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THE IMPORTANCE OF ARTIFICIAL WETLANDS IN THE CONSERVATION OF WETLAND BIRDS AND THE IMPACT OF LAND USE ATTRIBUTES AROUND THE WETLANDS: A STUDY FROM THE AJARA CONSERVATION RESERVE, WESTERN GHATS, INDIA

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The Importance of Artificial Wetlands in the Conservation of Wetland Birds and the Impact of Land Use Attributes Around the Wetlands: a Study from the Ajara Conservation Reserve, Western Ghats, India. Patil, S., Choudaj, K. — Artificial wetlands are built to meet the rising human population's water needs, with little attention paid to their ecological significance. The current study was carried out to assess the importance of artificial wetlands in biodiversity conservation. Habitat quality of wetlands was assessed using the birds as an ecological indicator. Bird surveys were carried out at the five artificial wetlands located in the Ajara conservation reserve, northern Western Ghats, India. Bird surveys were conducted for five years (2011–2015). During the study, 165 bird species were recorded, including 34 wetland birds and 131 wetland-associated birds. Wetlands in forested areas have a higher richness of wetland birds. Wetlands surrounded by exotic plantations, agriculture, and human settlements exhibit lower wetland bird richness than wetlands in forested areas. Land use attributes around the wetlands affect wetland bird diversity. The current study gives a glimpse that these artificial wetlands could serve as a possible habitat for wetland birds.
Key words: agriculture, aquatic birds, exotic plantations, forest, human, wetland ecosystem.

Introduction

The development of a freshwater ecosystem requires many years. Various organisms establish themselves one after the other during these years, eventually forming a complex unit of an ecosystem that is self-sustaining. These wetlands provide feeding, breeding, and nesting grounds for many organisms, such as fish, amphibians, reptiles, birds, etc. Wetlands encompass at least 6 % of the earth's surface area and have become a conservation priority due to the ecosystem services they provide. The main functions performed by the wetlands are water filtration, water storage, biological productivity, and habitat for wildlife. Grimmett et al. (2011) classified bird habitats into forest, scrubland, wetland (inland and littoral), marine, grassland, desert, and agricultural land.

India is the home of many species of birds, including local as well as migrant birds. They play an important role in human life — culturally, socially, and scientifically. The avifauna of the Indian subcontinent is diverse (1370 species, i. e. 13 % of the world's birds), with 141 endemic species (Grimmett et al., 2011). Wetlands, both natural and artificial, support a large number of birds, especially migratory and resident water birds, as they have high nutritive value (Paracuellos, 2006). Birds use wetlands for feeding, resting, breeding, nesting, and rearing young ones as well as for social interactions (Steward, 2007). Bird preference for wetlands is decided by food availability and the size of the wetlands (Paracuellos, 2006), abiotic factors (Jaksic, 2004; Lagos et al., 2008), and the level of disturbance.

Habitat selection of birds depends on the vegetative structure, competitors, and productivity of the habitat (Cody, 1981). Birds have a higher position at the trophic level; they are very sensitive to environmental changes and act as an ecological indicator to evaluate different habitats both qualitatively and quantitatively (Bilgrami, 1995). Several studies compared bird diversity between natural and artificial wetlands and illustrated the ecological value of artificial wetlands for birds (Bellio et al., 2009; Ma et al., 2004). Natural wetlands are altered due to anthropogenic pressure; artificial wetlands have become important habitats for birds (Bellio et al., 2009). These man-made wetlands are not substituting for natural wetlands or cannot be compared with natural wetlands, but can act as a potential alternative habitat for birds.

Maharashtra is very rich in bird fauna. In total 556 bird species were recorded (Mahabal et al., 2012), out of which 357 species were recorded from the Kolhapur District (ebird.org). Wetlands in and around Kolhapur city are hotspots for birding. Among wetlands, the highest number of bird species is recorded from Kalamba reservoir (200 species), followed by the famous Rankala lake (152 species) and Rajaram talav (126 species) (ebird.org). Many small artificial wetlands have the potential to harbour rich biodiversity that needs to be studied. This study was designed to address this research gap. In this study, we surveyed the avifaunal diversity of five artificial wetlands and their surrounding habitats from Ajara conservation reserve, located in the southern part of Kolhapur District, Maharashtra, India. The study objective was to generate information on the avian diversity of artificial wetlands that are in different habitats such as forests, exotic plantations, agriculture, and human settlements. We hypothesised that bird species richness declines with increasing human interference.

Material and methods

Study area

The current study was carried out in the Ajara conservation reserve, located in the northern Western Ghats, India (fig. 1). Ajara is famous for its natural landscape; most of the area is covered with forest and falls. The climate is moderately subtropical, with an average annual rainfall of 2000 mm. The forest found here mainly belongs to the southern moist mixed deciduous forests (3B/C2) and the west coast semi-evergreen mixed forests (2A/C2) (Champion & Seth, 1968). The study was carried out at five artificial wetlands and their surrounding habitats: Gavase, Dhangarmola, Khanapur, Erandol, and Ningudage (table 1).

Bird survey

A bird survey was carried out in the years 2011 to 2015. Bird surveys were carried out during the winter and summer seasons (October to May). Each wetland and its surrounding habitat (within 200 m from the edge of the wetland) were surveyed for wetland and wetland-associated birds. Each wetland was surveyed at least once per month in the winter and summer months. Birds were surveyed in the morning between 7.00 and 11.00 am. Some of the visits to wetlands were in the afternoon and evening. Both audio-visual cues were used for the identification of birds. Birds were observed through binoculars (Nikon 8 × 40) and photographed with a DSLR camera (Canon 600D). Birds were identified using field guides by Ali (2002) and Grimmett et al. (2011). For

Table 1. Details of the five man-made wetlands from Ajara conservation reserve

Sr. No.	Name of the Wetland	Year of construction	Submergence area in monsoon 2014, ha	Habitat surrounding wetland
1	Gavase	2003	37.04	Natural forest
2	Dhangarmola	2000	55.17	Natural forest
3	Khanapur	1995	71.48	Exotic plantation, Agriculture
4	Erandol	1998	20.71	Agriculture, Human settlement
5	Ningudage	1982	4.28	Agriculture, Human settlement

Data on the submergence area of wetlands was extracted from Patil et al. (2014).

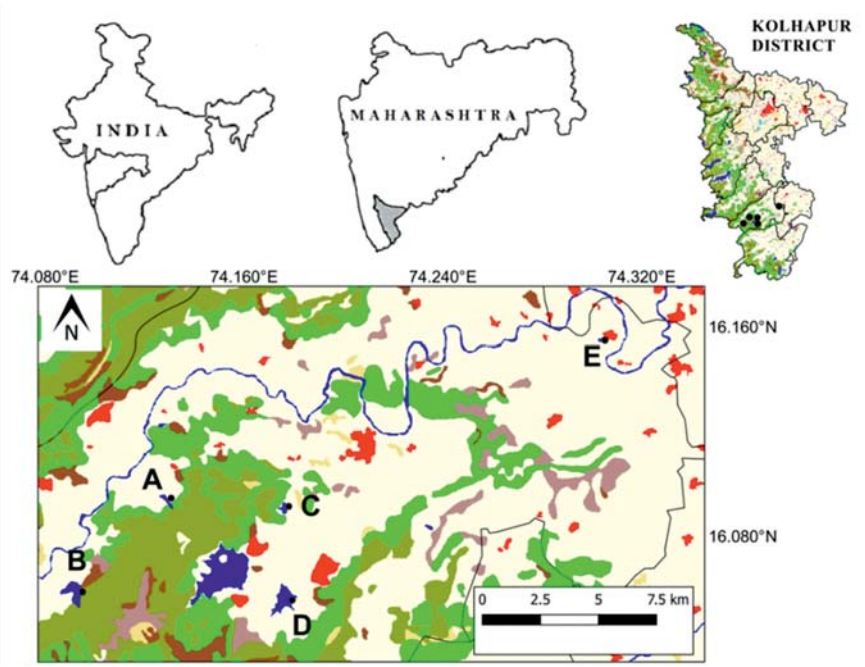

Fig. 1. Map of study sites: A — Gavase wetland, B — Dhangarmola wetland, C — Khanapur wetland, D — Erandol wetland, E — Ningudage wetland. Adopted from Patil & Choudaj (2022).

the nomenclature and taxonomy of birds, we used Praveen et al. (2016). All the birds seen were used for the preparation of two checklists; wetland birds and wetland-associated birds. All the birds recorded were classified into four foraging guilds: insectivores, predators, herbivores, and omnivores. Those who exclusively feed on insects were classified as insectivores, predators who feed on animals, herbivores that feed on leaves, fruits, berries, seeds, grains, nectar, etc., and omnivores that feed on both plants and animals. The feeding preferences of birds were extracted from Ali (2002).

Results

In this study total of 165 bird species were recorded, comprised of 34 wetland birds and 131 wetland-associated bird species (table 2 & 3). The highest number of bird species was recorded at Gavase wetland (161 species), followed by Dhangarmola (157 species), Khanapur (116 species), Erandol (97 species) and Ningudage wetland (88 species) (fig. 2). The highest numbers of wetland birds were recorded at Gavase and Dhangarmola wetlands (34 species); the lowest number was recorded at Ningudage wetland (24 bird species) (fig. 2). The highest numbers of winter migratory wetland birds were recorded at Gavase and Dhangarmola wetlands, followed by Khanapur, Erandol and Ningudage (table 2). Some wetland birds such as Ruddy Shelduck (*Tadorna ferruginea*), Little Ringed Plover (*Cha-*

Table 2. Checklist of wetland birds recorded at five man-made wetlands, Ajara conservation reserve during 2011–2015

No.	Common name, Scientific name, residential status, feeding guild	A	B	C	D	E
1	Ruddy Shelduck, *Tadorna ferruginea* (Pallas, 1764) WM, Omn	+	+	–	–	–
2	Indian Spot-billed Duck, *Anas poecilorhyncha* (J.R.Forster,1781) R, Hrb	+	+	+	+	+
3	Pied Kingfisher, *Ceryle rudis* (Linnaeus, 1758) R, Pred	+	+	+	+	+
4	White-throated Kingfisher, *Halcyon smyrnensis* (Linnaeus, 1758) R, Pred	+	+	+	+	+
5	Common Kingfisher, *Alcedo atthis* (Linnaeus, 1758) R, Pred	+	+	+	+	+
6	White-breasted, Waterhen *Amaurornis phoenicurus* (Pennant, 1769) R, Omn	+	+	+	+	+

7	Eurasian Moorhen, *Gallinula chloropus* (Linnaeus, 1758) R, Omn	+	+	+	+	+
8	Eurasian Coot, *Fulica atra* (Linnaeus, 1758) R, Omn	+	+	+	+	+
9	Common sandpiper, *Actitis hypoleucos* (Linnaeus, 1758) WM, Pred	+	+	+	+	–
10	Little Ringed Plover, *Charadrius dubius* (Scopoli, 1786) R, Pred	+	+	–	–	–
11	Small Pratincole, *Glareola lactea* (Temminck, 1820) R, Insc	+	–	–	–	–
12	River Tern, *Sterna aurantia* (J. E. Gray, 1831) R, Pred	+	+	+	+	+
13	Little Cormorant, *Microcarbo niger* (Vieillot, 1817) R, Pred	+	+	+	+	+
14	Indian Cormorant, *Phalacrocorax fuscicollis* (Stephens,1826) R, Pred	+	+	+	+	+
15	Indian Pond Heron, *Ardeola grayii* (Sykes, 1832) R, Pred	+	+	+	+	+
16	Grey Heron, *Ardea cinerea* (Linnaeus, 1758) R, Pred	+	+	+	+	+
17	Purple Heron, *Ardea purpurea* (Linnaeus, 1766) R, Pred	+	+	+	+	+
18	Black-crowned Night-Heron, *Nycticorax nycticorax* (Linnaeus, 1758) R, Pred	+	+	–	–	+
19	Great Egret, *Ardea alba* (Linnaeus, 1758) R, Pred	+	+	+	+	+
20	Intermediate Egret, *Ardea intermedia* (Wagler, 1827) R, Pred	+	+	+	+	+
21	Little Egret, *Egretta garzetta* (Linnaeus, 1766) R, Pred	+	+	+	+	+
22	Cattle Egret, *Bubulcus ibis* (Linnaeus, 1758) R, Pred	+	+	+	+	+
23	Red-naped Ibis, *Pseudibis papillosa* (Temminck, 1824) R, Omn	+	+	+	+	–
24	Black-headed Ibis, *Threskiornis melanocephalus* (Latham, 1790) R, Pred	+	+	+	+	–
25	Eurasian Spoonbill, *Platalea leucorodia* (Linnaeus, 1758) R, Pred	+	+	+	+	–
26	Painted Stork, *Mycteria leucocephala* (Pennant, 1769) R, Pred	+	+	+	+	–
27	Asian Openbill, *Anastomus oscitans* (Boddaert, 1783) R, Pred	+	+	+	–	–
28	Woolly-necked Stork, *Ciconia episcopus* (Boddaert, 1783) R, Pred	+	+	–	+	–
29	Black-winged Stilt, *Himantopus himantopus* (Linnaeus, 1758) R, Pred	+	+	+	+	–
30	Little Grebe, *Tachybaptus ruficollis* (Pallas, 1764) R, Pred	+	+	–	–	+
31	White Wagtail *Motacilla alba* (Linnaeus, 1758) WM, Insc	+	+	+	+	+
32	White-browed Wagtail, *Motacilla maderaspatensis* (Gmelin,1789) R, Insc	+	+	+	+	+
33	Western Yellow Wagtail, *Motacilla flava* (Linnaeus, 1758) WM, Insc	+	+	+	–	+
34	Grey Wagtail, *Motacilla cinerea* (Tunstall, 1771) WM, Insc	+	+	+	+	+

Note: A — Gavase Wetland; B — Dhangarmola Wetland; C — Khanapur Wetland; D — Erandol Wetland, E — Ningudage Wetland; "+" — present; "–" — absent; R — resident; WM — winter migratory; Omn — omnivore, Hrb — herbivore; Pred — predator; Insc — insectivore.

Table 3. Checklist of wetland associated birds recorded at and around the man-made wetlands, Ajara conservation reserve during 2011–2015

No.	Common name, Scientific name, residential status, feeding guild	A	B	C	D	E
1	Indian Peafowl, *Pavo cristatus* (Linnaeus, 1758) R, Omn	+	+	+	+	+
2	Grey Junglefowl, *Gallus sonneratii* (Temminck, 1813) R, Omn	+	+	+	–	–
3	Red Spurfowl, *Galloperdix spadicea* (Gmelin, 1789) R, Omn	+	+	+	–	–
4	Grey Francolin, *Francolinus pondicerianus* (Gmelin, 1789) R, Omn	+	+	+	–	–
5	Jungle Bush-Quail, *Perdicula asiatica* (Latham, 1790) R, Omn	+	+	–	–	–
6	Painted Bush-Quail, *Perdicula erythrorhyncha*(Sykes, 1832) R, Omn	+	+	–	–	–
7	Barred Buttonquail, *Turnix suscitator*(Gmelin, 1789) R, Omn	+	+	+	–	–
8	Rufous Woodpecker, *Micropternus brachyurus* (Vieillot, 1818) R, Pred	+	+	–	–	–
9	Yellow-crowned Woodpecker, *Leiopicus mahrattensis* (Latham, 1801) R, Insc	+	–	–	–	–
10	Brown-capped Pygmy Woodpecker, *Yungipicus nanus* (Vigors, 1832) R, Pred	+	+	–	–	–
11	Black-rumped Flameback, *Dinopium benghalense* (Linnaeus, 1758) R, Pred	+	–	–	–	–
12	Coppersmith Barbet, *Psilopogon haemacephalus* (Muller, 1776) R, Hrb	+	+	+	+	+
13	Brown-headed Barbet, *Psilopogon zeylanicus* (Gmelin, 1788) R, Omn	+	+	+	–	–
14	White-cheeked Barbet, *Psilopogon viridis* (Boddaert, 1783) R, Omn	+	+	+	–	–
15	Indian Grey Hornbill, *Ocyceros birostris* (Scopoli, 1786) R, Omn	+	+	+	+	+
16	Malabar Grey Hornbill, *Ocyceros griseus* (Latham, 1790) R, Omn	+	+	–	–	–
17	Malabar Pied-Hornbill, *Anthracoceros coronatus* (Boddaert, 1783) R, Omn	+	+	–	–	–

18	Great Hornbill, *Buceros bicornis* (Linnaeus, 1758) R, Omn	+	+	–	–	–
19	Common Hoopoe, *Upupa epops* (Linnaeus, 1758) R, Pred	+	+	+	+	+
20	Indian Roller, *Coracias benghalensis*(Linnaeus, 1758) R, Pred	+	+	+	+	+
21	Green Bee-eater, *Merops orientalis* (Latham, 1801) R, Insc	+	+	+	+	+
22	Chestnut-headed Bee-eater, *Merops leschenaulti* (Vieillot, 1817) R, Insc	+	+	–	–	–
23	Asian Koel, *Eudynamys scolopaceus* (Linnaeus, 1758) R, Omn	+	+	+	+	+
24	Common Hawk Cuckoo, *Hierococcyx varius* (Vahl, 1797) R, Omn	+	+	+	+	–
25	Indian Cuckoo, *Cuculus micropterus* (Gould, 1837) R, Omn	+	+	–	–	–
26	Grey-bellied Cuckoo, *Cacomantis passerinus* (Vahl, 1797) R, Insc	+	–	–	–	–
27	Blue-faced Malkoha, *Phaenicophaeus viridirostris* (Jerdon, 1840) R, Pred	+	+	–	–	+
28	Sirkeer Malkoha, *Taccocua leschenaultii* (Lesson, 1830) R, Omn	+	+	–	–	–
29	Greater Coucal, *Centropus sinensis* (Stephens, 1815) R, Pred	+	+	+	+	+
30	Fork-tailed Drongo-Cuckoo, *Surniculus dicruroides* (Hodgson, 1839) R, Pred	–	+	–	–	–
31	Vernal Hanging-Parrot, *Loriculus vernalis* (Sparrman, 1787) R, Hrb	+	+	–	–	–
32	Rose-ringed Parakeet, *Psittacula krameri* (Scopoli, 1769) R, Hrb	+	+	+	+	+
33	Plum-headed Parakeet, *Psittacula cyanocephala* (Linnaeus, 1766) R, Hrb	+	+	–	–	–
34	Alexandrine Parakeet, *Psittacula eupatria* (Linnaeus, 1766) R, Hrb	+	+	–	–	–
35	Indian Swiftlet, *Aerodramus unicolor* (Jerdon, 1840) R, Insc	+	+	+	+	+
36	Asian Palm-Swift, *Cypsiurus balasiensis* (Gray, 1829) R, Insc	+	+	+	+	+
37	Little Swift, *Apus affinis* (Gray, 1830) R, Insc	+	+	+	+	+
38	Wire-tailed Swallow, *Hirundo smithii* (Leach, 1818) R, Insc	+	+	+	+	+
39	Red-rumped Swallow, *Cecropis daurica* (Laxmann, 1769) R, Insc	+	+	–	–	–
40	Dusky Crag Martin, *Ptyonoprogne concolor* (Sykes, 1832) R, Insc	+	+	+	+	+
41	Indian Eagle-Owl, *Bubo bengalensis* (Franklin, 1831) R, Pred	+	+	–	–	–
42	Brown Wood-Owl, *Strix leptogrammica* (Temminck, 1831) R, Pred	+	+	+	–	–
43	Brown Fish-Owl, *Ketupa zeylonensis* (Gmelin, 1788) R, Pred	+	+	+	–	–
44	Barn Owl, *Tyto alba* (Scopoli, 1769) R, Pred	+	+	+	+	+
45	Spotted Owlet, *Athene brama* (Temminck, 1821) R, Pred	+	+	+	+	+
46	Indian Nightjar, *Caprimulgus asiaticus* (Latham, 1790) R, Insc	+	+	+	+	–
47	Laughing Dove, *Streptopelia senegalensis* (Linnaeus, 1766) R, Hrb	+	+	+	+	+
48	Spotted Dove, *Streptopelia chinensis* (Scopoli, 1786) R, Hrb	+	+	+	+	+
49	Eurasian collared-Dove, *Streptopelia decaocto* (Frivaldszky, 1838) R, Hrb	+	+	+	+	+
50	Asian Emerald Dove, *Chalcophaps indica* (Linnaeus, 1758) R, Hrb	+	+	+	–	–
51	Rock Pigeon, *Culumba livia* (Gmelin, 1789) R, Hrb	+	+	+	+	+
52	Pompadour green Pigeon, *Treron pompadora* (Gmelin, 1789) R, Hrb	+	+	–	–	–
53	Yellow-legged Green Pigeon, *Treron phoenicopterus* (Latham, 1790) R, Hrb	+	+	+	–	–
54	Red-wattled Lapwing, *Vanellus indicus* (Boddaert, 1783) R, Pred	+	+	+	+	+
55	Yellow-wattled, Lapwing *Vanellus malabaricus* (Boddaert, 1783) R, Pred	+	+	+	+	+
56	Short-toed Snake-Eagle, *Circaetus gallicus* (Gmelin, 1788) R, Pred	+	+	+	–	–
57	Crested Serpent-Eagle, *Spilornis cheela* (Latham, 1790) R, Pred	+	+	+	+	–
58	Black Eagle, *Ictinaetus malaiensis* (Temminck, 1822) R, Pred	+	+	–	–	–
59	Tawny Eagle, *Aquila rapax* (Temminck, 1828) R, Pred	+	+	+	–	–
60	Bonelli's Eagle, *Aquila fasciata* (Vieillot, 1822) R, Pred	+	+	+	+	+
61	Booted Eagle, *Aquila pennata* (Gmelin, 1788) R, Pred	+	+	–	–	–
62	Osprey, *Pandion haliaetus* (Linnaeus, 1758) R, Pred	–	–	+	–	–
63	Eurasian Sparrowhawk, *Accipiter nisus* (Linnaeus, 1758) R, Pred	+	+	–	–	–
64	Black Kite, *Milvus migrans* (Boddaert, 1783) R, Pred	+	+	+	+	+
65	Common Kestrel, *Falco tinnunculus* (Linnaeus, 1758) R, Pred	+	+	+	+	–
66	Black-winged Kite, *Elanus caeruleus* (Desfontaines, 1789) R, Pred	+	+	+	+	+
67	Brahminy Kite, *Haliastur Indus* (Boddaert, 1783) R, Pred	+	+	+	+	+
68	Shikra, *Accipiter badius* (Gmelin, 1788) R, Pred	+	+	+	+	+
69	Oriental Honey-buzzard, *Pernis ptilorhyncus* (Temminck, 1821) R, Pred	+	+	–	–	–
70	Peregrine Falcon, *Falco peregrines* (Tunstall, 1771) R, Pred	+	–	+	–	–
71	Indian Pitta, *Pitta brachyura* (Linnaeus, 1766) R, Pred	+	–	–	–	–

72	Long-tailed Shrike, *Lanius schach* (Linnaeus, 1758) R, Pred	+	+	+	+	+
73	Bay-backed Shrike, *Lanius vittatus* (Valenciennes, 1826) R, Pred	+	+	–	–	–
74	Black Drongo, *Dicrurus macrocercus* (Vieillot, 1817) R, Omn	+	+	+	+	+
75	Ashy Drongo, *Dicrurus leucophaeus* (Vieillot, 1817) R, Omn	+	+	+	+	+
76	White-bellied Drongo, *Dicrurus caerulescens* (Linnaeus, 1758) R, Omn	+	+	–	–	–
77	House Crow, *Corvus splendens* (Vieillot, 1817) R, Omn	+	+	+	+	+
78	Large-billed Crow, *Corvus macrorhynchos* (Wagler, 1827) R, Omn	+	+	+	+	+
79	Small Minivet, *Pericrocotus cinnamomeus* (Linnaeus, 1766) R, Insc	+	+	+	+	–
80	White-browed, Fantail *Rhipidura aureola* (Lesson, 1831) R, Insc	+	+	+	+	+
81	Eurasian Golden Oriole, *Oriolus oriolus* (Linnaeus, 1758) R, Omn	+	+	–	–	–
82	Black-hooded Oriole, *Oriolus xanthornus* (Linnaeus, 1758) R, Omn	+	–	–	–	–
83	Rufous Treepie, *Dendrocitta vagabunda* (Latham, 1790) R, Omn	–	+	–	–	–
84	Asian Paradise-Flycatcher, *Terpsiphone paradisi* (Linnaeus, 1758) R, Insc	+	+	–	–	–
85	Common Iora, *Aegithina tiphia* (Linnaeus, 1758) R, Insc	+	+	+	+	+
86	Blue-capped Rock-Thrush, *Monticola cinclorhyncha* (Vigors, 1832) R, Omn	+	+	–	–	–
87	Malabar Whistling-Thrush, *Myophonus horsfieldii* (Vigors, 1831) R, Omn	+	+	–	–	–
88	Orange-headed Thrush, *Geokichla citrina* (Latham, 1790) R, Omn	+	+	–	–	–
89	Oriental Magpie-Robin, *Copsychus saularis* (Linnaeus, 1758) R, Insc	+	+	+	+	+
90	Indian Robin, *Saxicoloides fulicata* (Linnaeus, 1766) R, Pred	+	+	+	+	+
91	White-rumped Shama, *Copsychus malabaricus* (Scopoli, 1788) R, Pred	+	+	–	–	–
92	Tickell's Blue Flycatcher, *Cyornis tickelliae* (Blyth, 1843) R, Insc	+	+	+	+	+
93	White-bellied Blue Flycatcher, *Cyornis pallidipes*(Jerdon, 1840) R, Insc	+	+	+	–	–
94	Indian Blackbird, *Turdus simillimus* (Jerdon, 1839) R, Omn	–	+	–	–	–
95	Indian Blue Robin, *Larvivora brunnea* (Hodgson, 1837) R, Insc	+	–	–	–	–
96	Pied Bushchat, *Saxicola caprata* (Linnaeus, 1766) R, Insc	+	+	+	+	+
97	Siberian Stonechat, *Saxicola maurus* (Pallas, 1773) R, Insc	+	+	–	–	–
98	Common Myna, *Acridotheres tristis* (Linnaeus, 1766) R, Omn	+	+	+	+	+
99	Jungle Myna, *Acridotheres fuscus*(Wagler, 1827) R, Omn	+	+	+	+	+
100	Brahminy Starling, *Sturnia pagodarum* (Gmelin, 1789) R, Omn	+	+	+	+	+
101	Cinereous Tit, *Parus cinereus* (Vieillot, 1818) R, Omn	+	+	+	+	+
102	Red-whiskered Bulbul, *Pycnonotus jocosus* (Linnaeus, 1758) R, Omn	+	+	+	+	+
103	Red-vented Bulbul, *Pycnonotus cafer* (Linnaeus, 1766) R, Omn	+	+	+	+	+
104	White-browed Bulbul, *Pycnonotus luteolus* (Lesson, 1841) R, Omn	+	+	–	–	–
105	Ashy Prinia, *Prinia socialis* (Sykes, 1832) R, Insc	+	+	+	+	+
106	Plain Prinia, *Prinia inornata* (Sykes, 1832) R, Omn	+	+	+	+	+
107	Grey-breasted, Prinia *Prinia hodgsonii* (Blyth, 1844) R, Insc	+	+	+	+	+
108	Oriental White-Eye, *Zosterops palpebrosus*(Temminck, 1824) R, Omn	+	+	+	+	+
109	Common Tailorbird, *Orthotomus sutorius* (Pennant, 1769) R, Omn	+	+	+	+	+
110	Large Grey Babbler, *Argya malcolmi* (Sykes, 1832) R, Omn	+	+	+	+	+
111	Jungle Babbler, *Turdoides striata* (Dumont, 1823) R, Omn	+	+	+	–	–
112	Yellow-eyed Babbler, *Chrysomma sinense* (Gmelin, 1789) R, Omn	+	+	+	+	+
113	Indian Scimitar-Babbler, *Pomatorhinus horsfieldii* (Sykes, 1832) R, Omn	+	+	–	–	–
114	Puff -throated Babbler, *Pellorneum ruficeps* (Swainson, 1832) R, Omn	+	+	+	–	–
115	Rufous Babbler, *Turdoides subrufa* (Jerdon, 1839) R, Omn	+	+	–	–	–
116	Malabar Lark, *Galerida malabarica* (Scopoli, 1786) R, Omn	+	+	+	+	+
117	Rufous-tailed Lark, *Ammomanes phoenicura* (Franklin, 1831) R, Omn	+	+	+	+	–
118	Purple Sunbird, *Cinnyris asiaticus* (Latham, 1790) R, Omn	+	+	+	+	+
119	Purple-rumped, Sunbird, *Leptocoma zeylonica* (Linnaeus, 1766) R, Omn	+	+	+	+	+
120	Pale-billed, Flowerpecker, *Dicaeum erythrorhynchos* (Latham, 1790) R, Hrb	+	+	+	+	+
121	Thick-billed, Flowerpecker, *Dicaeum agile* (Tickell, 1833) R, Hrb	+	+	–	–	–
122	Forest Wagtail, *Dendronanthus indicus* (Gmelin, 1789) R, Omn	+	+	+	–	–
123	Paddyfield Pipit, *Anthus rufulus*(Vieillot, 1818) R, Pred	+	+	+	+	+
124	House Sparrow, *Passer domesticus* (Linnaeus, 1758) R, Omn	+	+	+	+	+
125	Baya Weaver, *Ploceus philippinus* (Linnaeus, 1766) R, Omn	+	+	+	+	+

126	Golden-fronted Leafbird, *Chloropsis aurifrons* (Temminck, 1829) R, Omn	+	+	–	–	–
127	Red Avadavat, *Amandava amandava* (Linnaeus, 1758) R, Omn	+	+	+	+	+
128	Scaly-breasted, Munia, *Lonchura punctulata* (Linnaeus, 1758) R, Omn	+	+	+	+	+
129	Tricolored Munia, *Lonchura malacca* (Linnaeus, 1766) R, Hrb	+	+	+	+	+
130	White-rumped Munia, *Lonchura striata* (Linnaeus, 1766) R, Omn	+	+	+	+	+
131	Indian Silverbill, *Lonchura malabarica* (Linnaeus, 1758) R, Omn	+	+	+	+	+

Note: A — Gavase Wetland; B — Dhangarmola Wetland; C — Khanapur Wetland; D — Erandol Wetland, E — Ningudage Wetland; "+" — present; "–" — absent; R — resident; WM — winter migratory; Omn — omnivore, Hrb — herbivore; Pred — predator; Insc — insectivore.

radrius dubois), and Small Pratincole (*Glareola lactea*) were only recorded at Gavase and Dhangarmola wetlands (table 2) and are winter migratory. Feeding guild wise classification of wetland birds is given in the figure 3. Number of predators was highest at each wetland and number of herbivores was least at each wetland. Jaccard's similarity values of wetland and wetland-associated bird species among wetlands are given in table 4. Gavase and Dhangarmola wetlands have the highest similarity of wetland and wetland-associated species.

Discussion

Wetlands provide various ecosystem services, they support unique biodiversity. Wetlands are a productive, biologically diversified, and vulnerable habitat (Gibbs, 1993). Wetlands are one of the world's most endangered environments among diverse habitats (Prasad et al., 2015). Over half of the world's wetlands have been lost due to various human activities over the last century, and the habitat quality of the remaining ones has decreased (Zhijun et al., 2010). Domestic sewage, industrial effluents, solid waste dumping, overexploitation of natural resources, and conversion of wetlands to barren lands are some of the factors contributing to the degradation of wetlands in India. This resulted in a loss of biodiversity and disruption of wetland services (Ramachandra, 2006).

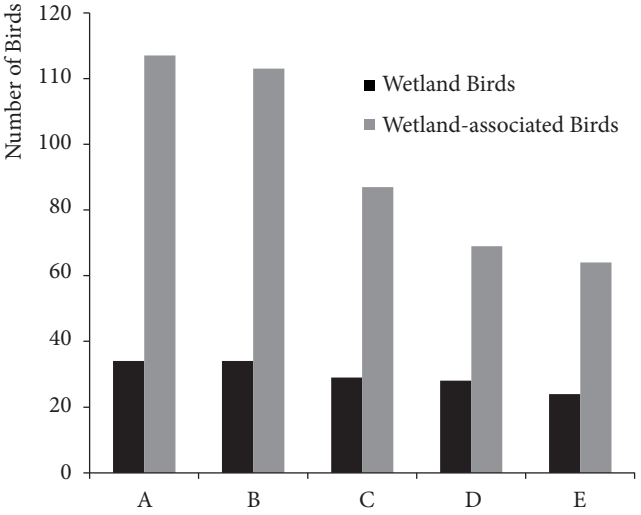

Fig. 2. Total number of wetland and wetland associated birds recorded at five artificial wetlands during 2011–2015: A —Gavase wetland; B — Dhangarmola wetland; C — Khanapur wetland; D — Erandol wetland; E — Ningudage wetland.

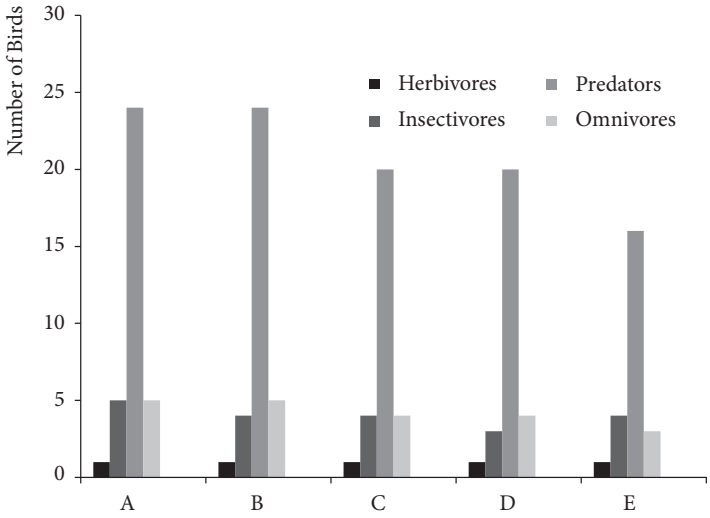

Fig. 3. Classification of wetland birds based on feeding guild recorded at five artificial wetlands during 2011–2015: A — Gavase wetland; B — Dhangarmola wetland; C — Khanapur wetland; D — Erandol wetland; E — Ningudage wetland.

The degradation of natural wetlands has adverse effects on the ecosystem services they provide by affecting sustainability of wetland biodiversity. Natural wetlands have more species and higher abundances, certain artificial wetlands have the potential to support similarly diverse communities (Giosa et al., 2018). It was found that wetlands, which are located in the natural forest, have a higher diversity of wetland birds than wetlands located in habitats like agriculture and human settlement. Wetland biodiversity is affected by land-use attributes around wetlands (Findlay & Bourdages, 2001; Houlahan et al., 2006), and surrounding areas also serve an important supporting function to wetlands (Mitsch & Gosselink, 2000). Forests had a positive influence on mitigating water quality degradation (Sliva & Williams, 2001) and maintaining biodiversity (Houlahan et al., 2006). The occurrence of the high number of birds at Gavase and Dhangarmola wetlands is due to habitat suitability and low human disturbance.

It was observed that the Khanapur wetland, which was in the same hill range as Gavase and Dhangarmola wetlands, located, but observed lower diversity of both wetland birds and wetland-associated birds. The possible reason could be that Khanapur wetland was surrounded by a plantation of exotic plant *Acacia auriculiformes* (Australian Acacia), which might be the reason for the lower richness of wetland and wetland-associated birds. Exotic plants support fewer birds compared to natural vegetation and reduce the overall diversity of birds by affecting natural vegetation (Choudaj & Wankhade, 2021). It was seen that the diversity of both wetland and wetland-associated birds was lower at Ningudage wetland as compared to other wetlands. Ningudage wetland is smaller in size as compared to other wetlands, located adjacent to human settlement; frequent human disturbance might be one of the causes for the overall lower richness of birds. The study found that the richness of predators was highest in each wetland and the richness of herbivores was lowest. The lack of aquatic vegetation in these wetlands is the reason for the lowest richness of herbivorous birds. These wetlands were constructed under the Watershed Development Programme. As natural wetlands under anthropogenic pressure, these wetlands can aid in wetland bird conservation.

Fig. 4. Photographs of some of the wetland birds: a — Ruddy Shelduck *Tadorna ferruginea*; b — Little Ringed Plover *Charadrius dubius*; c — Small Pratincole *Glareola lacteal*; d — Painted Stork *Mycteria leucocephala*; e — Black-headed Ibis *Threskiornis melanocephalus*; f — Asian Openbill *Anastomus oscitans*; g — Eurasian Spoonbill *Platalea leucorodia*; h — Black-winged Stilt *Himantopus himantopus*; i — River Tern *Sterna aurantia.*

In the Indian context, wetlands account for 4.7 % of the total geographic area. India is losing wetlands rampantly due to urbanization, land-use changes and pollution (Bassi et al., 2014) and also, India lacks a proper regulatory framework for the conservation of wetlands. Birds prefer natural wetlands, but when natural wetlands are unavailable or of poor quality, birds prefer artificial wetlands (Ma et al., 2004). From the study, we reaffirm that artificial wetlands appear to play a supporting role; natural wetlands can be supplemented by artificial wetlands.

Conclusions

The avian diversity of artificial wetlands has been studied, noted with different species richness among these wetlands. Wetlands that are proximate to forests hold higher bird diversity than other wetlands. This study describes that exotic plants have a negative impact on wetland and wetland-associated birds. Land use attributes around the wetlands, human interference and anthropogenic pressure affect wetland biodiversity. It can be concluded from the study that artificial wetlands do support wetland birds. Artificial wetlands should be managed scientifically for better conservation of wetland birds.

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