



Birds of Mahi River estuary, Gujarat, India

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The Mahi River is one of the major rivers of Gujarat. The estuarine stretch extending up to 50km was considered for the present study. The vast and complex ravines of the Mahi River make the habitat more suitable for terrestrial birds just in the vicinity of the river channel. The salinity flux, a typical estuarine character, also provides a freshwater habitat upstream while the estuarine mouth downstream can be considered as a high marine influenced zone. These eventually may result in changes in the inhabitant water fowl community. Sparse studies have been carried out and documented so far for the Mahi Estuary. The estuary has been studied previously by Jadhav & Parasharya (2004) who detailed the distribution of flamingoes at Khambhat and Dhuvran (downstream of the Mahi). Work has been done on the avian diversity of Vadodara District which covers some part of the present study area (Padate et al. 2001). Moreover, literature surveys of a few years show notes of some important sightings like Black-necked Stork and Blue-tailed Bee-eater (Patel 2008). Unusual sightings of Crab Plovers (*Dromas ardeola*) have been reported by Parasharya (2008) on Dhadhar Estuary, Gulf

of Khambhat; whereas it is well reported in Gulf of Kutch (Palmer & Briggs 1986). In the present study the same was sighted at the mouth of the Mahi Estuary which could be the supportive observation and new for the upper part of Gulf of Khambhat. The present study provides a comprehensive checklist of birds of the Mahi Estuary by covering more than 15 sites along the estuarine stretch.

Study Area

The Mahi estuarine stretch extends up to 50km, from Kamboi (22°12'52.38"N & 72°37'17.89"E) to Fajalpur (22°26'08.95"N & 73°04'26.98"E) (Fig. 1). The estuarine belt covers around 50km passing through Anand, Vadodara and Bharuch districts. The uppermost reaches (Fajalpur and Vasad) typically serve as freshwater habitat with floating and emergent vegetation, very rarely having saline flux; while the lowest reaches (Kamboi and Khambhat) reflect marine habitat with daily tidal cycles. The estuarine part also provides the isolated islands in the channel and the ravines and cliffs on the adjacent banks at many sites which serve as good habitat for the terrestrial birds. Aquatic pollution due to industrial effluents is the major cause of the degradation of the habitat.

Materials and Methods

The study was conducted from August 2006 to July 2009. Salinity was measured from different sites using handheld refractometer (ERMA made) with salinity range of 1-100 ppt. Salinity less than 1ppt from upstream reaches was measured using titrimetric method (AgNO₃) (Eaton et al. 1995). For the sake of convenience, easy understanding of estuarine dynamics and to check variations in avian distribution, the estuary was divided into upstream (Fresh water condition: 0.05-0.1 ppt), midstream (Oligohaline condition: 0.09-1.6 ppt) and downstream (Euhaline condition: 9.6-39.3 ppt) based on the monitored salinity status and range. The study area was covered by delineating 15 different stations along the estuary covering all different parts. Birds were observed libitum using binoculars and identified using standard field guides (Ali 1996; Grimmett et al. 1998). Aquatic birds of the Mahi Estuary as well as the birds of the adjacent ravines/banks within the vicinity of 50m were recorded. In case of complications in identification, especially of gulls and terns, photographs were taken when possible and later identified. Data were divided into upstream, midstream and downstream and was further compiled and subjected to similarity (Jaccards and Sorenson indices) and diversity indices (Shannon-Wiener, Simpson and Berger Parker) using PAST statistical software.

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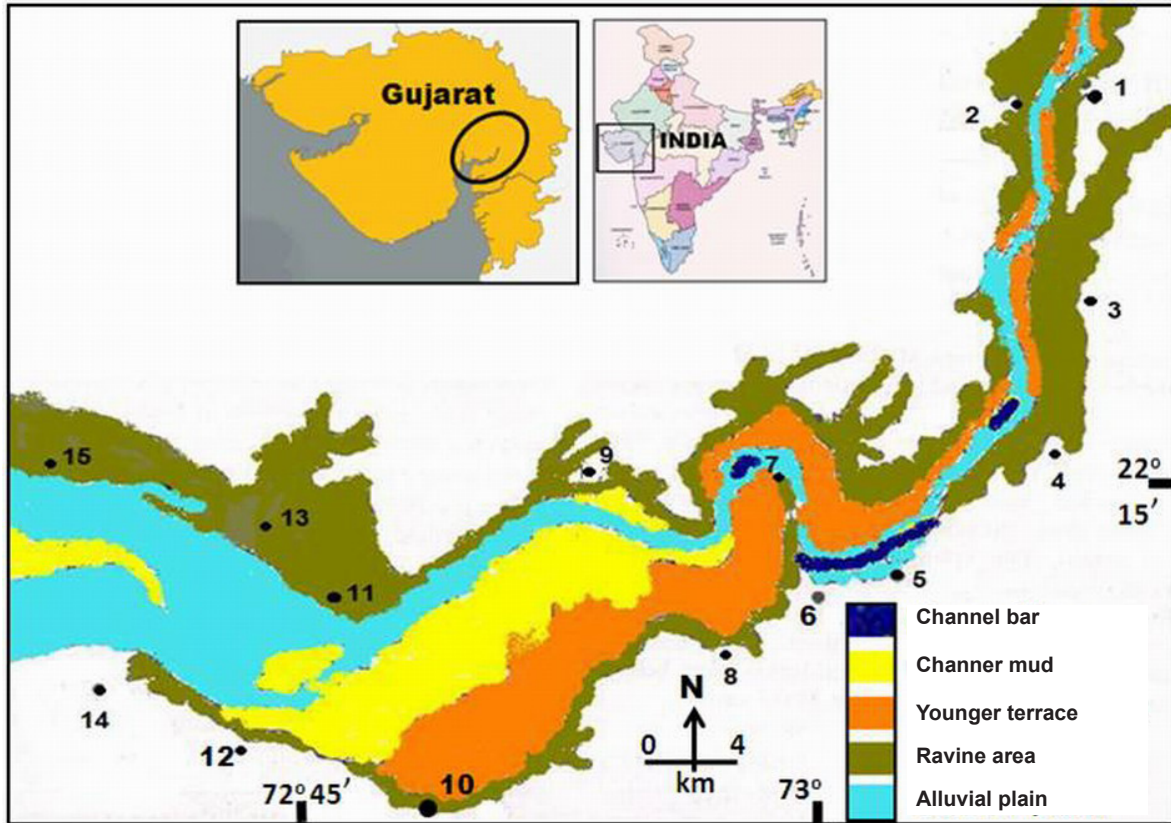


Figure 1. Study site Mahi River Estuary from Fajalpur (Vasad – Upstream) to downstream (Kamboi). Spots showing the locations of the different observation points along the river. (1-3 Upstream, 4-9 Midstream, 10-15 Downstream)
 1 - Fajalpur; 2 - Vasad; 3 - Umeta; 4 - Gambhira; 5-Mujpur; 6 - Dabka; 7 - Mohammadpura; 8 - Chokari; 9 - Badalpur; 10 - Sarod; 11 - Dhuvaran; 12 - Nahar; 13 - Bajipur; 14 - Kamboi; 15 - Khambhat.

Results and Discussion

A total of 118 species were reported belonging to 42 families during the study period (Appendix 1). Although, some of the families were represented by one or two species, family Scolopidae dominated with 10 representatives (Table 1) and was mainly confined to the lower reaches of the estuary. Species richness was higher upstream with 68 species contributing 37% of the total number followed by midstream 63 species (33%) and downstream 57 species (30%) (Fig. 2). However, no significant difference in diversities among the three zones was noted (Table 2). Jaccard’s and Sorenson’s similarity indices depicted higher similarity between upstream and midstream followed by midstream and downstream. The higher diversity in upstream and midstream can probably be attributed to the appropriate feeding landscape available for aquatic birds and the adjacent bushy habitat in the gorges and ravines for terrestrial birds.

Conclusively, it can be stated that the Mahi Estuary and the adjacent ravines/gorges and bushy habitat within provides excellent environment for a variety of birds. As the present investigation did not include a detailed study of interior ravines, further surveys in the ravines and adjacent terrestrial region can certainly make a good addition to the present checklist.

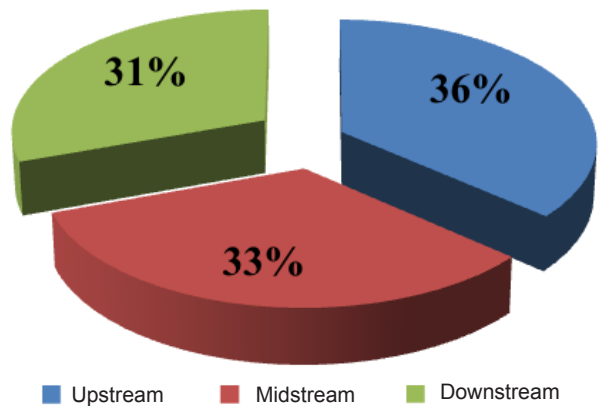


Figure 2. Percentage species richness along the three estuarine gradations.

The upstream estuarine region is closer to the Vadodara industrial zone dominated by petrochemical and other organic industries. However, the effluent discharges of these industries are released in the lower estuarine region through Asia’s longest effluent channel. Therefore, the animal diversity and density in certain polluted pockets of the lower estuarine region is very low leading to lesser diversity of dependent avifauna. The freshwater upstream site has religious importance

Table 1. Species richness of the reported families from the study area.

	Family	No. species		Family	No. species
1	Phasianidae	2	22	Podicipedidae	1
2	Anatidae	5	23	Ardeidae	9
3	Upupidae	1	24	Phoenicopteridae	1
4	Alcedinidae	2	25	Threskiornithidae	4
5	Meropidae	2	26	Pelecanidae	1
6	Cuculidae	3	27	Ciconiidae	3
7	Psittacidae	1	28	Laniidae	1
8	Apodidae	1	29	Corvidae	3
9	Strigidae	1	30	Oriolidae	1
10	Columbidae	5	31	Dicruridae	1
11	Gruidae	1	32	Thurdinae	4
12	Rallidae	3	33	Sturnidae	3
13	Rostratulidae	1	34	Hirundinidae	4
14	Scolopacidae	10	35	Pycnonotidae	2
15	Burhinidae	1	36	Cisticolidae	2
16	Recurvirostridae	1	37	Sylviidae	7
17	Charadriidae	3	38	Alaudidae	1
18	Jacaniidae	2	39	Nectariniidae	1
19	Dromadidae	1	40	Passeridae	1
20	Laridae	8	41	Montacillidae	7
21	Accipitridae	6	42	Phalacrocoracidae	1

resulting in high pilgrim pressure. However, since the long term quantitative data on pilgrim inflow is not available, it cannot be correlated with present avifaunal diversity. Further, the analysis of biomagnifications of pollutants and their influences on avifauna require a long term study; it is not possible to establish direct relationship between these factors and the present avifauna. It can be suggested that the increased human interventions in the upstream areas and the pollution stress on the downstream habitat may pressurize the estuarine complex and, if not mitigated, can eventually result in decrease in avifaunal diversity.

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Table 2. Similarity and diversity index at different estuarine zones

Study Site	Similarity Index		Study Site	Diversity Index		
	Jaccard Index SC _j	Sorrenson Index SC _s		Shannon Index	Simpson Index	Berger-Parker Index
Upstream-Midstream	0.28	0.56	Upstream	4.22	0.985	0.01
Upstream - Downstream	0.17	0.35	Midstream	4.14	0.984	0.01
Midstream - Downstream	0.26	0.53	Downstream	4.06	0.982	0.01

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Appendix 1. Checklist of birds with their location distribution.

	Family/Common name	Scientific name	Status	Up stream	Mid stream	Down stream
	Phasianidae					
1	Grey Francolin	<i>Francolinus pondicerianus</i>	RB	-	-	+
2	Indian Peafowl	<i>Pavo cristatus</i>	RB	-	-	+
	Anatidae					
3	Lesser Whistling Duck	<i>Dendrocygna javanica</i>	RB	+	+	-
4	Greylag Goose	<i>Anser anser</i>	M	+	+	-
5	Brahminy Duck	<i>Tadorna ferruginea</i>	M	+	+	-
6	Spot-billed Duck	<i>Anas poecilorhyncha</i>	RB	+	-	-
7	Comb Duck	<i>Sarkidiornis melanotos</i>	RB	+	-	-
	Upupidae					
8	Common Hoopoe	<i>Upupa epops</i>	M	-	-	+
	Alcedinidae					
9	White-throated Kingfisher	<i>Halcyon smyrnensis</i>	RB	+	+	+
10	Lesser Pied Kingfisher	<i>Ceryle rudis</i>	RB	+	+	-
	Meropidae					
11	Small Green Bee-eater	<i>Merops orientalis</i>	R	+	+	+
12	Blue-tailed Bee-eater	<i>Merops phillippinis</i>	RB	+	-	+
	Cuculidae					
13	Pied Cuckoo	<i>Clamator jacobinus</i>	rS	+	-	-
14	Asian Koel	<i>Eudynamys scolopacea</i>	RB	+	+	+
15	Greater Coucal	<i>Centropus sinensis</i>	RB	+	+	+
	Psittacidae					
16	Rose-ringed Parakeet	<i>Psittacula krameri</i>	RB	+	+	+
	Apodidae					
17	House Swift	<i>Apus affinis</i>	RB	+	-	-
	Strigidae					
18	Spotted Owlet	<i>Athene brama</i>	RB	-	+	+
	Columbidae					
19	Blue Rock Pigeon	<i>Columba livia</i>	RB	+	+	+
20	Oriental Turtle Dove	<i>Streptopelia orientalis</i>	M	-	+	+
21	Spotted Dove	<i>Streptopelia chinensis</i>	RB	-	+	+
22	Eurasian Collared Dove	<i>Streptopelia decaocto</i>	RB	-	+	-
23	Yellow-footed Green Pigeon	<i>Treron phoenicoptera</i>	RB			
	Gruidae					
24	Common Crane	<i>Grus grus</i>	M	-	+	-
	Rallidae					
25	White-breasted Waterhen	<i>Amaurornis phoenicurus</i>	RB	+	-	-
26	Purple Swamphen	<i>Porphyrio porphyrio</i>	RB	+	-	-
27	Common Coot	<i>Fulica atra</i>	RB,M	+	-	-
	Rostratulidae					
28	Fantail Snipe	<i>Gallinago gallinago</i>	M	+	-	-
	Scolopacidae					
29	Black-tailed Godwit	<i>Limosa limosa</i>	M	-	-	+
30	Eurasian Curlew	<i>Numenius arquata</i>	M	-	-	+
31	Common Redshank	<i>Tringa totanus</i>	M	-	-	+
32	Marsh Sandpiper	<i>Tringa stagnatilis</i>	M	+	+	-
33	Common Greenshank	<i>Tringa nebularia</i>	M	-	-	+
34	Green Sandpiper	<i>Tringa ochropus</i>	M	-	+	-
35	Common Sandpiper	<i>Actitis hypoleucos</i>	M	+	+	-

	Family/Common name	Scientific name	Status	Up stream	Mid stream	Down stream
36	Sanderling	<i>Calidris alba</i>	M	-	-	+
37	Little Stint	<i>Calidris minuta</i>	M	+	+	-
38	Curlew Sandpiper	<i>Calidris ferruginea</i>	M	-	-	+
	Burhinidae					
39	Great Thick-knee	<i>Esacus recurvirostris</i>	RB	+	-	-
	Recurvirostridae					
40	Black-winged Stilt	<i>Himantopus himantopus</i>	RB	+	+	-
	Charadriidae					
41	Red-wattled Lapwing	<i>Vanellus indicus</i>		+	+	+
42	Little-ringed Plover	<i>Charadrius dubius</i>	M	+	-	+
43	Kentish Plover	<i>Charadrius alexandrinus</i>	RB	-	-	+
	Jacanidae					
44	Pheasant-tailed Jacana	<i>Hydrophasianus chirurgus</i>	RB	+	-	-
45	Bronze-winged Jacana	<i>Metopidius indicus</i>	RB	+	-	-
	Dromadidae					
46	Crab Plover	<i>Dromas ardeola</i>	M	-	-	+
	Laridae					
47	Brown-headed Gull	<i>Larus brunnicephalus</i>	M	-	-	+
48	Black-headed Gull	<i>Larus ridibundus</i>	M	-	-	+
49	Slender-billed Gull	<i>Larus genei</i>	M	-	+	-
50	Yellow-legged Gull	<i>Larus cachinnans</i>	M	-	+	-
51	Gull-billed Tern	<i>Gelochelidon nilotica</i>	M	-	+	+
52	Caspian Tern	<i>Sterna caspia</i>	RB,M	-	+	+
53	River Tern	<i>Sterna aurantia</i>	RB	+	+	+
54	Common Tern	<i>Sterna hirundo</i>	M	-	+	-
	Accipitridae					
55	Black-shouldered Kite	<i>Elanus caeruleus</i>	RB	-	-	+
56	Black Kite	<i>Milvus migrans</i>	RB	+	-	-
57	Brahminy Kite	<i>Haliastur indus</i>	RB	-	+	-
58	Western Marsh Harrier	<i>Circus aeruginosus</i>	M	-	+	+
59	Montagu's Harrier	<i>Circus pygargus</i>	M	-	-	+
60	Shikra	<i>Accipiter badius</i>	RB	-	+	+
	Podicipedidae					
61	Little Grebe	<i>Tachybaptus ruficollis</i>	RB	+	-	-
	Phalacrocoracidae					
62	Little Cormorant	<i>Phalacrocorax niger</i>	RB	+	+	-
	Ardeidae					
63	Little Egret	<i>Egretta garzetta</i>	RB	+	+	-
64	Western Reef Egret	<i>Egretta gularis</i>	RB	-	+	+
65	Grey Heron	<i>Ardea cinerea</i>	RB	+	+	-
66	Purple Heron	<i>Ardea purpurea</i>	RB	+	-	-
67	Great Egret	<i>Casmerodius albus</i>	RB	-	+	+
68	Intermediate Egret	<i>Mesophoyx intermedia</i>	RB	+	+	+
69	Cattle Egret	<i>Bubulcus ibis</i>	RB	+	-	+
70	Indian Pond Heron	<i>Ardeola grayii</i>	RB	+	+	+
71	Black-crowned Night Heron	<i>Nycticorax nycticorax</i>	RB	+	-	-
	Phoenicopteridae					
72	Lesser Flamingo	<i>Phoenicopus minor</i>	RB,M	-	+	+
	Threskiornithidae					
73	Glossy Ibis	<i>Plegadis falcinellus</i>	RB,M	+	-	-

	Family/Common name	Scientific name	Status	Up stream	Mid stream	Down stream
74	Black-headed Ibis	<i>Threskiornis melanocephalus</i>	RB	+	+	-
75	Black Ibis	<i>Pseudibis papillosa</i>	RB	+	+	-
76	Eurasian Spoonbill	<i>Platalea leucorodia</i>	RB,M	-	+	-
	Pelecanidae					
77	Great White Pelican	<i>Pelecanus onocrotalus</i>	RB,M	-	+	-
	Ciconiidae					
78	Painted Stork	<i>Mycteria leucocephala</i>	RB	+	+	+
79	Asian Openbill	<i>Anastomus oscitans</i>	RB	+	+	+
80	White-necked Stork	<i>Ciconia episcopus</i>	RB	-	+	-
	Laniidae					
81	Bay-backed Shrike	<i>Lanius vittatus</i>	RB	-	-	+
	Corvidae					
82	Indian Treepie	<i>Dendrocitta vagabunda</i>	RB	+	+	+
83	House Crow	<i>Corvus splendens</i>	RB	+	+	+
84	Jungle Crow	<i>Corvus macrorhynchos</i>	RB	+	+	-
	Oriolidae					
85	Eurasian Golden Oriole	<i>Oriolus oriolus</i>	M	-	-	+
	Dicruridae					
86	Black Drongo	<i>Dicrurus macrocerus</i>	RB	+	+	+
	Turdinae					
87	Oriental Magpie Robin	<i>Copsychus saularis</i>	RB	+	+	+
88	Indian Robin	<i>Saxicoloides fulicata</i>	RB	+	+	-
89	Common Stonechat	<i>Saxicola torquata</i>	M	-	+	-
90	Pied Bushchat	<i>Saxicola caprata</i>	M	-	+	-
	Sturnidae					
91	Rosy Starling	<i>Sturnus roseus</i>	M	-	-	+
92	Common Myna	<i>Acridotheres tristis</i>	RB	+	+	+
93	Bank Myna	<i>Acridotheres ginginianus</i>	RB	+	+	+
	Hirundinidae					
94	Dusky Crag Martin	<i>Hirundo concolor</i>	RB	+	-	-
95	Common Swallow	<i>Hirundo rustica</i>	M	-	-	+
96	Wire-tailed Swallow	<i>Hirundo smithii</i>	RB	+	-	-
97	Red-rumped Swallow	<i>Hirundo daurica</i>	M	+	-	-
	Pycnonotidae					
98	White-eared Bulbul	<i>Pycnonotus leucotis</i>	RB	-	-	+
99	Red-vented Bulbul	<i>Pycnonotus cafer</i>	RB	+	+	+
	Cisticolidae					
100	Ashy Prinia	<i>Prinia socialis</i>		+	-	-
101	Plain Prinia	<i>Prinia inornata</i>		+	+	-
	Sylviidae					
102	Thick-billed Warbler	<i>Acrocephalus aedon</i>	V	-	-	+
103	Indian Great Reed Warbler	<i>Acrocephalus stentoreus</i>	RB,M	+	-	-
104	Booted Warbler	<i>Hippolais caligata</i>	M	+	-	-
105	Common Tailorbird	<i>Orthotomus sutorius</i>	RB	-	+	+
106	Common Babbler	<i>Turdoides caudatus</i>	RB	-	+	+
107	Large Grey Babbler	<i>Turdoides malcolmi</i>	RB	-	+	-
108	Jungle Babbler	<i>Turdoides striatus</i>	RB	+	+	-
	Alaudidae					
109	Black-crowned Sparrow-Lark	<i>Eremopterix nigriceps</i>	R	-	-	+

	Family/Common name	Scientific name	Status	Up stream	Mid stream	Down stream
	Nectariniidae					
110	Purple Sunbird	<i>Nectarinia asiatica</i>	RB	+	-	-
	Passeridae					
111	House Sparrow	<i>Passer domesticus</i>	RB	-	+	+
	Motacillidae					
112	White Wagtail	<i>Motacilla alba</i>	M	+	-	-
113	Large Pied Wagtail	<i>Motacilla maderaspatensis</i>	RB	+	-	-
114	Yellow Wagtail	<i>Motacilla flava</i>	M	+	-	-
115	Grey Wagtail	<i>Motacilla cinerea</i>	M	+	-	-
116	Tawny Pipit	<i>Anthus campestris</i>	M	-	-	+
117	Baya Weaver	<i>Ploceus philippinus</i>	RB	+	-	-
118	White-throated munia	<i>Lonchura malabarica</i>	RB	+	+	-

R - Residents; RB - Resident Breeding (breeding recorded in Gujarat); M - Migratory; S - Summer visitor; V - Vagrant
+ - Present, - - Absent

