

Assessment of Breeding Status of Birds in Selected Urban Wetlands of Greater Bangalore, Karnataka

Devaraju R., Mahaboob Basha P.

Received 3 August 2021, Accepted 8 October 2021, Published on 12 November 2021

ABSTRACT

The most critical and challenging phase in avian life history is their reproductive phase. A highly vulnerable and stressful period as different stages attained by birds during breeding are exposed to a varying degree of abiotic and biotic stressors prevailing in their habitat. The present study assessed the avifaunal breeding status in selected urban wetlands of Bangalore for three breeding seasons from August 2016 to July 2019. A total of 35-species of birds representing 9-orders and 19-families have been reported to breed in the study areas, among them, 18-species timed their breeding in monsoon (51%), 9-species in winter (26%) and 8-species in summer (23%). Altogether 1316 nests of 28-breeding species representing 8-orders, 17-families were reported. *Passeriformes* (54%) were the dominant nesting species, followed by *Pelicaniformes* (25%) and *Ciconiiformes* (17%) comprising colonial nesting water birds. Breeding birds were aggregated into solitary nesters (57%), colonial nesters (29%) and solitary or colonial nesters (14%) based on their nest habits.

Nesting pattern varied greatly among the breeding species, accordingly, nests were categorized into pendant nest (47%), platform nest (46%), domed-nest (3.3%), oblong purse-shaped nest (1.6%), cup-nest (0.6%), cavity or hole nest (0.4%) and bowl-shaped nest (0.5%). *Acacia* sp. (34%) and *Bambusa* sp. (24%) were among the 32 nesting sites most preferred by nesting bird species. The study finds that the loss or decline in natural nesting sites and nesting materials had led a severe competition among nesting species that drove them to rely upon unnatural nesting sites like electrical poles, towers, holes, or cavities in buildings, bridges and flyovers and an introduction of anthropogenic materials in their nests availed from the municipality waste accumulations around the wetland areas.

Keywords Abiotic stressors, Anthropogenic nesting material, Colonial nesters, Solitary nesters, Unnatural nesting sites.

INTRODUCTION

In recent decades' intense urbanization had changed the facets of urban landscapes and witnessed an increasing tendency in bird species world wide to colonize and adapt to urban environments (Luniak 2004, Wang *et al.* 2009). The ornithological studies concerning the urban environments have received global attention and growing concern worldwide. The synurbanization processes had brought in birds-marked behavioral changes in their feeding and

Devaraju R., Mahaboob Basha P.*
Department of Zoology, Bangalore University, Bangalore, Karnataka 560056, India
Email : pmbashabub@rediffmail.com
*Corresponding author

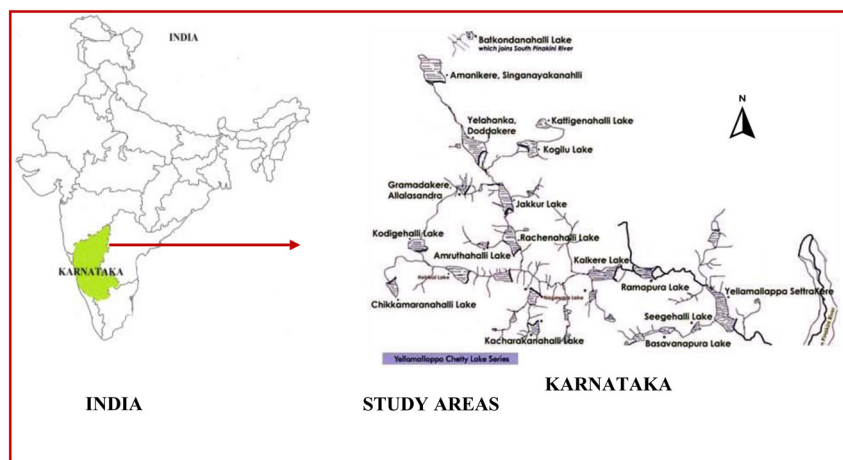


Fig. 1. Map showing geographical location of study areas in Bangalore urban district, Karnataka, India.

nesting pattern ultimately lowering their reproductive fitness (Reynolds *et al.* 2019). Being influenced by extreme urban environments and ecologically trapped (Schlaepfer *et al.* 2002) urban birds were posed to serious challenges (Marzluff 2016, Reynolds *et al.* 2019). Lack of natural nesting environment in their breeding range has a notable effect on the reproductive phenology of urban birds, which mainly manifest through their breeding behaviors, especially in the selection of unnatural nesting sites, and incorporation of anthropogenic nesting materials in their nests (Jagiello *et al.* 2018, Townsend and Barker 2014). This may damage eggs, nestling mortality due to entanglement, injuries and ingestion of debris (Jagiello *et al.* 2018, Townsend and Barker 2014), thereby affecting the overall reproductive success of birds (Hanmer *et al.* 2017). The present study aims to assess the reproductive status of wetland avifauna concerning ornitho-ecological conditions in Bangalore's selected urban wetlands and design appropriate conservation strategies to enhance their reproductive performance.

MATERIALS AND METHODS

Study area

Greater Bangalore is the metropolitan and the capital

city of the Indian state, Karnataka, situated in the heart of south Deccan plateau of Peninsular India to the south-eastern corner of Karnataka state between the latitudes (12°39'–13°13'N) and longitudes (77°22'–77°52'E) with an aerial extent of about 2190 sq km (SAC 2010) at an average elevation of 900 m above mean sea level. Bangalore enjoys a salubrious and equable climate throughout the year (Ramachandra *et al.* 2015). The garden city supports a wide range of avifaunal communities in its green space and dry-deciduous type of vegetation. Four lakes Yale Mallappa Shetty Kere (YMSK 286 ha), Rampura (110 ha), KR Puram (Vengainakere, 40 ha) and Rachenahalli (60 ha) lakes were selected for the present study (Fig. 1).

Methodology

Weekly wise regular field visits were conducted for three breeding seasons from August 2016 to July 2019. Observations on birds' breeding activities were recorded in the early morning (6 : 00–10 : 00 h) and the evening (4 : 00–6 : 00 h), following road transect and point count methods. Some aspects of breeding such as courtship and plumage displays, courtship-feeding, allo-preening, mating and warning calls, territorial defence, collection and carrying of nesting materials, construction of nests, feeding the

Table 1. List of breeding species and their status in the urban wetland habitats of Bangalore, Karnataka, India.

Order/ Common name	Family/ Scientific name	Nest	Eggs	Stage of offspring observed	Reproductive activity observed
Accipitriformes					
1 Greater spotted eagle	Accipitridae <i>Aquila clanga</i>	√	–	–	Nesting, courtship, guarding the nest and feeding the nestlings
2 Black kite	<i>Milvus migrans</i>	√	–	Hatchlings and juvenile	Nesting, courtship, guarding the nest and feeding the nestlings
3 Brahminy kite	<i>Haliastur indus</i>	√	–	–	Nesting and courtship feeding
4 Shikra	<i>Accipiter badius</i>	√	–	Juvenile	Incubation of eggs
Charadriiformes					
5 Bronze-winged jacana	Jacaniidae <i>Metopidius indicus</i>	√	–	Juvenile	–
Ciconiiformes					
6 Black-crowned night-heron	Ardeidae <i>Nycticorax nycticorax</i>	√	–	–	Incubation of eggs
7 Indian pond heron	<i>Ardeola grayii</i>	–	–	–	Breeding plumage display
8 Purple heron	<i>Ardea purpurea</i>	√	–	Juvenile	Feeding the young ones
9 Grey heron	<i>Ardea cinerea</i>	√	–	Juvenile	Collection of nesting material, nesting, incubation and feeding the nestlings
10 Painted storks	Ciconiidae <i>Mycteria leucocephala</i>	√	–	Nestling and Juvenile	Collection of nesting material, nesting, incubation and feeding the nestlings
11 Oriental white ibis	Threskiornithidae <i>Threskiornis melanocephalus</i>	√	–	Nestling and Juvenile	Collection of nesting material, nesting, incubation of eggs
12 Glossy ibis	<i>Plegadis falcinellus</i>	√	–	Juvenile	Collection of nesting material, nesting, incubation of eggs
13 Little egret	<i>Egretta garzetta</i>	–	–	–	Breeding plumage display
14 Cattle egret	<i>Bubulcus ibis</i>	–	–	–	Courtship and breeding plumage display
Cuculiformes					
15 Greater coucal	Cuculidae <i>Centropus sinensis</i>	√	–	–	Incubation of eggs
16 Pied crested cuckoo	<i>Clamator jacobinus</i>	–	–	Juvenile	–
17 Common hawk cuckoo	<i>Hierococcyx varius</i>	√	–	Juvenile	Incubation of eggs
Galliformes					
18 Grey-francolin	Phasianidae <i>Francolinus pondicerianus</i>	–	–	Juvenile	– Feeding the young ones
Gruiformes					
19 White-breasted-waterhen	Rallidae <i>Amaurornis phoenicurus</i>	√	–	–	Feeding the young ones in the feeding ground
20 Common moorhen	<i>Gallinula chloropus</i>	√	–	Juvenile	Feeding the young ones in the feeding ground
21 Purple moorhen	<i>Porphyrio porphyrio</i>	√	–	Juvenile	Feeding the young ones in the feeding ground
Passeriformes					
22 House crow	Corvidae <i>Corvus splendens</i>	√	√	Nestling and Juvenile	Incubation and feeding the nestlings
23 Ashy prinia	Cisticolidae <i>Prinia socialis</i>	√	√	Hatchlings and Nestlings	Nesting, incubation of eggs, feeding the nestlings and removal of faecal sacs
24 White-throated munia	Estrildidae <i>Euodice malabarica</i>	√	–	–	Nest construction

Table 1. Continued.

Order/ Common name	Family/ Scientific name	Nest	Eggs	Stage of offspring observed	Reproductive activity observed
25	Indian magpie robin Muscicapidae <i>Copsychus saularis</i>	–	–	–	Collection of nesting material
26	Purple sunbird Nectariniidae <i>Cinnyris asiaticus</i>	√	√	Hatchlings and Nestlings	Nesting, incubation of eggs, feeding the nestlings and removal of faecal sacs
27	Purple-rumped sunbird <i>Leptocoma zeylonica</i>	√	√	Hatchlings and Nestlings	Nesting, incubation of eggs, feeding the nestlings and removal of faecal sacs
28	Baya weaver Ploceidae <i>Ploceus philippinus</i>	√	–	–	Nest construction
29	Streaked weaver <i>Ploceus manyar</i>	√	–	–	Nest construction
30	Red vented bulbul Pycnonotidae <i>Pycnonotus cafer</i>	√	√	Hatchlings and Nestlings	Incubation and feeding the nestlings
31	Common myna Sturnidae <i>Acridotheres tristis</i>	√	–	Fledgling	Collection of nesting material
32	Spot-billed pelican Pelecaniformes Pelecanidae <i>Pelecanus philippensis</i>	√	–	Juvenile	Courtship, collection of nesting material and incubation of eggs
33	Little cormorant Phalacrocoracidae <i>Phalacrocorax niger</i>	√	–	Juvenile	Nest construction, incubation of eggs and feeding the juveniles
34	Great cormorant <i>Phalacrocorax carbo</i>	√	–	Juvenile	Nest construction, incubation of eggs and feeding the juveniles
35	White-checked barbet Piciformes Megalaimidae <i>Megalaima viridis</i>	√	–	–	Feeding the nestlings

nestlings (Black kites, ashy prinia) and the precocial young birds in the feeding ground (moorhens), incubation of eggs, removal of faecal sacs (as observed in purple rumped sunbird), nest dismantling and shifting of nest contents (as in case of Ashy prinia) including the impact of proximate factors on the reproductive behaviors of birds were documented.

Searching and monitoring of bird nests

A systematic examination of vegetation was carried out in each breeding season for the location of nests. The movements of birds while searching and carrying nesting materials, food for the nestlings, removal of faecal sacs, including their behavioral cues such as contact, mating, warning and aggressive calls around the nesting sites were taken as clues for the exact loca-

tion of their nests. Standard protocols were followed during nest searching and monitoring (Martin *et al.* 2013) and utmost care was taken to ensure the safety of the nest, eggs and hatchlings from observer-induced nest predation and mortality (Martin and Geupel 1993). Photographs of nests, eggs and nestlings were taken with the aid of a digital 16.1 megapixels' camera (Canon Power Shot S×60 HS). Binoculars (Olympus 10×15) we used to locate the nests placed far away from human sight, such as aquatic vegetation and in the nesting colony. Birds with short breeding cycles such as *prinias* and sun birds their breeding activities were monitored daily. Wherever possible deserted and dead nests were utilized for analysis of nesting material composition. Nest site preferences and diversity in nest architectural design, natural and anthropogenic nesting materials used by birds were documented.

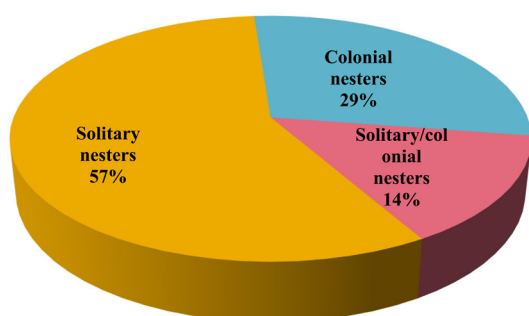


Fig. 2. Percent composition of breeding bird species as per nest habit in the urban wetland habitats of Bangalore, Karnataka, India.

RESULTS AND DISCUSSION

Data on breeding bird species

A total of 35-breeding species of birds representing 9-orders and 19-families have been reported to breed in the study areas. Among them, 16-species (46%) were water-associated and 19-species (54%) were water-dependent (Table 1). Among the 28 nesting species reported 16-species were solitary nesters (57%), 8-species were colonial nesters (29%) and 4-species were solitary or colonial nesters (14%) (Fig. 2). KR Puram lake (19 species) and YMSK lakes (18 species) host a large number of nesting species, followed by Rachenahalli (13-species) and Rampura lakes (10-species). *Passeriformes*, *Pelecaniformes*, *Accipitriformes*, *Gruiformes*, *Cuculiformes* and *Galliformes*, Excepting, *Ciconiiformes*



Fig. 3. Cattle egret in a spectacular and vibrant breeding plumage - Reported from YMSK lake in Bangalore, Karnataka, India.

(Painted storks) and *Piciformes* (Barbets) were the dominant breeding species in YMSK lake. KR Puram lake provides the nesting habitat for colonial nesters of the orders *Ciconiiformes* and *Pelecaniformes* including solitary nesters belonging to the orders *Passeriformes*, *Accipitriformes*, *Gruiformes*, *Cuculiformes*, *Piciformes* except *Galliformes* (Grey francolin). Rampura lake provides suitable nesting habitat for *Accipitriformes*, *Cuculiformes* and *Passeriformes* while *Galliformes*, *Ciconiiformes*, *Piciformes* and *Pelecaniformes* (Cormorants) were not reported. *Ciconiiformes*, *Pelecaniformes* were the dominant colonial nesters while *Gruiformes*, *Passeriformes* and *Accipitriformes* were the solitary nesters in Rachenahallilake and the orders *Galliformes* and *Piciformes* were not reported (Tables 2, 3). Previous studies reported that Indian cities serve as refuges for colonial nesting water birds, offering them suitable microhabitats for feeding, nesting and breeding activities (Urfi 2010) besides reducing their predation pressure during breeding (Roshnath *et al.* 2019). A total of 5-nesting colonies of baya weavers in YMSK and Rampura lakes and 3-nesting colonies of water birds comprising 5-groups of colonial nesters with a total of 10 associating water bird species such as cormorants (little, Indian and great cormorants), herons (black-crowned night-heron, grey and purple herons), ibis (oriental white ibis and glossy ibis), pelicans (spot-billed pelican) and storks (painted storks) in YMSK, KR Puram and Rachenahalli lakes have been reported. Though Rampura lakes provides an excellent feeding and wintering grounds for water birds but their nesting colonies were not reported due to severe anthropogenic activities in the area (Figs. 4-6).

Nest and nest characteristics

The present study documented 1316-nests of 28 nesting species. *Passeriformes* were the most dominant nesting bird species with a totalling of 698-nests followed by *Pelecaniformes* (328), *Ciconiiformes* (225), *Accipitriformes* (38), *Gruiformes* (9) and *Cuculiformes* (6). Birds exhibit an enormous diversity in architectural skill in designing their nests, ranging from the tiny cups of humming birds through the largest nesting colony of sociable weaver *Philetairus socius*; accordingly, nests were categorized into 7

Table 2. List of nesting bird species their nest site preferences and nest characteristics in the urban wetland habitats of Bangalore, Karnataka, India.

Orders /common name	Family Scientific name	Nest habit	Nest type	Nesting site	Nest count
1 Greater spotted eagle	<i>Aquila clanga</i>	Solitary	Platform nest	Tree or electric pole or pylon	4
2 Black kite	<i>Milvus migrans</i>	Solitary	Platform nest	Tree or electric pole or pylon	30
3 Brahminy kite	<i>Haliastur indus</i>	Solitary	Platform nest	Tree or electric pole or pylon	2
4 Shikra	<i>Accipiter badius</i>	Solitary	Platform nest	Tree	2
5 Bronze-winged jacana	<i>Metopidius-indicus</i>	Solitary	Platform nest	Aquatic vegetation	1
6 Black-crowned night-heron	<i>Nycticorax nycticorax</i>	Solitary/colony	Platform nest	Tree	20
7 Purple heron	<i>Ardea purpurea</i>	Solitary/colony	Platform nest	Tree or reeds	6
8 Grey heron	<i>Ardea cinerea</i>	Solitary/colony	Platform nest	Tree or reeds	33
9 Painted storks	<i>Mycteria leucocephala</i>	Colony	Platform nest	Tree	57
10 Oriental white ibis	<i>Threskiornis melanocephalus</i>	Colony	Platform nest	Tree	95
11 Glossy ibis	<i>Plegadis falcinellus</i>	Colony	Platform nest	Tree	14
12 Greater coucal	<i>Centropus sinensis</i>	Solitary	Domed/Globular mass	Tree	6
13 White-breasted waterhen	<i>Amaurornis phenicurus</i>	Solitary	Cup nest	Tree or reeds	2
14 Common moorhen	<i>Gallinula chloropus</i>	Solitary	Bowl shaped	Aquatic vegetation	2
15 Purple moorhen	<i>Porphyrio porphyrio</i>	Solitary	Bowl shaped	Aquatic vegetation	4
16 House crow	<i>Corvus splendens</i>	Solitary	Platform nest	Tree	17
17 Ashy prinia	<i>Prinia socialis</i>	Solitary	Cup/dome/funnel/oblong	Shrub or grass	31
18 White-throated munia	<i>Euodice malabarica</i>	Colony	Domed nest	Tree	34
19 Purple sunbird	<i>Cinnyris asiaticus</i>	Solitary	Pendulous nest	Tree or shrub	1
20 Purple-rumped sunbird	<i>Leptocoma zeylonica</i>	Solitary	Pendulous nest	Tree or shrub	17
21 Baya weaver	<i>Ploceus philippinus</i>	Colony	Pendulous nest	Tree or shrubs	585
22 Streaked weaver	<i>Ploceus manyar</i>	Solitary/colony	Pendulous nest	Tree or reeds	17
23 Red-vented bulbul	<i>Pycnonotus cafer</i>	Solitary	Cup nest	Shrubs	1
24 Common myna	<i>Acridotheres tristis</i>	Solitary	Cavity or hole nest	Cavities in trees or weep holes in flyovers/bridges	5
25 Spot-billed pelican	<i>Pelecanus philippensis</i>	Colony	Platform nest	Tree	23
26 Little cormorant	<i>Phalacrocorax niger</i>	Colony	Platform nest	Tree or electric pole or pylon	48
27 Great cormorant	<i>Phalacrocorax carbo</i>	Colony	Platform nest	Tree or electric pole or pylon	257
28 White-cheeked barbet	<i>Megalaima viridis</i>	Solitary	Cavity or hole nest	Holes or cavities in old trees	1

Table 3. Arya wise representation of nesting bird species in the urban wetland of Bangalore, Karnataka, India

Sl. No.	Common name	Scientific name	Study areas				Total nest count
			Ymsk	KR puram	Ram-pura	Rache-na-halli	
1	Greater spotted eagle	<i>Aquila clanga</i>	3	-	1	-	4
2	Black kite	<i>Milvus migrans</i>	16	3	7	4	30
3	Brahminy kite	<i>Haliastur indus</i>	1	-	-	1	2
4	Shikra	<i>Accipiter badius</i>	-	1	-	1	2
5	Bronze-winged jacana	<i>Metopidius indicus</i>	1	-	-	-	1
6	Black-crowned night-heron	<i>Nycticorax nycti corax</i>	-	17	-	3	20
7	Purple heron	<i>Ardea purpurea</i>	4	2	-	-	6
8	Grey heron	<i>Ardea cinerea</i>	5	23	-	5	33
9	Painted storks	<i>Mycteria leucocephala</i>	-	57	-	-	57
10	Oriental white ibis	<i>Threskiornis melanocephalus</i>	-	95	-	-	95
11	Glossy ibis	<i>Plegadis falcinellus</i>	-	14	-	-	14
12	Greater coucal	<i>Centropus sinensis</i>	3	1	1	1	6
13	White-breasted waterhen	<i>Amaurionis phoenicurus</i>	2	-	-	-	2
14	Common moorhen	<i>Gallinula chloropus</i>	1	-	-	2	3
15	Purple moorhen	<i>Porphyrio porphyrio</i>	-	1	1	2	4
16	House crow	<i>Corvus splendens</i>	6	4	3	4	17
17	Ashy prinia	<i>Prinia socialis</i>	12	4	7	8	31
18	White-throated munia	<i>Euodice malabarica</i>	28	-	6	-	34
19	Purple sunbird	<i>Cinnyris asiaticus</i>	-	1	-	-	1
20	Purple-rumped sunbird	<i>Leptocoma zeylonica</i>	13	-	4	-	17
21	Baya weaver	<i>Ploceus philippinus</i>	544	-	41	-	585
22	Streaked weaver	<i>Ploceus manyar</i>	15	-	2	-	17
23	Red-vented bulbul	<i>Pycnonotus cafer</i>	-	1	-	-	1
24	Common myna	<i>Acridotheres tristis</i>	2	1	-	2	5
25	Spot-billed pelican	<i>Pelecanus philippensis</i>	-	12	-	11	23
26	Little cormorant	<i>Phalacrocorax niger</i>	26	12	-	10	48
27	Great cormorant	<i>Phalacrocorax carbo</i>	222	35	-	-	257
28	White-checked barbet	<i>Megalaima viridis</i>	-	1	-	-	1
			904	285	73	54	1316

types, namely platform nest (609), Pendant nest (620), Domed nest (44), Oblong purse-shaped nest (21), Cup-nest (9), Bowl-shaped nest (7) and Cavity or hole nest (6). Ashy prinia, *Prinia socialis* the most active breeding species among solitary nesters, shown maximum diversity in nesting patterns comprising cup-shaped, funnel-shaped, dome-shaped and oblong purse-shaped nests (Ali 2012) (Table 2).

Season wise nest count analysis reveals that pre-monsoon season appears to be the favoable season for nesting activities and a total of 679-nests (51%) were located followed by monsoon season with 491 nests (37%) and the least in winter season

with 146 nests (12%). The highest nests were counted in May (449) and the least in November (1). The observation confirms with Zacharias and Gaston's (1983) findings on the breeding seasons of birds of Calicut southwest India. The highest nest counts recorded in May and June months coincide with the fresh vegetation and abundance of insects such as caterpillars, swarms of flying ants, acacia ants and termites as promoted by local showers during pre-monsoon rains, which attract large numbers of insectivorous birds while declined nesting activities reported after that from July - November was due to heavy monsoon and post-monsoon rains, uprooted trees, loss of free-floating and submerged vegetation, lack of perching and roosting sites making the

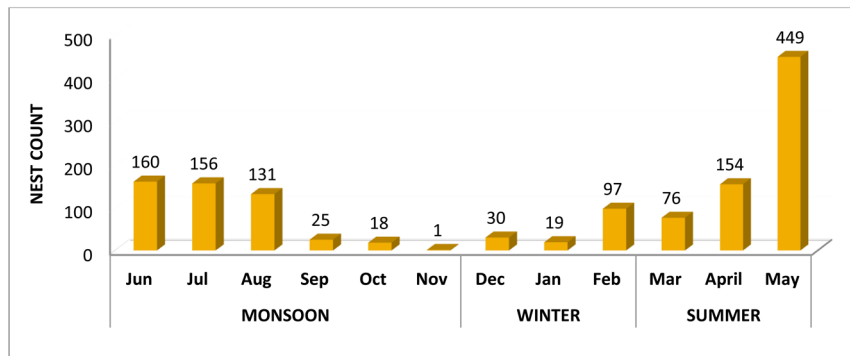


Fig. 4. Seasonal variation in nest count of breeding bird species in the urban wetland habitats of Bangalore, Karnataka, India.

habitat unsuitable for breeding activities (Fig. 4).

CONCLUSION

The findings of the study suggest that urban wetlands through as refuges for solitary and colonial nesters ; however, the behavioral shift in choosing unnatural nesting sites and anthropogenic nesting materials observed were attributed to the impact of intense urbanization. The loss of buffer vegetation, natural agro ecosystems and felling of acacia nesting trees in the immediate catchment areas to widen roads for

agricultural and industrial activities has drastically declined the reproductive performances of birds, especially in YMSK and Rampura lakes. Therefore, there is a need to mitigate on going human bird conflicts by safeguarding their nesting ranges through policy interventions and stringent conservative laws. Planting suitable trees, enhancing vegetation cover in the buffer zone and the catchment areas to provide feeding, nesting and breeding activities. Further setting off the state wetland authority and local expert and monitoring committees, comprising environment a lists, ecologists and education-alists



Fig. 5. Nesting colony of great cormorants in YMSK lake, Bangalore, Karnataka, India.

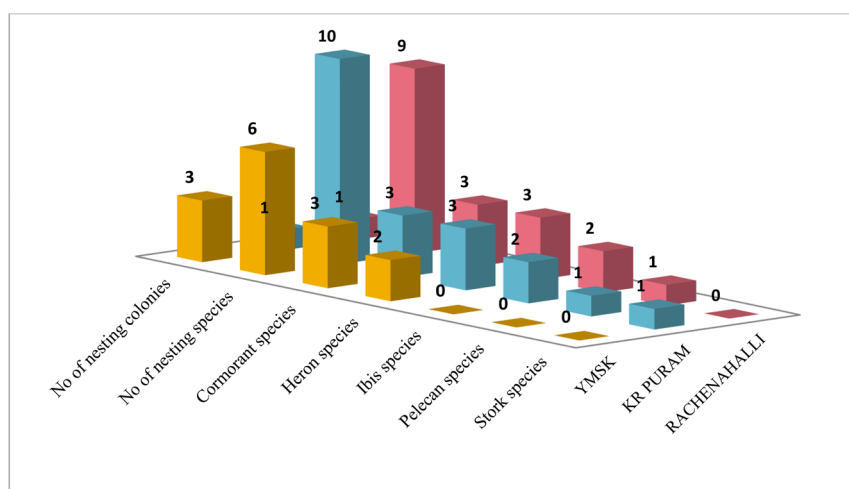


Fig. 6. Composition of nesting colonies of water birds in the urban wetlands of Bangalore, Karnataka, India.

to monitor, suggest and implement conservative measures to protect the urban wetlands from anthropogenic activities. Furthermore, creating awareness among the people about the importance of local water bodies and educating them on the wise use of wetland resources through community participation and effective implementation, monitoring and evaluation of conservative programs from time to time would serve as better conservation strategies to enhance the reproductive performances of wetland birds.

REFERENCES

- Ali AMS, Asokan S, Manikannan R, Radhakrishnan P (2011) Checklist and nesting patterns of avifauna in and around Mayiladuthurai region, Tamil Nadu, India. *J Threatened Taxa* 3 (6) : 1842—1850.
- Ali S (2012) The Book of Indian birds. 13th revised edn. Oxford University Press, New Delhi, pp 326.
- Hanmer HJ, Thomas RL, Beswick GJF, Collins BP, Fellowes MDE (2017) Use of anthropogenic material affects bird nest arthropod community structure: Influence of urbanization and consequences for ectoparasites and fledging success. *J Ornithol* 158 : 1045—1059.
- Jagiello ZA, Dylewski L, Winiarska, D, Zolnierowicz KM, Tobolka M (2018) Factors determining the occurrence of anthropogenic materials in nests of the white stork *Ciconia ciconia*. *Environ Sci Pollut Res* 25 : 14726—14733.
- Jahan I, Begum S, Feeroz MM, Das DK, Datta AK (2018) Nesting pattern of birds in Jahangirnagar University Campus, Bangladesh. *J Threatened Taxa* 10 (5) : 11618—11635.
- Luniak M (2004) Synurbization-adaptation of animal wildlife to urban development. In : Shaw *et al.* (eds). Proc 4th Int Urban Wildlife Sym, pp 50—55.
- Marzluff JM (2016) A decadal review of urban ornithology and a prospectus for the future. *Ibis* 159 : 1—13.
- Martin JM, Bailey R, Phillips T, Cooper C, Dickinson J, Lowe J, Rietsma R, Gifford K, Bonney R (2013) Nest Watch Nest Monitoring Manual. Ithaca, NY : Cornell Lab of Ornithology, pp 1—33.
- Martin TE, Geupel GR (1993) Nest-monitoring plots : Methods for locating nests and monitoring success. *J Field Ornithol* 64 (4) : 507—519.
- National wetland atlas. Karnataka. SAC, ISRO, Ahmedabad, India 2010 : 204.
- Ramachandra TV, Asulabha KS, Sincy V, Bhat Sudarshan, Bharath H Aithal (2015) Wetlands : Treasures of Bangalore ENVIS Technical Report 101, Energy and wetlands, research group, CES, IISc, Bangalore.
- Roshnath R, Athira K, Sinu PA (2019) Does predation pressure drive heronry birds to nest in the urban landscape? *J Asia-Pacific Biodiver* 12 : 311—315.
- Reynolds JS, Ibanez-Alamo JD, Sumasgutner P, Mainwaring MC (2019) Urbanization and nest building in birds: A review of threats and opportunities. *J Ornithol* 1160 : 841—860.
- Schlaepfer M, Runge MC, Sherman PW (2002) Ecological and evolutionary traps. *Trends Ecol Evol* 117 (10) : 474—480.

- Townsend AK, Barker CM (2014) Plastic and the nest entanglement of urban and agricultural crows. *PLOS ONE* 1: e88006.
- Urfi AJ (2010) Using heronry birds to monitor urbanization impacts: A case study of painted stork *Mycteria leucocephala* nesting in the Delhi Zoo, India. *Ambio* 39 (2): 190–193.
- Wang Y, Chen S, Blair RB, Jiang P, Ding P (2009) Nest composition adjustments by Chinese bulbuls *Pycnonotus sinensis* in an urbanized landscape of Hangzhou (E China). *Acta Ornithologica* 44 (2): 185–192.
- Zacharias VJ, Gaston AJ (1983) Breeding seasons of birds at Calicut, southwest India. *The British Ornithologists Union Ibis* 125: 407–412.