



Coastal wetlands and waterbirds of Navi Mumbai: Current status



Bombay Natural History Society

COASTAL WETLANDS AND WATERBIRDS OF NAVI MUMBAI: CURRENT STATUS

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1. Introduction

The rapid expansion of the world's urban population is a significant global driver of land-use conversion and ecosystem modification (Leston and Rodewald 2006), which has resulted into tremendous loss in the biodiversity, particularly so in tropical cities. Mumbai located in coastal plains of the Western Ghats is no exception to this. It has always been a center of development since European colonization due to its key geographic position and abundance of natural resources. It is the financial capital of the nation and ninth populous city in the world with a current population of 26.6 million (UN 2012) which would grow to 44 million by 2052 and spread over 1050 sq. km., almost double the present area of 603 sq. km. (Kamdar 2014). This means there will be tremendous pressure on the already shrunken natural habitats, especially mangroves and remnant forest patches, that will eventually impact the local biodiversity (Nagendra et al. 2013). While looking at the coastal nature of the city, loss of the biodiversity, natural vegetation in particular, may not only leaves the city vulnerable to local environmental issues such as floods, runoff of pollutants, reduction in the groundwater but also global disasters like cyclone, tsunamis and sea level rise due to global climate change (Kleppel et al. 2006). Therefore, it is indeed crucial now to know how changing land use patterns would influence the local biodiversity in this region for its conservation and management.

Mumbai is a well-known and important site for migratory birds due to its extensive mudflats, favorite foraging areas for shorebirds— some of the key areas are Mahul-Sewri Creek, Thane Creek and wetlands and Navi Mumbai. These areas are under huge anthropogenic pressure, as urban lands replacing the natural habitats. Hence we shortlisted nine wetlands in Thane Creek and Navi Mumbai for investigating the status of waterbirds and wetlands. However, only six wetlands were monitored considering their high potential to support and sustain large populations of waterbirds (Map 1). All these wetlands were used by birds as high tide roosting sites. Local people also utilized these wetlands for fishing and salt farming and hence their water level is controlled by tide gates and pipe culverts. These wetlands are diverse in size, depth, distance from shore and surrounding habitat: Bhendkhal is a smallest (8 ha) and Panje is the largest wetland (124 ha); Non-Residential Indian (NRI) complex and Bhandup Pumping Station (BPS) wetlands are comparatively deeper than other wetlands; Belpada and BPS are relatively distant from the shore and they are embedded in mangroves whereas NRI, TSC and Bhendkhal are surrounded by human settlements. All these factors influence the composition and abundance of the waterbirds in the wetlands.

These wetlands have an interesting ecological history. Navi Mumbai, where these wetlands are located, had been covered with large expanses of salt pans and paddy fields

till the 1970s. Tidal water was regulated by tide gates for agriculture, salt farming and fishing, however, these traditional practices were declined remarkably by 1980s. This coincided with the establishment of City and Industrial Development Corporation of Maharashtra (CIDCO), which was founded to develop this region into the new metropolitan area, now known as Navi Mumbai, in order to shift exploding population in old Mumbai. Thus, increasing land prices, changing hydrology and economy of this region due to construction activities, government policies and changing lifestyles could have made people to abandon farming and fishing. This might have brought transformation in this region — new wetlands were formed naturally in abandoned salt pans and paddy fields and artificially by soil excavation — existing wetlands became shallow or disappeared due to heavy siltation and landfilling and along with uncultivated and unmanaged lands, they were replaced by prolific growth of mangroves and scrubs.

Currently, these wetlands are in grave threat from unsustainable developmental activities, especially landfilling for residential, recreational and commercial purpose. Though these wetlands constitute a small fraction of area, they support around a quarter of a million birds belong to more than a hundred species and most of them are migratory with declining populations around the globe. Therefore, it is crucial to assess the potential of these wetlands and threats to them in order to implement the appropriate conservation and management actions for long term preservation of these habitats. We conducted monthly bird counts on all six wetlands from January to September 2018 and examined their water regulation mechanism and threats. In addition, we also collected secondary data from fishermen, farmers and other local people on past and present ecological history of this region and particularly of these wetlands. We did the supervised classification of Landsat images of 1973, 1987, 2002 and 2018 for quantifying land use and land cover change around these wetlands. Nine categories were finalized for classification, viz., seawater, salt pan, mudflat, settlement, agriculture, settlement, mangrove, closed forest (semi-evergreen and moist deciduous forest) and open forest (grassland and scrub). We not included seawater and mudflat in quantitative analysis, as seawater was not a category of interest and area of mudflat captured in the satellite image is depends on tide which was not constant in images we studied. Based on these multiple sources of information we assessed the current status of waterbirds and wetlands in Navi Mumbai and suggested actions for their conservation.

2. Wetlands

2.1. Panje Wetland

1. Characteristics

Location: This wetland is located on the west of Dongri and Panje villages (18°54'0.95"N, 72°57'2.04"E). It is enclosed by 8-10 feet high concrete wall and therefore almost isolated from tidal influence. West side of the wetland bordered with a narrow patch of mangrove (300–500m wide and 1.5 km long), whereas east side surrounded with degraded mangroves, villages and roads. Internally, the wetland is divided into a number of compartments using soil bunds, usually, most of the area is shallow but some parts are excavated and deepened for fishing. These areas are transformed into reeds.

Area: 124 ha

Number of bird species: 50 (Table 2.1.2)

Number of individuals: 565 (minimum)–11560 (maximum). The numbers of birds in the winter season can reach up to 50,000, however frequently observed numbers fluctuate between 15000 to 20000.

Number of migratory species: 31

Number of near-threatened species: 6

Number of vulnerable species: 1

Wildlife Protection Act schedule species: Schedule I–5, Schedule IV –45

Remark: The site was notified as a Special Economic Zone (SEZ) of Uran, Navi Mumbai in 2009.

2. Water control

A narrow creek on the west side of the wetland runs in the northwest to southeast direction from Mora to Funde, is replenishes it through discharging water during high tide. However, the quantity of water entering the wetland is controlled by a tidal gate (Image 1) and three single concrete pipe culverts on this creek (Map 4; Images 2-4). A tidal gate is located (18°53'41.25"N, 72°56'50.14"E) on the southwest of the wetland. It is about 40m wide and 7-8m high with two rows of square iron flap valves (35 above and 35 below). This gate is constructed and monitored by CIDCO. The wetland also has three single concrete pipe culverts (<1m diameter), two located on northwest (18°54'24.14"N, 72°56'34.35"E; 18°54'11.24"N, 72°56'44.59"E) and one on southwest

(18°53'39.18"N, 72°57'4.78"E). These culverts are operated by local fisherman from Panje and Dongri villages.

During our site visit on 3rd October 2018 tidal gate was under maintenance, replacing old flaps and installing additional new flaps (some valves are open for a long period due to lack of flaps). We saw only four flaps from the lower row were open. Discussion with local people and gate operator revealed that 10 flaps must be opened to maintain the desirable water level in the wetland, opening 30–35 flaps would be recommended for the ideal water level in wetland and villages. Obstruction of high tidal water movement around the villages by tidal gate had altered local hydrology and created health-related issues in villages, viz., Panje, Dongri, Funde and Bokadvira. A restricted flow of tidal water had created stagnated water bodies around these villages which were excellent breeding grounds for mosquitoes and other parasites, those otherwise could be controlled by the natural tidal movement of water.

3. Chronology of wetland: Please refer to map 2, map 10, fig.1.

Table 2.1.1. Chronology of land use and land cover change in 2.5km radius circle around Panje Wetland (% = proportion of the land use or land cover category, ha = area of land use or land cover category in hectare).

	Mangrove		Saltpan		Wetland		Settlement		Open Forest		Closed Forest		Agriculture	
	%	ha	%	ha	%	ha	%	ha	%	ha	%	ha	%	ha
1973	9.25	136.42	6.20	91.42	7.48	110.36	8.34	123.00	11.96	176.48	5.83	85.98	50.95	751.71
1987	15.53	270.57	3.88	67.66	3.96	68.95	14.37	250.28	13.32	232.01	4.77	83.17	44.17	769.50
2002	19.18	426.30	9.49	210.87	0.79	17.63	27.24	605.61	15.38	341.80	1.50	33.26	26.43	587.48
2018	27.19	645.65	0.32	7.56	4.90	116.48	42.55	1010.43	10.78	256.07	1.74	41.35	12.52	297.28

Table 2.1.2. Protection and conservation status and summary statistic of observed populations of the waterbirds at Panje Wetland from January to September 2018.

WLPA=Wildlife Protection Act; IUCN=International Union for Conservation of Nature; LC=Least concerned; NT=Near threatened; V=Vulnerable; M=Migratory; R=Residential; Min=Minimum; Max=Maximum.

Common name	Scientific name	WLPA Status	IUCN Status	M/R	Min	Max	Mean
Lesser Whistling Duck	<i>Dendrocygna javanica</i>	IV	LC	M	4	200	35.33
Ruddy Shelduck	<i>Tadorna ferruginea</i>	IV	LC	M	5	5	0.83
Indian Spot-billed Duck	<i>Anas poecilorhyncha</i>	IV	LC	R	11	21	10.67
Little Grebe	<i>Tachybaptus ruficollis</i>	IV	LC	R	3	4	1.17
Painted Stork	<i>Mycteria leucocephala</i>	IV	NT	R	9	185	39.17
Greater Flamingo	<i>Phoenicopterus roseus</i>	I	LC	M	15	1500	411.67
Lesser Flamingo	<i>Phoeniconaias minor</i>	I	NT	M	1	432	78.50
Black-headed Ibis	<i>Threskiornis melanocephalus</i>	IV	NT	R	1	6	1.50
Glossy Ibis	<i>Plegadis falcinellus</i>	IV	LC	M	12	37	10.67

Eurasian Spoonbill	<i>Platalea leucorodia</i>	I	LC	M	2	70	19.83
Indian Pond Heron	<i>Ardeola grayii</i>	IV	LC	R	1	3	0.67
Grey Heron	<i>Ardea cinerea</i>	IV	LC	R	2	5	2.17
Purple Heron	<i>Ardea purpurea</i>	IV	LC	R	1	5	1.17
Great Egret	<i>Casmerodius albus</i>	IV	LC	R	2	3	1.17
Intermediate Egret	<i>Mesophoyx intermedia</i>	IV	LC	R	5	25	9.33
Little Egret	<i>Egretta garzetta</i>	IV	LC	R	2	20	6.67
Western Reef Egret	<i>Egretta gularis</i>	IV	LC	R	2	10	4.17
Little Cormorant	<i>Phalacrocorax niger</i>	IV	LC	R	1	38	18.33
Brahminy Kite	<i>Heliastur indus</i>	I	LC	R	2	2	0.33
Western Marsh Harrier	<i>Circus aeruginosus</i>	I	LC	M	1	1	0.17
White-breasted Waterhen	<i>Amaurornis phoenicurus</i>	IV	LC	R	2	2	0.67
Purple Swamphen	<i>Porphyrio porphyrio</i>	IV	LC	R	2	2	0.33
Eurasian Coot	<i>Fulica atra</i>	IV	LC	R	5	9	3.67
Black-winged Stilt	<i>Himantopus himantopus</i>	IV	LC	R	8	200	94.33
Pied Avocet	<i>Recurvirostra avosetta</i>	IV	LC	M	2	2	0.33
Red-wattled Lapwing	<i>Vanellus indicus</i>	IV	LC	R	2	3	0.83
Pacific Golden Plover	<i>Plover Pluvialis fulva</i>	IV	LC	M	2	2	0.33
Grey Plover	<i>Pluvialis squatarola</i>	IV	LC	M	5	10	2.50
Greater Sand Plover	<i>Charadrius leschenaultii</i>	IV	LC	M	208	1050	418
Lesser Sand Plover	<i>Charadrius mongolus</i>	IV	LC	M	122	3250	970.33
Ruff	<i>Philomachus pugnax</i>	IV	LC	M	2	2	0.33
Red-necked Phalarope	<i>Phalaropus lobatus</i>	IV	LC	M	1	1	0.17
Black-tailed Godwit	<i>Limosa limosa</i>	IV	NT	M	30	278	109.67
Whimbrel	<i>Numenius phaeopus</i>	IV	LC	M	9	20	6.83
Eurasian Curlew	<i>Numenius arquata</i>	IV	NT	M	1	80	23
Common Redshank	<i>Tringa totanus</i>	IV	LC	M	17	350	136.17
Marsh Sandpiper	<i>Tringa stagnatilis</i>	IV	LC	M	1	29	11.67
Common Greenshank	<i>Tringa nebularia</i>	IV	LC	M	5	27	7
Terek sandpiper	<i>Xenus cinereus</i>	IV	LC	M	24	24	4
Common Sandpiper	<i>Actitis hypoleucos</i>	IV	LC	M	15	15	2.50
Little Stint	<i>Calidris minuta</i>	IV	LC	M	505	2100	735
Curlew Sandpiper	<i>Calidris ferruginea</i>	IV	NT	M	53	3250	779
Dunlin	<i>Calidris alpina</i>	IV	LC	M	3	1050	175.50
Broad-billed Sandpiper	<i>Limicola falcinellus</i>	IV	LC	M	700	900	266.67
Heuglin's Gull	<i>Larus heuglini</i>	IV	LC	M	38	38	6.33
Black-headed Gull	<i>Chroicocephalus ridibundus</i>	IV	LC	M	26	26	4.33
Gull-billed Tern	<i>Gelochelidon nilotica</i>	IV	LC	M	10	1500	335
Caspian Tern	<i>Hydroprogne caspia</i>	IV	LC	M	10	59	21.83
Whiskered Tern	<i>Chlidonias hybrida</i>	IV	LC	M	7	872	317.50
Indian Skimmer	<i>Rynchops albicollis</i>	IV	V	M	1	1	0.17

2.2. Belpada Wetland

1. Characteristics

Location: This wetland is located (18°55'45.68"N, 72°59'50.68"E) on the northwest of Belpada village, Uran tahsil. It is situated between two narrow creeks on the east and west sides and surrounded by mangroves. This wetland also has scattered patches of mangroves.

Area: 30 ha

Number of bird species: 30 (Table 2.2.2)

Number of individuals: 15 (minimum)–605 (maximum)

Number of migratory species: 19

Number of near-threatened species: 5

Wildlife Protection Act schedule species: Schedule I–5, Schedule IV –25

2. Water control

In this wetland during high tide water enters from both the creeks. East side of the wetland is bordered by the creek (about 30–40m wide) which has sluice gate at beginning of the wetland (18°55'55.54"N, 73°0'5.76"E; Map 5). However, water from this creek enters into wetland through single concrete pipe culvert (18°55'48.61"N, 73°0'1.12"E). Similarly, two narrow channels after flowing 400–500m from west creek drain into the wetland through single concrete pipe culverts at the west (18°55'49.51"N, 72°59'43.64"E) and south (18°55'34.64"N, 72°59'43.90"E). This wetland was used for fishing by local people but currently (after 2017) the channels are not being monitored.

3. Chronology of wetland: Please refer to map 2 and map 10, and fig.1.

Table 2.2.1. Chronology of land use and land cover change in 2.5km radius circle around Belpada Wetland (% = proportion of the land use or land cover category, ha = area of land use or land cover category in hectare).

	Mangrove		Saltpan		Wetland		Settlement		Open Forest		Closed Forest		Agriculture	
	%	ha	%	ha	%	ha	%	ha	%	ha	%	ha	%	ha
1973	15.21	298.66	13.82	271.29	7.54	147.98	6.56	128.75	16.32	320.38	2.83	55.62	37.73	740.82
1987	31.23	464.34	0.41	6.09	1.57	23.30	15.19	225.83	21.76	323.43	0.31	4.62	29.53	439.01
2002	17.30	407.50	0.74	17.51	5.55	130.66	27.64	650.94	8.92	210.15	0.04	0.83	39.82	937.85
2018	40.74	972.49	0.00	0.00	2.22	53.00	53.64	1280.29	3.15	75.15	0.02	0.37	0.23	5.52

Table 2.2.2. Protection and conservation status and summary statistic of observed populations of the waterbirds at Belpada Wetland from January to September 2018.

WLPA=Wildlife Protection Act; IUCN=International Union for conservation of Nature; LC=Least concerned; NT=Near threatened; M=Migratory; R=Residential; Min=Minimum; Max=Maximum.

Common name	Scientific name	WLPA status	IUCN status	M/R	Min	Max	Mean
Lesser Whistling Duck	<i>Dendrocygna javanica</i>	IV	LC	M	3	50	8.83
Indian Spot-billed Duck	<i>Anas poecilorhyncha</i>	IV	LC	R	4	11	2.50
Painted Stork	<i>Mycteria leucocephala</i>	IV	NT	R	16	16	2.67
Greater Flamingo	<i>Phoenicopterus roseus</i>	I	LC	M	180	200	63.33
Lesser Flamingo	<i>Phoeniconaias minor</i>	I	NT	M	10	10	1.67
Black-headed Ibis	<i>Threskiornis melanocephalus</i>	IV	NT	R	1	1	0.17
Eurasian Spoonbill	<i>Platalea leucorodia</i>	I	LC	M	1	4	0.83
Grey Heron	<i>Ardea cinerea</i>	IV	LC	R	1	1	0.17
Intermediate Egret	<i>Mesophoyx intermedia</i>	IV	LC	R	1	2	1
Little Egret	<i>Egretta garzetta</i>	IV	LC	R	1	3	1
Western Reef Egret	<i>Egretta gularis</i>	IV	LC	R	1	1	0.50
Little Cormorant	<i>Phalacrocorax niger</i>	IV	LC	R	2	14	3.17
Indian Cormorant	<i>Phalacrocorax fuscicollis</i>	IV	LC	R	1	1	0.17
Black-winged Kite	<i>Elanus caeruleus</i>	I	LC	R	23	23	3.83
Western Marsh Harrier	<i>Circus aeruginosus</i>	I	LC	M	1	1	0.17
Black-winged Stilt	<i>Himantopus himantopus</i>	IV	LC	R	2	6	1.33
Pacific Golden Plover	<i>Plover Pluvialis fulva</i>	IV	LC	M	13	13	2.17
Grey Plover	<i>Pluvialis squatarola</i>	IV	LC	M	1	19	4.83
Lesser Sand Plover	<i>Charadrius mongolus</i>	IV	LC	M	4	4	0.67
Black-tailed Godwit	<i>Limosa limosa</i>	IV	NT	M	1	1	0.17
Common Redshank	<i>Tringa totanus</i>	IV	LC	M	4	35	6.50
Marsh Sandpiper	<i>Tringa stagnatilis</i>	IV	LC	M	6	6	1
Common Greenshank	<i>Tringa nebularia</i>	IV	LC	M	2	10	2
Wood Sandpiper	<i>Tringa glareola</i>	IV	LC	M	6	6	1
Little Stint	<i>Calidris minuta</i>	IV	LC	M	150	194	57.33
Curlew Sandpiper	<i>Calidris ferruginea</i>	IV	NT	M	56	56	9.33
Slender-billed Gull	<i>Chroicocephalus genei</i>	IV	LC	M	36	36	6
Gull-billed Tern	<i>Gelochelidon nilotica</i>	IV	LC	M	7	10	2.83
Caspian Tern	<i>Hydroprogne caspia</i>	IV	LC	M	1	1	0.17
Whiskered Tern	<i>Chlidonias hybrida</i>	IV	LC	M	1	1	0.17

2.3. Bhendkhal Wetland

1. Characteristics

Location: This site is located (18°52'21.68"N, 72°59'10.42"E) south of Bhendkhal village, Uran tahsil. It has six wetlands, a freshwater wetland (on northwest) and five saltwater wetlands. These wetlands are surrounded by mangroves on east and west sides, the north side is delimited with settlement while the south side is bordered by a creek.

Area: 8 ha

Number of bird species: 40 (Table 2.3.2)

Number of individuals: 42 (minimum)–814 (maximum)

Number of migratory species: 19

Number of near-threatened species: 3

Wildlife Protection Act schedule species: Schedule I–4, Schedule IV –36

Remark: The site was notified as a Special Economic Zone (SEZ) of Uran, Navi Mumbai.

2. Water control

Though south and east sides of the wetland are 150m away from a broad creek (200m wide), water enters in it through two single concrete pipe culverts on north (18°52'25.51"N, 72°59'20.92"E; 18°52'22.91"N, 72°59'23.42"E; Map 6). These channels are very narrow, 160–170m long and flow through a small patch of mangrove on the east. Currently, the water intake was reduced due to landfilling and other ongoing construction activities. The freshwater wetland is totally depended on rainfall for water and become dry soon after the rainy season.

3. Chronology of wetland: Please refer to map 2 and map 10, and fig.1.

Table 2.3.1. Chronology of land use and land cover change in 2.5km radius circle around Bhendkhal Wetland (% = proportion of the land use or land cover category, ha = area of land use or land cover category in hectare).

	Mangrove		Saltpan		Wetland		Settlement		Open Forest		Closed Forest		Agriculture	
	%	ha	%	ha	%	ha	%	ha	%	ha	%	ha	%	ha
1973	10.99	183.79	0.97	16.16	10.36	173.24	6.36	106.41	0.53	8.89	1.13	18.94	69.66	1165.19
1987	17.18	285.97	3.48	57.87	1.75	29.16	5.46	90.90	0.38	6.25	0.02	0.37	71.73	1193.62
2002	13.50	256.95	5.21	99.26	1.38	26.36	32.73	623.15	2.71	51.55	0.10	1.84	44.37	844.68
2018	26.21	538.46	0.00	0.00	4.33	88.97	40.57	833.51	1.90	39.07	0.08	1.63	26.92	553.10

Table 2.3.2. Protection and conservation status and summary statistic of observed populations of the waterbirds at Bhendkhal Wetlands from January to September 2018.

WLPA=Wildlife Protection Act; IUCN=International Union for Conservation of Nature; LC=Least concerned; NT=Near threatened, M=Migratory; R=Residential; Min=Minimum; Max=Maximum.

Common name	Scientific name	WLPA Status	IUCN Status	M/R	Min	Max	Mean
Lesser Whistling Duck	<i>Dendrocygna javanica</i>	IV	LC	M	4	550	112.80
Ruddy Shelduck	<i>Tadorna ferruginea</i>	IV	LC	M	3	3	0.60
Indian Spot-billed Duck	<i>Anas poecilorhyncha</i>	IV	LC	R	3	67	20.40
Little Grebe	<i>Tachybaptus ruficollis</i>	IV	LC	R	45	3	1
Painted Stork	<i>Mycteria leucocephala</i>	IV	NT	R	51	47	18.40
Greater Flamingo	<i>Phoenicopterus roseus</i>	I	LC	M	1	51	10.20
Black-headed Ibis	<i>Threskiornis melanocephalus</i>	IV	NT	R	1	2	1
Glossy Ibis	<i>Plegadis falcinellus</i>	IV	LC	M	1	1	0.20
Eurasian Spoonbill	<i>Platalea leucorodia</i>	I	LC	M	8	8	1.60
Indian Pond Heron	<i>Ardeola grayii</i>	IV	LC	R	1	4	1
Grey Heron	<i>Ardea cinerea</i>	IV	LC	R	1	1	0.60
Purple Heron	<i>Ardea purpurea</i>	IV	LC	R	2	15	3.40
Cattle Egret	<i>Bubulcus ibis</i>	IV	LC	R	5	5	1
Great Egret	<i>Casmerodius albus</i>	IV	LC	R	1	4	1.40
Intermediate Egret	<i>Mesophoyx intermedia</i>	IV	LC	R	4	22	8
Little Egret	<i>Egretta garzetta</i>	IV	LC	R	1	8	1.80
Western Reef Egret	<i>Egretta gularis</i>	IV	LC	R	1	2	0.60
Little Cormorant	<i>Phalacrocorax niger</i>	IV	LC	R	1	21	5.20
Indian Cormorant	<i>Phalacrocorax fuscicollis</i>	IV	LC	R	1	1	0.20
Osprey	<i>Pandion haliaetus</i>	I	LC	M	1	1	0.20
Western Marsh Harrier	<i>Circus aeruginosus</i>	I	LC	M	3	3	0.60
Purple Swampphen	<i>Porphyrio porphyrio</i>	IV	LC	R	2	8	4.20
Eurasian Coot	<i>Fulica atra</i>	IV	LC	R	2	69	42.20
Pheasant-tailed Jacana	<i>Metopidius indicus</i>	IV	LC	R	3	3	0.60
Black-winged Stilt	<i>Himantopus himantopus</i>	IV	LC	R	4	17	6.60
Red-wattled Lapwing	<i>Vanellus indicus</i>	IV	LC	R	2	3	1.40
Little Ringed Plover	<i>Charadrius dubius</i>	IV	LC	M	1	1	0.20
Common Snipe	<i>Gallinago gallinago</i>	IV	LC	M	34	34	6.80
Black-tailed Godwit	<i>Limosa limosa</i>	IV	NT	M	12	12	2.40
Common Redshank	<i>Tringa totanus</i>	IV	LC	M	1	13	2.80
Marsh Sandpiper	<i>Tringa stagnatilis</i>	IV	LC	M	24	24	4.80
Common Greenshank	<i>Tringa nebularia</i>	IV	LC	M	2	2	0.40
Common Sandpiper	<i>Actitis hypoleucos</i>	IV	LC	M	11	11	2.20
Little Stint	<i>Calidris minuta</i>	IV	LC	M	60	60	12
Brown-headed Gull	<i>Chroicocephalus</i>	IV	LC	M	4	4	0.80
Black-headed Gull	<i>Chroicocephalus</i>	IV	LC	M	6	6	1.20
Gull-billed Tern	<i>Gelochelidon nilotica</i>	IV	LC	M	7	7	1.40
Whiskered Tern	<i>Chlidonias hybrida</i>	IV	LC	M	5	6	2.20
White-throated	<i>Halcyon smyrnensis</i>	IV	LC	R	1	1	0.20
Common Kingfisher	<i>Alcedo atthis</i>	IV	LC	R	1	1	0.20

2.4. *Training Ship Chanakya (TSC) Wetland*

1. Characteristics

Location: This wetland is located (19°0'56.54"N 73°0'20.48"E) behind the Training Ship Chanakya (TSC) Maritime Institute, Palm Beach Road, Seawoods. West side of this wetland is bound with a large patch of abandoned paddy fields and scrub (200m wide 1.5 km long), which separated from the seashore by a narrow strip of mangroves (100-200m wide and 1.5 km long). In contrast, the east side of the wetland is demarcated by palm beach road and beyond it is a dense urban settlement. Whereas north and south sides of the wetland are bordered with mangroves.

Area: 13 ha

Number of bird species: 21 (Table 2.4.2)

Number of individuals: 32 (minimum)–1174 (maximum)

Number of migratory species: 11

Number of near-threatened species: 4

Number of vulnerable species: 1

Wildlife Protection Act schedule species: Schedule I–2, Schedule IV –19

2. Water control

This wetland is replenished during high tide by small water channel (<5m wide) on the north, water also enters from the south end but don't have a well-defined channel like north (Map 7). The water level is mainly controlled by a wooden sluice gate (2–2.5m high and 2m wide; 19°1'5.85"N, 73°0'19.46"E) on the north channel and about one hectare of the area around the gate is used for fishing. Water is usually taken during the highest high tides of the month and is released back during the lowest low tides of the month to maintain the productivity of this fishing pond. However, almost 93% of the wetland is submerged in the water (>50cm deep) because of blocking the drainage of the water by the pond, this water would be used as a reserve in case fishermen failed to replenish the pond during high tide.

Discussion with local fisherman revealed that during the colonial period this entire stretch of coast from Seawood to Koparkhairane was regulated with tidal gates for production of salt and paddy and it continued till the 1970s. After that, the tidal gates were abandoned due to lack of maintenance, even though the area was used for salt production and paddy cultivation till the 1980s and early 1990s. But rapid urbanization in this area increased the prices of the lands and disturbed the local hydrodynamics of

the area on which local people depended for salt, paddy and fish. It had resulted into abandoning of agriculture, salt framing and fishing and hence entire landscape transformed into dense urban settlements, deep wetlands, shrublands and mangroves.

3. Chronology of wetland: Please refer to map 3 and map 10 and fig.1.

Table 2.4.1. Chronology of land use and land cover change in 2.5km radius circle around TSC Wetland (% = proportion of the land use or land cover category, ha = area of land use or land cover category in hectare).

	Mangrove		Saltpan		Wetland		Settlement		Open Forest		Closed Forest		Agriculture	
	%	ha	%	ha	%	ha	%	ha	%	ha	%	ha	%	ha
1973	0.47	3.88	7.54	62.95	15.07	125.88	16.16	134.93	5.27	44.01	0.97	8.09	54.53	455.38
1987	13.56	130.24	0.00	0.00	0.49	4.73	15.67	150.54	12.78	122.75	0.14	1.38	57.35	550.73
2002	19.01	199.28	0.00	0.00	8.09	84.83	69.82	732.09	2.99	31.33	0.09	0.97	0.00	0.00
2018	29.64	356.87	0.00	0.00	5.08	61.13	64.46	776.08	0.66	7.91	0.11	1.33	0.05	0.62

Table 2.4.2. Protection and conservation status and summary statistic of observed populations of the waterbirds at TSC Wetland from January to September 2018.

WLPA=Wildlife Protection Act; IUCN=International Union for Conservation of Nature; LC=Least concerned; NT=Near threatened; M=Migratory; R=Residential; Min=Minimum; Max=Maximum.

Common name	Scientific name	WLPA Status	IUCN Status	M/R	Min	Max	Mean
Indian Spot-billed Duck	<i>Anas poecilorhyncha</i>	IV	LC	R	2	9	4
Painted Stork	<i>Mycteria leucocephala</i>	IV	NT	R	1	3	1
Greater Flamingo	<i>Phoenicopterus roseus</i>	I	LC	M	45	70	28.75
Lesser Flamingo	<i>Phoeniconaias minor</i>	I	NT	M	3	700	175.75
Indian Pond Heron	<i>Ardeola grayii</i>	IV	LC	R	1	3	1.50
Grey Heron	<i>Ardea cinerea</i>	IV	LC	R	1	1	0.25
Great Egret	<i>Casmerodius albus</i>	IV	LC	R	1	10	3.50
Intermediate Egret	<i>Mesophoyx intermedia</i>	IV	LC	R	1	13	8
Little Egret	<i>Egretta garzetta</i>	IV	LC	R	1	6	2.75
Little Cormorant	<i>Phalacrocorax niger</i>	IV	LC	R	2	25	8
Indian Cormorant	<i>Phalacrocorax fuscicollis</i>	IV	LC	R	1	1	0.25
White-breasted Waterhen	<i>Amaurornis phoenicurus</i>	IV	LC	R	1	1	0.50
Lesser Sand Plover	<i>Charadrius mongolus</i>	IV	LC	M	7	7	1.75
Eurasian Curlew	<i>Numenius arquata</i>	IV	NT	M	74	74	18.50
Common Redshank	<i>Tringa totanus</i>	IV	LC	M	5	36	10.25
Marsh Sandpiper	<i>Tringa stagnatilis</i>	IV	LC	M	2	2	0.50
Common Greenshank	<i>Tringa nebularia</i>	IV	LC	M	3	3	0.75
Curlew Sandpiper	<i>Calidris ferruginea</i>	IV	NT	M	9	9	2.25
Dunlin	<i>Calidris alpina</i>	IV	LC	M	1	1	0.25
Slender-billed Gull	<i>Chroicocephalus genei</i>	IV	LC	M	1	1	0.25
Gull-billed Tern	<i>Gelochelidon nilotica</i>	IV	LC	M	2	3	1.25

2.5. Non-Residential Indian (NRI) Complex Wetland

1. Characteristics

Location: This wetland is located (19°0'24.24"N, 73° 0'42.47"E) near NRI Complex, south of TSC. West and south sides of this wetland are surrounded with mangroves, whereas northeast and southeast sides are bordered by residential apartments. It is divided into two compartments by soil bund, the smaller compartment on north and larger compartment on south. Bund on west separating this wetland from mangrove has almost a km long dirt path, planted with aesthetic trees and is used for walking and jogging. Southeast side of this wetland is also bordered with tall trees.

Area: 19 ha

Number of bird species: 37 (Table 2.5.2)

Number of individuals: 130 (minimum)–5755 (maximum)

Number of migratory species: 22

Number of near-threatened species: 4

Number of vulnerable species: 1

Wildlife Protection Act schedule species: Schedule I–3, Schedule IV –33

2. Water control

This wetland has a sluice gate (19°0'8.08"N, 73°0'47.58"E) and two single concert pipe culverts (19°0'26.02"N, 73° 0'36.12"E; 19°0'21.97"N, 73°0'37.62"E; Map 8) to control the high tide water entering in it. Pipe culverts on the west side of the wetland, about 150m apart from each other, are located on very narrow bifurcated channels (<5m wide), those drain into a comparatively larger channel located at 500m. A sluice gate is placed on a narrow channel at the south end of the wetland, this channel after flowing 400m through mangroves reaches to the shore. This wetland is mainly used for fishing hence is relatively deeper, this could be the reason it is preferred by large size birds like flamingos or birds those can swim like ducks.

3. Chronology of wetland: Please refer to map 3 and map 10, and fig.1.

Table 2.5.1. Chronology of land use and land cover change in 2.5km radius circle around

NRI complex Wetland (% = proportion of the land use or land cover category, ha = area of land use or land cover category in hectare).

	Mangrove		Saltpan		Wetland		Settlement		Open Forest		Closed Forest		Agriculture	
	%	ha	%	ha	%	ha	%	ha	%	ha	%	ha	%	ha
1973	1.53	13.05	7.79	66.40	16.77	142.95	16.91	144.17	4.48	38.20	1.22	10.43	51.29	437.24
1987	16.22	160.92	0.00	0.00	0.54	5.33	19.75	196.00	13.60	134.95	0.19	1.84	49.70	493.16
2002	16.14	171.40	0.28	3.01	8.04	85.40	68.49	727.33	3.50	37.19	0.14	1.52	3.40	36.08
2018	27.10	346.12	0.00	0.00	6.41	81.82	65.78	840.06	0.55	7.03	0.11	1.36	0.05	0.62

Table 2.5.2. Protection and conservation status and summary statistic of observed populations of the waterbirds at NRI complex Wetland from January to September 2018.

WLPA=Wildlife Protection Act; IUCN=International Union for conservation of Nature; LC=Least concerned; NT=Near threatened; M=Migratory; R=Residential; Min=Minimum; Max=Maximum.

Common name	Scientific name	WLPA	IUCN	M/R	Min	Max	Mean
Lesser Whistling	<i>Dendrocygna javanica</i>	IV	LC	M	9	9	1.80
Indian Spot-billed	<i>Anas poecilorhyncha</i>	IV	LC	R	2	5	1.80
Little Grebe	<i>Tachybaptus ruficollis</i>	IV	LC	R	1	5	1.20
Painted Stork	<i>Mycteria leucocephala</i>	IV	NT	R	25	173	59.40
Asian Openbill	<i>Anastomus oscitans</i>	IV	LC	R	0	0	0
Greater Flamingo	<i>Phoenicopterus roseus</i>	I	LC	M	74	74	14.80
Lesser Flamingo	<i>Phoeniconaias minor</i>	I	NT	M	5	5350	1071
Indian Pond Heron	<i>Ardeola grayii</i>	IV	LC	R	1	7	2.40
Grey Heron	<i>Ardea cinerea</i>	IV	LC	R	2	2	0.40
Purple Heron	<i>Ardea purpurea</i>	IV	LC	R	0	0	0
Cattle Egret	<i>Bubulcus ibis</i>	IV	LC	R	1	1	0.20
Intermediate Egret	<i>Mesophoyx intermedia</i>	IV	LC	R	2	19	7
Little Egret	<i>Egretta garzetta</i>	IV	LC	R	1	18	5.20
Western Reef Egret	<i>Egretta gularis</i>	IV	LC	R	1	1	0.40
Little Cormorant	<i>Phalacrocorax niger</i>	IV	LC	R	16	33	9.80
Black-winged Kite	<i>Elanus caeruleus</i>	I	LC	R	22	22	4.40
Eurasian Coot	<i>Fulica atra</i>	IV	LC	R	8	8	1.60
Black-winged Stilt	<i>Himantopus himantopus</i>	IV	LC	R	1	3	0.80
Red-wattled Lapwing	<i>Vanellus indicus</i>	IV	LC	R	1	5	2.60
Pacific Golden Plover	<i>Plover Pluvialis fulva</i>	IV	LC	M	4	4	0.80
Grey Plover	<i>Pluvialis squatarola</i>	IV	LC	M	13	13	2.60
Whimbrel	<i>Numenius phaeopus</i>	IV	LC	M	2	2	0.40
Eurasian Curlew	<i>Numenius arquata</i>	IV	NT	M	13	15	5.60
Common Redshank	<i>Tringa totanus</i>	IV	LC	M	9	186	69.80
Marsh Sandpiper	<i>Tringa stagnatilis</i>	IV	LC	M	2	4	1.20
Common	<i>Tringa nebularia</i>	IV	LC	M	12	12	2.40
Common Sandpiper	<i>Actitis hypoleucos</i>	IV	LC	M	2	3	1.60
Ruddy Turnstone	<i>Arenaria interpres</i>	IV	LC	M	2	2	0.40
Curlew Sandpiper	<i>Calidris ferruginea</i>	IV	NT	M	1	1	0.20
Broad-billed	<i>Limicola falcinellus</i>	IV	LC	M	7	7	1.40
Caspian Gull	<i>Larus cachinnans</i>	IV	LC	M	32	32	6.40

Brown-headed Gull	<i>Chroicocephalus</i>	IV	LC	M	390	390	78
Black-headed Gull	<i>Chroicocephalus</i>	IV	LC	M	10	520	106
Slender-billed Gull	<i>Chroicocephalus genei</i>	IV	LC	M	74	150	44.80
Gull-billed Tern	<i>Gelochelidon nilotica</i>	IV	LC	M	13	200	42.60
Caspian Tern	<i>Hydroprogne caspia</i>	IV	LC	M	8	8	1.60
Whiskered Tern	<i>Chlidonias hybrida</i>	IV	LC	M	20	390	87.40

2.6. *Bhandup Pumping Station (BPS) Wetland*

1. Characteristics

Location: This wetland is located (19°8'21.31"N, 72°57'40.10"E) on the east of Bhandup, Thane. It is completely surrounded with mangroves, except east which is occupied with salt farms.

Area: 11 ha

Number of bird species: 30 (Table 6)

A number of individuals: 12 (minimum)–3352 (maximum).

Number of migratory species: 14

Number of near-threatened species: 4

Wildlife Protection Act schedule species: Schedule I–7, Schedule IV –23

2. Water control

The water level in this wetland is controlled by iron sluice gate (19°8'19.81"N, 72°57'48.34"E) on the east (Map 9). Usually, it has deep water and occasionally used for fishing.

3. Chronology of wetland: Please refer to map 3 and map 10, and fig. 1.

Table 2.6.1. Chronology of land use and land cover change in 2.5km radius circle around BPS Wetland (% = proportion of the land use or land cover category, ha = area of land use or land cover category in hectare).

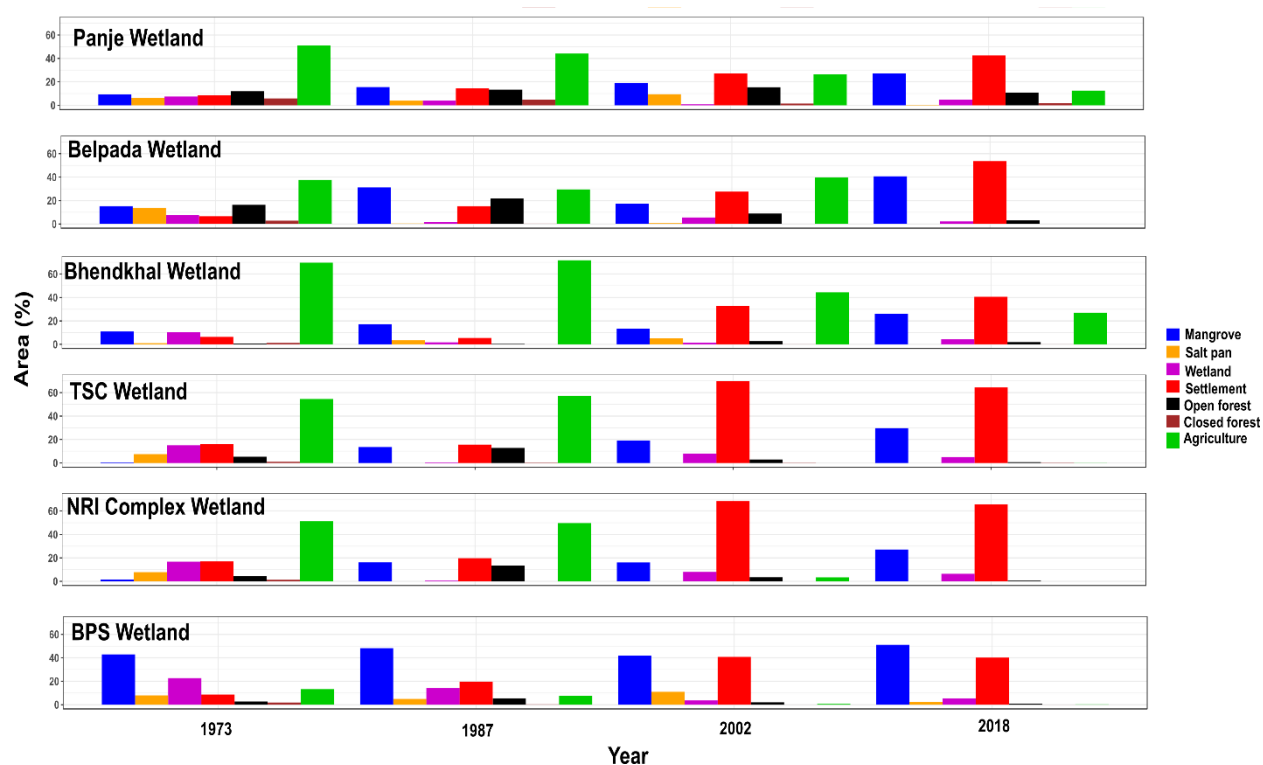
	Mangrove		Saltpan		Wetland		Settlement		Open Forest		Closed Forest		Agriculture	
	%	ha	%	ha	%	ha	%	ha	%	ha	%	ha	%	ha
1973	42.90	651.88	7.90	120.02	22.66	344.28	8.69	132.06	2.72	41.37	1.84	27.90	13.29	201.95
1987	48.23	769.83	4.90	78.16	14.05	224.26	19.68	314.20	5.37	85.73	0.29	4.60	7.48	119.44
2002	41.83	689.71	10.95	180.62	3.68	60.67	40.79	672.52	2.05	33.81	0.01	0.21	0.68	11.28
2018	51.08	999.61	2.24	43.87	5.31	103.93	40.21	786.90	0.82	15.97	0.06	1.26	0.28	5.45

Table 2.6.2. Protection and conservation status and summary statistic of observed populations of the waterbirds at BPS Wetland from January to September 2018.

WLPA=Wildlife Protection Act; IUCN=International Union for Conservation of Nature; LC=Least concerned; NT=Near threatened; M=Migratory; R=Residential; Min=Minimum; Max=Maximum.

Common name	Scientific name	WLPA Status	IUCN Status	M/R	Min	Max	Mean
Lesser Whistling Duck	<i>Dendrocygna javanica</i>	IV	LC	M	2	2	0.33
Cotton Pygmy Goose	<i>Nettapus coromandelianus</i>	IV	LC	M	5	5	0.83
Indian Spot-billed Duck	<i>Anas poecilorhyncha</i>	IV	LC	R	2	105	17.83
Garganey	<i>Anas querquedula</i>	IV	LC	M	3	3	0.50
Little Grebe	<i>Tachybaptus ruficollis</i>	IV	LC	R	1	10	2
Painted Stork	<i>Mycteria leucocephala</i>	IV	NT	R	1	18	3.17
Greater Flamingo	<i>Phoenicopterus roseus</i>	I	LC	M	2	2650	442.17
Lesser Flamingo	<i>Phoeniconaias minor</i>	I	NT	M	700	700	116.67
Black-headed Ibis	<i>Threskiornis melanocephalus</i>	IV	NT	R	2	2	0.33
Eurasian Spoonbill	<i>Platalea leucorodia</i>	I	LC	M	14	14	2.33
Indian Pond Heron	<i>Ardeola grayii</i>	IV	LC	R	1	1	0.17
Grey Heron	<i>Ardea cinerea</i>	IV	LC	R	1	4	0.83
Great Egret	<i>Casmerodius albus</i>	IV	LC	R	1	1	0.17
Intermediate Egret	<i>Mesophoyx intermedia</i>	IV	LC	R	1	50	9.17
Little Egret	<i>Egretta garzetta</i>	IV	LC	R	1	98	16.67
Western Reef Egret	<i>Egretta gularis</i>	IV	LC	R	1	1	0.17
Little Cormorant	<i>Phalacrocorax niger</i>	IV	LC	R	1	5	2.33
Black Kite	<i>Milvus migrans</i>	I	LC	R	1	1	0.50
Brahminy Kite	<i>Heliastur indus</i>	I	LC	R	1	1	0.17
Osprey	<i>Pandion haliaetus</i>	I	LC	M	1	1	0.17
Western Marsh Harrier	<i>Circus aeruginosus</i>	I	LC	M	1	4	1.33
Common Moorhen	<i>Gallinula chloropus</i>	IV	LC	R	1	1	0.17
Eurasian Coot	<i>Fulica atra</i>	IV	LC	R	1	8	1.50
Black-winged Stilt	<i>Himantopus himantopus</i>	IV	LC	R	1	88	15.17
Black-tailed Godwit	<i>Limosa limosa</i>	IV	NT	M	1	1	0.17
Common Redshank	<i>Tringa totanus</i>	IV	LC	M	1	1	0.17
Marsh Sandpiper	<i>Tringa stagnatilis</i>	IV	LC	M	7	7	1.17
Wood Sandpiper	<i>Tringa glareola</i>	IV	LC	M	1	1	0.17
Common Sandpiper	<i>Actitis hypoleucos</i>	IV	LC	M	1	1	0.17
Whiskered Tern	<i>Chlidonias hybrida</i>	IV	LC	M	6	78	19.67

A)



B)

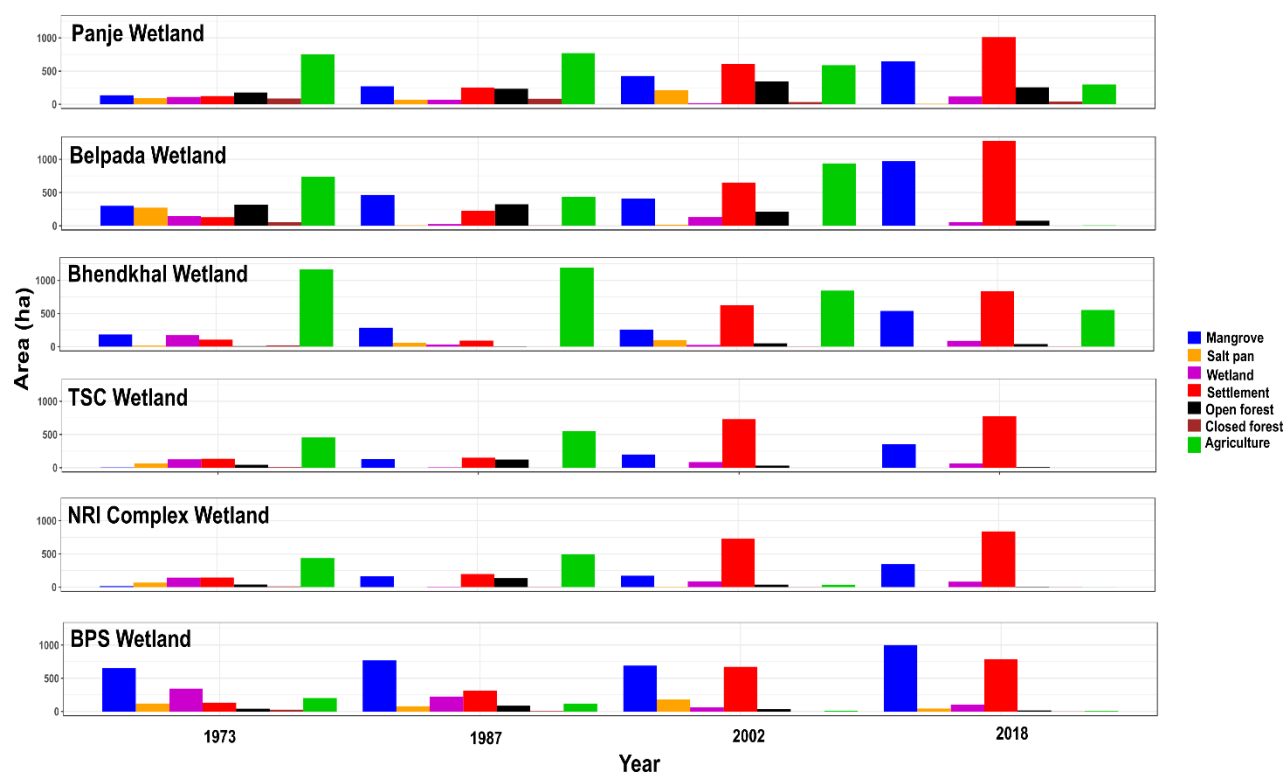


Fig. 1. Land use and land cover change in 2.5 km radius circle around wetlands in A) percentages and B) hectares.

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

4. Threats, potential consequences and conservation and management actions for the preservation of the wetlands

Wetlands	Threats	Potential consequences	Conservation and management actions
Panje Wetland	• Landfilling • Excavation • Blocking of tidal water • Intensive fishing • Health-related issues in nearby villages • Overcrowding of spectators and birdwatchers	• Partial or complete destruction of this wetland would lead to the displacement of a large population of the waterbirds, which may induce random movement of the flocks in search of suitable high tide roosts or increase competition for space and food in already existing habitat due to overpopulation. In both, the scenarios birds will be under tremendous stress and are more likely to spend much time in the air and form large flocks which seem alarming for aircraft. • Waterbirds will lose a large amount of energy	• Panje Wetland is the largest migratory waterbird congregation site in Navi Mumbai and one of the best birding sites in Maharashtra. We suggest declaring this and other wetlands as protected areas associated with Thane Creek Flamingo Sanctuary because waterbirds from the sanctuary are using these wetlands as high tide roost when sanctuary gets flooded during high tide. • One of the most critical factors in

		in search of new habitats or while competing in existing habitat or if they found suitable roost at a longer distance, ultimately, they may not store the fats (energy reserve) essential for completing their migration. It would adversely affect the survival of the birds and will impact negatively to already declining populations of these species. • Stagnation of sewage water, rainwater and tide water during highest tide in villages, especially around creek/water channels will cause serious health and hygiene issues due to blocking of hightide water. • Loss of this wetland will pose extremely high risk of bird hazard to Navi Mumbai International Airport	sustaining bird population in this wetland is the presence and depth of water, preferably less than 25cm deep (<10cm deep would be ideal). We recommend 20-25 flaps of the tidal gate should be opened periodically to replenish the wetland and pipe culverts are also operated accordingly to maintain a desirable level of water and avoid excessive draining which eventually dries the wetland. • Landfilling, excavation of soil and deepening of the wetland should be strictly prevented. • Intensive fishing should be avoided and two hours before and after high tide (total four hours) would be declared as no fishing hours. • A number of people visiting a wetland,
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			especially birdwatchers and spectators, should be regulated in order to prevent excessive stress on birds due to human disturbances. • Construction of container terminal by Port of Singapore Authority (PSA) – see addendum for details.
TSC Wetland	• Landfilling for residential, recreational and commercial development • Excavation of soil • Intensive fishing • Overcrowding of spectators and birdwatchers	• This wetland serves as a refuge for a large number of lesser flamingos and other waders. partial or complete reclamation of it will cause displacement of large flocks of birds more likely to inland wetlands at Jawaharlal Nehru Port Trust (JNPT) and Uran. This would be a matter of serious concern for upcoming Navi Mumbai International Airport (NMIA). • The water level in the wetland plays a crucial role in bird congregation and hence highwater level maintained for fishing forces birds to move in search of suitable roosting	• TSC Wetland is an important site for bird congregation during high tide as it is adjacent to mudflats of Thane-Vashi creek area which is feeding ground for a large number of wintering birds visiting Mumbai and Navi-Mumbai shores. Hence, land reclamation work should be strictly prohibited at this site. • This wetland should be declared amongst protected areas associated with Thane Creek Flamingo Sanctuary because waterbirds from the

		sites during hightide, which can result into large flocks of wandering birds in the air and it may not be the favorable situation for aircraft.	sanctuary are using it as high tide roost when sanctuary gets flooded during high tide. • Traditional fishing practices should be managed in such a way that water level in the wetland is kept ideal for birds (10-25cm deep). • The number of people visiting a wetland, especially birdwatchers and spectators, should be regulated in order to prevent excessive stress on birds due to human disturbances.
NRI Wetland	• Landfilling • Intensive fishing • Overcrowding of spectators and birdwatchers	• This wetland is inhabited by large flocks of lesser flamingos, greater flamingos and ducks. Therefore, it is also overcrowded with spectators and birdwatchers. This disturbance along with other human disturbances such as construction, landfill reclamation and modification of wetland for	• Traditional fishing practices should be managed in such a way that water level in the wetland is kept ideal for birds (10-25cm deep). • The number of people visiting a wetland, especially birdwatchers and

		fishing may lead to the displacement of large flocks of birds more likely to inland wetlands at JNPT and Uran. This would be a matter of serious concern for upcoming Navi Mumbai International Airport (NMIA).	spectators, should be regulated in order to prevent excessive stress on birds due to human disturbances.
Bhendkal Wetland	Landfilling	This is a complex wetland which has fresh as well as brackish water areas. The freshwater area of this wetland is an only remaining site for residential breeding birds like purple moorhens, Eurasian coots, Spot-billed ducks and Pheasant-tailed Jacana in this area. Landfilling and excavation of this wetland will eradicate breeding grounds of these residential birds and feeding and resting grounds of migratory birds like ducks, godwits, ruff and marsh sandpipers, and displace these birds to nearby wetlands. Those wetlands would be overpopulated and likely to induce the stress among birds due to competition for limited space and food, which may put them in the air for long and it seems	It is a unique wetland, has both fresh as well as brackish water and only suitable wetland for waterbirds on the south coast of Uran-JNPT, therefore ongoing land reclamation work in this wetland must be stopped.

		hazardous while looking at a close distance of this wetland and other wetlands to NMIA.	
Belpada Wetland	• Mangrove plantation	• Waterbirds prefer to congregate at open wetlands those have low water depth and sparse vegetation. This wetland is the only remnant patch in this area which surrounded by mangroves and shrubs, but it seems more likely that resilient and dominant mangrove species like <i>Avicenia marina</i>, already growing rapidly in this region, will cover this wetland in near future. It will force birds to move in the adjoining wetlands which may result in overcrowding, competition and considerable movement of the flocks in the air.	• This wetland should be managed to improve and sustain waterbird populations. This could be achieved by simple management practices like uprooting of the mangrove saplings and cutting of the existing mangrove trees in this wetland. Plantation of mangroves in this wetland should be avoided.
BPS Wetland	• Overcrowding of spectators and birdwatchers • Intensive fishing	• This wetland is a well-known birding site and therefore always crowded with spectators, birdwatchers and photographers. This overcrowding of people can induce stress among waterbirds and they may move to other wetlands or keep flying until the high	• This wetland should be declared as protected areas associated with Thane Creek Flamingo Sanctuary because waterbirds from the sanctuary are using it as high tide roost when sanctuary gets flooded during high

		tide recedes or settle in unsuitable habitat. All these situations would adversely affect the survival of the birds and ultimately have a negative impact on their populations.	tide and it is very close to the sanctuary. • Intensive fishing should be avoided and two hours before and after high tide (total four hours) would be declared as no fishing hours. • The number of people visiting a wetland, especially birdwatchers and spectators, should be regulated in order to prevent excessive stress on birds due to human disturbances.
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5. *Images and maps*



Image 1: Tide gate on the creek at Panje Wetland. Image shows upper 35 flip valves while lower 35 valves are submerged. Currently these flaps are open allowing tidal water to flood the wetland. The closer of these flaps will kill the entire wetland



Image 2: Wooden sluice gate on the water channel at TSC.



Image 3: Single concrete pipe culvert with a door at Panje Wetland.



Image 4: Single concrete pipe culvert with fishing net at Panje Wetland.



Image 5: Ongoing landfilling activity at Jasai. Once this large wetland supported thousands of migratory birds but now it is totally destroyed.

6. *References*

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7. Addendum



Fig.2. Map showing the new container terminal (white arrow), area of the mudflat likely to affect (blue polygon) and Panje Wetland (red polygon).

Ports of Singapore Authority (PSA) constructed 1 km long container terminal on the south-eastern side of the JNPT, near Panje, Uran and was opened on 2nd February 2018. In the second phase, PSA will be going to extend this terminal 1km more by 2022 (Fig.2., Manoj, 2018)

This terminal is adjacent to Panje Wetland which is one of the most preferred high tide roosting site for the shorebirds (for details see section 2.1). Currently, the aerial distance between Mora Jetty and the terminal is 2.17 km and it will be reduced to 1.17 km after the further extension of the terminal. Hence, it seems likely that it will affect the water movement in the existing mudflat and roughly 700 ha of the area will be going to influence. It may have adverse impact on the shorebirds because they mainly feed on the benthic fauna in the mudflats and due to restricted movement of water, it will diminish.

We suggest the assessment of shorebirds and benthic fauna in the potential influence area should be carried out to understand the impact of this terminal on the shorebirds and to develop an appropriate conservation plan.

8. Map legend

Map 1: Land use and land cover map of Mumbai showing wetlands monitored in this study, it is developed using band combinations of 7, 5 and 3 from Landsat 8 image taken in January 2018. Forest and mangroves appear in shades of green, the darker color indicates healthy and dense vegetation; urban areas look cyan or purple; and soil varies from dark to light brown, moist soils are darker in color. Wetlands appear dark blue and coastal water from light to dark blue.

Map 2: Land use and land cover maps of wetlands in Navi Mumbai, viz., Panje, NSPS, Bhendkhal, Jasai and Belpada were developed using band combinations 2, 3 and 4 (Landsat 1 = 1973–1987) and 7, 5 and 3 (Landsat 5, 7 and 8 = 1993–2018). Forest and mangroves appear in shades of red or green, the darker color indicates healthy and dense vegetation; urban areas look cyan or purple; and soil varies from dark to light brown, moist soils are darker in color. Extensive stretches of paddy field and salt pans can easily recognize by light to dark brownish grey in color from 1973 to 1987; while they occupied with anthropogenic structures, wetlands and mangroves from 1993 to 2018 and saltpans and barren areas appear in light green or brown. Wetlands look dark blue. Black arrows show large expanses of saltpans and paddy fields, whereas yellow arrows highlight landfilling carried out at wetlands.

Map 3: Land use and land cover maps of wetlands in Navi Mumbai, viz., NRI, TSC, and DPS were developed using band combinations 2, 3 and 4 (Landsat 1 = 1973–1987) and 7, 5 and 3 (Landsat 5, 7 and 8 = 1993–2018). Forest and mangroves appear in shades of red or green, the darker color indicates healthy and dense vegetation; urban areas look cyan or purple; and soil varies from dark to light brown, moist soils are darker in color. Extensive stretches of paddy field and salt pans can easily recognize by light to dark brownish grey in color from 1973 to 1987; while they occupied with anthropogenic structures, wetlands and mangroves from 1993 to 2018 and saltpans and barren areas appear in light green or brown. Wetlands look dark blue. Black arrows show large expanses of saltpans and paddy fields, whereas yellow arrows highlight landfilling carried out at wetlands.