	LC	R	-	+	-	+	-	-	-	+	+
25	Great Cormorant	<i>Phalacrocorax carbo</i>	LC	R	-	-	-	-	-	-	-	-	+
	Accipitridae												
26	Black-winged Kite	<i>Elanus caeruleus</i>	LC	R	-	-	-	+	+	-	-	-	-
27	Black Kite	<i>Milvus migrans</i>	LC	R	-	-	+	-	-	-	-	-	+
28	Brahminy Kite	<i>Haliastur indus</i>	LC	R	-	-	+	-	-	-	+	-	+

Appendix 1. Checklist of birds found in study area with their IUCN status, migratory or residential nature and occurrence in different areas

Sr. No.	Common Name	Scientific Name	IUCN Category	Residential/ Migratory	NSPs	Bhendkhal	BPS	Belpada	NRI	Sewri	Panji	TSC	Thane Creek
	Pandionidae												
29	Osprey	<i>Pandion haliaetus</i>	LC	M	-	+	+	-	-	-	-	-	+
	Accipitridae												
30	Western Marsh Harrier	<i>Circus aeruginosus</i>	LC	M	-	+	+	+	-	-	+	-	+
	Rallidae												
31	White-breasted Waterhen	<i>Amaurornis phoenicurus</i>	LC	R	-	-	-	-	-	-	+	+	-
32	Purple Swamphen	<i>Porphyrio porphyrio</i>	LC	R	-	+	-	-	-	-	+	-	-
33	Common Moorhen	<i>Gallinula chloropus</i>	LC	R	-	-	+	-	-	-	-	-	-
34	Eurasian Coot	<i>Fulica atra</i>	LC	R	-	+	+	-	+	-	+	-	+
	Jacaniidae												
35	Pheasant-tailed Jacana	<i>Metopidius indicus</i>	LC	R	-	+	-	-	-	-	-	-	-

Appendix 1. Checklist of birds found in study area with their IUCN status, migratory or residential nature and occurrence in different areas

SR. NO.	COMMON NAME	SCIENTIFIC NAME	IUCN CATEGORY	RESIDENTIAL/ MIGRATORY	NSPS	BHENDKHAL	BPS	BELPADA	NRI	SEWRI	PANJE	TSC	THANE CREEK
	Recurvirostridae												
36	Black-winged Stilt	<i>Himantopus himantopus</i>	LC	R	+	+	+	+	+	-	+	-	+
37	Pied Avocet	<i>Recurvirostra avosetta</i>	LC	M	-	-	-	-	-	-	+	-	+
	Charadriidae												
38	Red-wattled Lapwing	<i>Vanellus indicus</i>	LC	R	-	+	-	-	+	-	+	-	+
39	Pacific Golden Plover	<i>Plover Pluvialis fulva</i>	LC	M	-	-	-	+	+	-	+	-	+
40	Grey Plover	<i>Pluvialis squatarola</i>	LC	M	-	-	-	+	+	-	+	-	+
41	Little Ringed Plover	<i>Charadrius dubius</i>	LC	M	-	+	-	-	-	-	-	-	+
42	Kentish Plover	<i>Charadrius alexandrinus</i>	LC	M	-	-	-	-	-	-	-	-	+
43	Greater Sand Plover	<i>Charadrius leschenaultii</i>	LC	M	-	-	-	-	-	-	+	-	+
44	Lesser Sand Plover	<i>Charadrius mongolus</i>	LC	M	-	-	-	+	-	-	+	+	+

Appendix 1. Checklist of birds found in study area with their IUCN status, migratory or residential nature and occurrence in different areas

SR. NO.	COMMON NAME	SCIENTIFIC NAME	IUCN CATEGORY	RESIDENTIAL/ MIGRATORY	NSPS	BHENDKHAL	BPS	BELPADA	NRI	SEWRI	PANJE	TSC	THANE CREEK
	Scolopacidae												
45	Ruff	<i>Philomachus pugnax</i>	LC	M	-	-	-	-	-	-	+	-	-
46	Red-necked Phalarope	<i>Phalaropus lobatus</i>	LC	M	-	-	-	-	-	-	+	-	-
47	Common Snipe	<i>Gallinago gallinago</i>	LC	M	-	+	-	-	-	-	-	-	-
48	Black-tailed Godwit	<i>Limosa limosa</i>	NT	M	-	+	+	+	-	+	+	-	+
49	Asian Dowitcher	<i>Limnodromus semipalmatus</i>	NT	M	-	-	-	-	-	-	-	-	+
50	Whimbrel	<i>Numenius phaeopus</i>	LC	M	-	-	-	-	+	-	+	-	-
51	Eurasian Curlew	<i>Numenius arquata</i>	NT	M	-	-	-	-	+	-	+	+	+
52	Common Redshank	<i>Tringa totanus</i>	LC	M	+	+	+	+	+	+	+	+	+
53	Marsh Sandpiper	<i>Tringa stagnatilis</i>	LC	M	-	+	+	+	+	+	+	+	+
54	Common Greenshank	<i>Tringa nebularia</i>	LC	M	-	+	-	+	+	+	+	+	+

Appendix 1. Checklist of birds found in study area with their IUCN status, migratory or residential nature and occurrence in different areas

SR. NO.	COMMON NAME	SCIENTIFIC NAME	IUCN CATEGORY	RESIDENTIAL/ MIGRATORY	NSPS	BHENDKHAL	BPS	BELPADA	NRI	SEWRI	PANJE	TSC	THANE CREEK
55	Wood Sandpiper	<i>Tringa glareola</i>	LC	M	-	-	+	+	-	-	-	-	+
56	Terek sandpiper	<i>Xenus cinereus</i>	LC	M	-	-	-	-	-	-	+	-	+
57	Common Sandpiper	<i>Actitis hypoleucos</i>	LC	M	-	+	+	-	+	+	+	-	+
58	Ruddy Turnstone	<i>Arenaria interpres</i>	LC	M	-	-	-	-	+	-	-	-	+
59	Little Stint	<i>Calidris minuta</i>	LC	M	+	+	-	+	+	-	+	-	+
60	Temminck's Stint	<i>Calidris temminckii</i>	LC	M	-	-	-	-	-	-	-	-	+
61	Curlew Sandpiper	<i>Calidris ferruginea</i>	NT	M	-	-	-	+	+	-	+	+	+
62	Dunlin	<i>Calidris alpina</i>	LC	M	-	-	-	-	-	-	+	+	+
63	Broad-billed Sandpiper	<i>Limicola falcinellus</i>	LC	M	-	-	-	-	+	-	+	-	+
64	Caspian Gull	<i>Larus cachinnans</i>	LC	M	-	-	-	-	+	-	-	-	
65	Heuglin's Gull	<i>Larus heuglini</i>	LC	M	-	-	-	-	-	-	+	-	+

Appendix 1. Checklist of birds found in study area with their IUCN status, migratory or residential nature and occurrence in different areas

SR. NO.	COMMON NAME	SCIENTIFIC NAME	IUCN CATEGORY	RESIDENTIAL/ MIGRATORY	NSPS	BHENDKHAL	BPS	BELPADA	NRI	SEWRI	PANJE	TSC	THANE CREEK
	Laridae												
66	Pallas's Gull	<i>Ichthyaeus ichthyaeus</i>	LC	M	-	-	-	-	-	+	-	-	-
67	Brown-headed Gull	<i>Chroicocephalus brunnicephalus</i>	LC	M	-	+	-	-	+	-	-	-	+
68	Black-headed Gull	<i>Chroicocephalus ridibundus</i>	LC	M	-	+	-	-	+	-	+	-	+
69	Slender-billed Gull	<i>Chroicocephalus genei</i>	LC	M	-	-	-	+	+	-	-	+	+
70	Gull-billed Tern	<i>Gelochelidon nilotica</i>	LC	M	-	+	-	+	+	-	+	+	+
71	Caspian Tern	<i>Hydroprogne caspia</i>	LC	M	-	-	-	+	+	-	+	-	+
72	Whiskered Tern	<i>Chlidonias hybrida</i>	LC	M	+	+	+	+	+	+	+	-	+
73	Indian Skimmer	<i>Rynchops albigollis</i>	V	M	-	-	-	-	-	-	+	-	-
	Alcedinidae												
74	White-throated Kingfisher	<i>Halcyon swynnensis</i>	LC	R	-	+	-	-	-	-	-	-	-
75	Common Kingfisher	<i>Alcedo atthis</i>	LC	R	-	+	-	-	-	-	-	-	-

*Abbreviations: NT = Near Threatened, V =Vulnerable, LC = Least Concern, M =Migratory, R = Resident, + = Presence, - Absence.

Appendix 2. Summary statistic of observed populations of the waterbirds recorded at six wetlands
Min = Minimum; Max =Maximum

Sr. No.	COMMON NAME	SCIENTIFIC NAME	BHENDKHAL			BEPADA			NRI			PANJE			TSC			BPS		
			Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean
1	Lesser Whistling Duck	<i>Dendrocygna javanica</i>	4	550	112.8	3	50	8.83	9	9	1.8	4	200	35.33	0	0	0	2	2	0.33
2	Ruddy Shelduck	<i>Tadorna ferruginea</i>	3	3	0.6	0	0	0	0	0	0	5	5	0.83	0	0	0	0	0	0
3	Indian Spot-billed Duck	<i>Anas poecilorhyncha</i>	3	67	20.4	4	11	2.5	2	5	1.8	11	21	10.66	2	9	4	5	5	0.83
4	Little Grebe	<i>Tachybaptus ruficollis</i>	45	3	1	0	0	0	1	5	1.2	3	4	1.16	0	0	0	0	0	0
5	Painted Stork	<i>Mycteria leucocephala</i>	51	47	18.4	16	16	2.66	25	173	59.4	9	185	39.16	1	3	1	1	18	3.17
6	Greater Flamingo	<i>Phoenicopterus roseus</i>	1	51	10.2	180	200	63.33	74	74	14.8	15	1500	411.67	45	70	28.75	0	0	0
7	Lesser Flamingo	<i>Phoeniconaias minor</i>	0	0	0	10	10	1.66	5	5350	1071	1	432	78.5	3	700	175.75	700	700	117
8	Black-headed Ibis	<i>Threskiornis melanolephalus</i>	1	2	1	1	1	0.16	0	0	0	1	6	1.5	0	0	0	2	2	33
9	Glossy Ibis	<i>Plegadis faknellus</i>	1	1	0.2	0	0	0	0	0	0	12	37	10.66	0	0	0	0	0	0
10	Eurasian Spoonbill	<i>Platalea leucorodia</i>	8	8	1.6	1	4	0.83	0	0	0	2	70	19.83	0	0	0	14	14	2.33
11	Striated Heron	<i>Butorides striata</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12	Indian Pond Heron	<i>Ardeola grayii</i>	1	4	1	0	0	0	1	7	2.4	1	3	0.66	1	3	1.5	1	1	0.17
13	Grey Heron	<i>Ardea cinerea</i>	1	1	0.6	1	1	0.16	2	2	0.4	2	5	2.16	1	1	0.25	1	4	0.83
14	Purple Heron	<i>Ardea purpurea</i>	2	15	3.4	0	0	0	0	0	0	1	5	1.16	0	0	0	0	0	0

Appendix 2. Summary statistic of observed populations of the waterbirds recorded at six wetlands
Min = Minimum; Max =Maximum

Sr. No.	COMMON NAME	SCIENTIFIC NAME	BHENDKHAL			BELPADA			NRI			PANJE			TSC			BPS		
			5	5	1	0	0	0	1	1	0.2	0	0	0	0	0	0	0	0	0
15	Cattle Egret	<i>Bubulcus ibis</i>																		
16	Great Egret	<i>Casmerodius albus</i>	1	4	1.4	0	0	0	0	0	0	2	3	1.16	1	10	3.5	1	1	0.17
17	Intermediate Egret	<i>Mesophyx intermedia</i>	4	22	8	1	2	1	2	19	7	5	25	9.33	1	13	8	1	50	9.17
18	Little Egret	<i>Egretta garzetta</i>	1	8	1.8	1	3	1	1	18	5.2	2	20	6.66	1	6	2.75	1	98	16.67
19	Western Reef Egret	<i>Egretta gularis</i>	1	2	0.6	1	1	0.5	1	1	0.4	2	10	4.16	0	0	0	1	1	0.17
20	Little Cormorant	<i>Phalacrocorax niger</i>	1	21	5.2	2	14	3.16	16	33	9.8	1	38	18.33	2	25	8	1	5	2.33
21	Indian Cormorant	<i>Phalacrocorax fuscicollis</i>	1	1	0.2	1	1	0.16	0	0	0	0	0	0	1	1	0.25	0	0	0
22	Black-winged Kite	<i>Elanus caeruleus</i>	0	0	0	23	23	3.83	22	22	4.4	0	0	0	0	0	0	0	0	0
23	Brahminy Kite	<i>Heliastur indus</i>	0	0	0	0	0	0	0	0	0	2	2	0.33	0	0	0	1	1	0.17
24	Osprey	<i>Pandion haliaetus</i>	1	1	0.2	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0.17
25	Western Marsh Harrier	<i>Circus aeruginosus</i>	3	3	0.6	1	1	0.16	0	0	0	1	1	0.16	0	0	0	1	4	1.33
26	White-breasted Waterhen	<i>Anaouornis phoeniceus</i>	0	0	0	0	0	0	0	0	0	2	2	0.66	1	1	0.5	0	0	0
27	Purple Swampphen	<i>Porphyrio porphyrio</i>	2	8	4.2	0	0	0	0	0	0	2	2	0.33	0	0	0	0	0	0
28	Common Moorhen	<i>Gallinula chloropus</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0.17
29	Eurasian Coot	<i>Fulica atra</i>	2	69	42.2	0	0	0	8	8	1.6	5	9	3.66	0	0	0	1	8	1.5

Appendix 2. Summary statistic of observed populations of the waterbirds recorded at six wetlands
Min = Minimum; Max =Maximum

Sr. No.	COMMON NAME	SCIENTIFIC NAME	BHENDKHAL			BELPADA			NRI			PANJE			TSC			BPS		
30	Pheasant-tailed Jacana	<i>Metopidius indicus</i>	3	3	0.6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
31	Black-winged Stilt	<i>Himantopus himantopus</i>	4	17	6.6	2	6	1.33	1	3	0.8	8	200	94.33	0	0	0	1	88	15.17
32	Pied Avocet	<i>Recurvirostra avosetta</i>	0	0	0	0	0	0	0	0	0	2	2	0.33	0	0	0	0	0	0
33	Red-wattled Lapwing	<i>Vanellus indicus</i>	2	3	1.4	0	0	0	1	5	2.6	2	3	0.83	0	0	0	0	0	0
34	Pacific Golden Plover	<i>Plover Pluvialis fulva</i>	0	0	0	13	13	2.16	4	4	0.8	2	2	0.33	0	0	0	0	0	0
35	Grey Plover	<i>Pluvialis squatarola</i>	0	0	0	1	19	4.83	13	13	2.6	5	10	2.5	0	0	0	0	0	0
36	Little Ringed Plover	<i>Charadrius dubius</i>	1	1	0.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
37	Greater Sand Plover	<i>Charadrius leschenaultii</i>	0	0	0	0	0	0	0	0	0	208	1050	418	0	0	0	0	0	0
38	Lesser Sand Plover	<i>Charadrius mongolus</i>	0	0	0	4	4	0.66	0	0	0	122	3250	970.33	7	7	1.75	0	0	0
39	Ruff	<i>Philomachus pugnax</i>	0	0	0	0	0	0	0	0	0	2	2	0.33	0	0	0	0	0	0
40	Red-necked Phalarope	<i>Phalaropus lobatus</i>	0	0	0	0	0	0	0	0	0	1	1	0.16	0	0	0	0	0	0
41	Common Snipe	<i>Gallinago gallinago</i>	34	34	6.8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
42	Black-tailed Godwit	<i>Limosa limosa</i>	12	12	2.4	1	1	0.16	0	0	0	30	278	109.67	0	0	0	1	1	0.17
43	Bar-tailed Godwit	<i>Limosa lapponica</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
44	Whimbrel	<i>Numenius phaeopus</i>	0	0	0	0	0	0	2	2	0.4	9	20	6.83	0	0	0	0	0	0
45	Eurasian Curlew	<i>Numenius arquata</i>	0	0	0	0	0	0	13	15	5.6	1	80	23	74	74	18.5	0	0	0

Appendix 2. Summary statistic of observed populations of the waterbirds recorded at six wetlands
Min = Minimum; Max =Maximum

Sr. No.	COMMON NAME	SCIENTIFIC NAME	BHIENDKHAL			BELPADA			NRI			PANJE			TSC			BPS		
			1	13	2.8	4	35	6.5	9	186	69.8	17	350	136.17	5	36	10.25	1	1	0.17
46	Common Redshank	<i>Tringa totanus</i>	1	13	2.8	4	35	6.5	9	186	69.8	17	350	136.17	5	36	10.25	1	1	0.17
47	Marsh Sandpiper	<i>Tringa stagnatilis</i>	24	24	4.8	6	6	1	2	4	1.2	1	29	11.66	2	2	0.5	7	7	1.17
48	Common Greenshank	<i>Tringa nebularia</i>	2	2	0.4	2	10	2	12	12	2.4	5	27	7	3	3	0.75	0	0	0
49	Wood Sandpiper	<i>Tringa glareola</i>	0	0	0	6	6	1	0	0	0	0	0	0	0	0	0	1	1	0.17
50	Terek sandpiper	<i>Xenus cinereus</i>	0	0	0	0	0	0	0	0	0	24	24	4	0	0	0	0	0	0
51	Common Sandpiper	<i>Actitis hypoleucos</i>	11	11	2.2	0	0	0	2	3	1.6	15	15	2.5	0	0	0	1	1	0.17
52	Ruddy Turnstone	<i>Arenaria interpres</i>	0	0	0	0	0	0	2	2	0.4	0	0	0	0	0	0	0	0	0
53	Little Stint	<i>Calidris minuta</i>	60	60	12	150	194	57.33	5	5	1	505	2100	735	0	0	0	0	0	0
54	Curlew Sandpiper	<i>Calidris ferruginea</i>	0	0	0	56	56	9.33	1	1	0.2	53	3250	779	9	9	2.25	0	0	0
55	Dunlin	<i>Calidris alpina</i>	0	0	0	0	0	0	0	0	0	3	1050	175.5	1	1	0.25	0	0	0
56	Broad-billed Sandpiper	<i>Limicola falcinellus</i>	0	0	0	0	0	0	7	7	1.4	700	900	266.67	0	0	0	0	0	0
57	Caspian Gull	<i>Larus cachimans</i>	0	0	0	0	0	0	32	32	6.4	0	0	0	0	0	0	0	0	0
58	Heuglin's Gull	<i>Larus heuglini</i>	0	0	0	0	0	0	0	0	0	38	38	6.33	0	0	0	0	0	0
59	Brown-headed Gull	<i>Chroicocephalus brunnicephalus</i>	4	4	0.8	0	0	0	390	390	78	0	0	0	0	0	0	0	0	0
60	Black-headed Gull	<i>Chroicocephalus ridibundus</i>	6	6	1.2	0	0	0	10	520	106	26	26	4.33	0	0	0	0	0	0

Appendix 2. Summary statistic of observed populations of the waterbirds recorded at six wetlands
Min = Minimum; Max =Maximum

Sr. No.	COMMON NAME	SCIENTIFIC NAME	BHENDKHAL			BELPADA			NRI			PANJE			TSC			BPS		
			0	0	0	36	36	6	74	150	44.8	0	0	0	1	1	0.25	0	0	0
61	Slender-billed Gull	<i>Chroicocephalus genei</i>																		
62	Gull-billed Tern	<i>Gelochelidon nilotica</i>	7	7	1.4	7	10	2.83	13	200	42.6	10	1500	335	2	3	1.25	0	0	0
63	Caspian Tern	<i>Hydroprogne caspia</i>	0	0	0	1	1	0.16	8	8	1.6	10	59	21.83	0	0	0	0	0	0
64	Common Tern	<i>Sterna hirundo</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
65	Whiskered Tern	<i>Chlidonias hybrida</i>	5	6	2.2	1	1	0.16	20	390	87.4	7	872	317.5	0	0	0	6	78	19.67
66	Indian Skimmer	<i>Rynchops albigollis</i>	0	0	0	0	0	0	0	0	0	1	1	0.16	0	0	0	0	0	0
67	White-throated Kingfisher	<i>Halcyon smyrnensis</i>	1	1	0.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
68	Common Kingfisher	<i>Alcedo atthis</i>	1	1	0.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Total		321	1101	282.8	536	736	185.5	791	7679	1639	1898		5087.5	164	978	270	754	1093	226.2

Appendix 3. **List of threatened birds in the study area**

SR. NO.	SPECIES	IUCN STATUS
1	Painted Stork <i>Mycteria leucocephala</i>	NT
2	Lesser Flamingo <i>Phoenicopterus minor</i>	NT
3	Black-headed Ibis <i>Threskiornis melanocephalus</i>	NT
4	Black-tailed Godwit <i>Limosa limosa</i>	NT
5	Asian Dowitcher <i>Limnodromus semipalmatus</i>	NT
6	Eurasian Curlew <i>Numenius arquata</i>	NT
7	Curlew Sandpiper <i>Calidris ferruginea</i>	NT
8	Indian Skimmer <i>Rynchops albicollis</i>	VU

Plate 1. Avifauna at TSC Wetland



Image 1.1: Mix flock of Little Stint *Calidris minuta*, Grey Plover *Pluvialis squatarola* and Great Knot *Calidris tenuirostris*



Image 1.2: Pacific Golden Plovers *Pluvialis fulva*



Image 1.3: Common Greenshank *Tringa nebularia*



Image 1.4: Common Redshank *Tringa totanus*



Image 1.5: Lesser Flamingos *Phoenicopterus minor* use wetlands as roosting sites during high tide



Image 1.6: Slender-billed Gull *Chroicocephalus genei*

Plate 2. Avifauna at Panje Wetland



Image 2.1: Panje Wetland



Image 2.2: Mixed flock of Lesser Sand Plover
Charadrius mongolus and Curlew Sandpiper
Calidris ferruginea



Image 2.3: Lesser Sand Plover (Sub-adult)
Charadrius mongolus



Image 2.4: Lesser Sand Plover (adult)
Charadrius mongolus



Image 2.5: Flock of Greater Flamingo
Phoenicopterus roseus



Image 2.6: Little Stint *Calidris minuta*

Plate 3. Avifauna Non-resident Indians (NRI) complex Wetland



Image 3.1: Wetland behind NRI colony



Image 3.2: Roosting flock of Lesser Flamingos
Phoenicopterus minor



Image 3.3: Flock of Lesser Flamingos
Phoenicopterus minor in flight



Image 3. 4: Intermediate Egret *Mesophoyx intermedia*



Image 3.5: Painted Stork *Mycteria leucocephala*



Image 3.6: Western Reef Egret *Egretta gularis*

Plate 4. Avifauna at Belpada Wetland



Image 4.1: Belpada Wetland



Image 4.2: Little Stint *Calidris minuta*



Image 4.3: Western Marsh Harrier *Circus aeruginosus*



Image 4.4: Osprey *Pandion haliaetus*



Image 4.5: Wood Sandpiper *Tringa glareola*



Image 4.6: Flock of Greater Flamingo
Phoenicopterus roseus

Plate 5. Avifauna at Bhendkhal Wetland



Image 5.1: Bhendkhal Wetland



Image 5.2: Common Snipe *Gallinago gallinago*



Image 5.3: Flock of Ruff *Philomachus pugnax*



Image 5.4: Flock of Common Teal *Anas crecca*



Image 5.5: Common Kingfisher *Alcedo atthis*



Image 5.6: Painted Stork *Mycteria leucocephala*

Plate 6. Avifauna at Bhandup Pumping Station



Image 6.1: Bhandup Pumping Station Wetland



Image 6.2: Mixed flock of egrets and Painted Stork
Mycteria leucocephala



Image 6.3: Northern Shoveler *Spatula clypeata*



Image 6.4: Mixed flock of Sandpipers,
Godwits and Plovers



Image 6.5: Black-winged Stilt *Himantopus himantopus*



Image 6.6: Black-tailed Godwit *Limosa limosa*

Plate 7. Avifauna at Thane Creek



Image 7.1: Flock of Lesser Flamingos *Phoenicopterus minor* floating in Thane Creek during high tide



Image 7.2: Lesser Whistling Ducks *Dendrocygna javanica* usually seen roosting on the mudflats



Image 7.3: Flock of Black-tailed Godwit *Limosa limosa*



Image 7.4: Exposed mudflat at Thane Creek during low tide



Image 7.5: Flock of Greater Flamingo *Phoenicopterus roseus* feeding on mudflat at Thane Creek



Image 7.6: Peregrine Falcon *Falco peregrinator* usually seen preying on waders

Plate 8. Bird ringing



Image 8.1: Checking wing moult of Whiskered Tern
Chlidonias hybrida



Image 8.2: Ringed individual of Red-Necked Phalarope *Phalaropus lobatus*



Image 8.3: Putting ring on Greater Flamingo
Phoenicopterus roseus



Image 8.4: Taking morphometric measurements of
Common Redshank *Tringa totanus*



Image 8.5: Putting ring on Curlew Sandpiper
Calidris ferruginea



Image 8.6: Taking morphometric measurements of
ringed individuals

Plate 9. ?????



Image 8.9: Putting flag on Greater Flamingo
Phoenicopterus roseus



Image 8.10: Releasing Greater Flamingo
Phoenicopterus roseus after ringing



Image 8.7: Curlew Sandpiper
Calidris ferruginea



Image 8.8: Common Redshank *Tringa totanus*



Image 8.9: Common Redshank *Tringa totanus*



Image 8.10: Grey Plover *Pluvialis squatarola*

Plate 10. Marking of transects, bird surveys and benthos sampling



Image 9.1: Transects were marked using numbered boards and flags



Image 9.2: Installing board with transect ID



Image 9.3: Wetland count survey



Image 9.4: Transect count survey in creek using hand rowed boat



Image 9.5: Sewing benthos samples



Image 9.6: Collection of benthos samples

