

### 3. STATUS AND ABUNDANCE OF WATERBIRDS IN PERIYAR LAKE, KERALA, INDIA<sup>1</sup>

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<sup>1</sup>Accepted February 08, 2022

First published: June 30, 2022 | doi: 10.17087/jbnhs/2022/v119/152350

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The significance of Periyar Lake for resident and migratory waterbirds was assessed through monthly surveys from October 2016 to February 2019. In all, 37 species of waterbirds were recorded. The waterbird population is dominated by the piscivorous guild: Great Cormorant *Phalacrocorax carbo*, Little Cormorant *Microcarbo niger*, White-breasted Kingfisher *Halcyon smyrnensis*, Pied Kingfisher *Ceryle rudis*, Little Egret *Egretta garzetta*, and Brahminy Kite *Haliastur indus*. The lake is an important breeding ground for Great Cormorant and Asian Woollyneck *Ciconia episcopus*, a Near Threatened species. Little Pratincole *Glareola lactea* and Vulnerable River Tern *Sterna aurantia* are seen breeding in the lake in recent years. Common Sandpiper *Actitis hypoleucus*, Green Sandpiper *Tringa ochropus*, and Grey Wagtail *Motacilla cinerea* are regular winter migrants. The winter migrant Osprey *Pandion haliaetus* was recorded even during the non-migratory season. Due to its habitat homogeneity, water depth, lack of satellite wetlands, and discontinuity with other waterbodies, the lake does not support migratory ducks and waders in large numbers, but is an important foraging and breeding ground for some species of resident waterbirds.

**Key words:** Waterbirds, Periyar Lake, Periyar Tiger Reserve, Cormorants, Threats

#### INTRODUCTION

The hilly state of Kerala, lying in the southern part of the Western Ghats, receives bounteous rainfall from the southwest monsoon. Many of its rivers originate in the hills; the west-flowing rivers form a vast wetland complex in the coastal plains, such as Vembanad-Kole, which is a major wetland for waterbirds (Sivaperuman and Jayson 2001). To control floods and provide water for irrigation and domestic use, several dams have been built across these rivers in the hills. These reservoirs and backwaters resulting from the dams serve as habitat for waterbird populations (Sashikumar *et al.* 2011a). One such dam, Mullaperiyar, was built across Periyar river in 1895, primarily to provide water to the adjacent water-starved districts of Tamil Nadu to the east.

The avifauna of Periyar Lake has been documented since the early 1900s (Ali and Whistler 1935–37; Jafer *et al.* 1997; Nair *et al.* 1985; Robertson and Jackson 1992; Santharam 1989; Sashikumar *et al.* 2011b; Srivastava *et al.* 1993; Srivastava *et al.* 1995; Veeramani *et al.* 2005; Vijayan *et al.* 1979). In recent years, birdwatchers visiting Periyar Lake have been uploading their sightings to <[www.ebird.org](http://www.ebird.org)>.

Dr Sálim Ali's pioneering surveys, with camps at Downton Estate and Kumily, covered parts of Periyar Tiger Reserve. The 11-day Kumily camp survey covered the lake and its environs; from Deramalai camp, the survey was conducted over five days. M.C.A. Jackson documented the birdlife in the lake

and its environs from 1935–72. Later, Robertson compiled all the notes of Jackson, added his own observations from 1988–92, and published a comprehensive document (Robertson and Jackson 1992). Although these publications provide insights into the bird diversity of Periyar Lake, information on species abundance is lacking. In this paper, we record the abundance and seasonality of waterbirds (including wetland-associates like Osprey *Pandion haliaetus* and wagtails) occurring in Periyar Lake, and assess the importance of this wetland for resident and wintering birds.

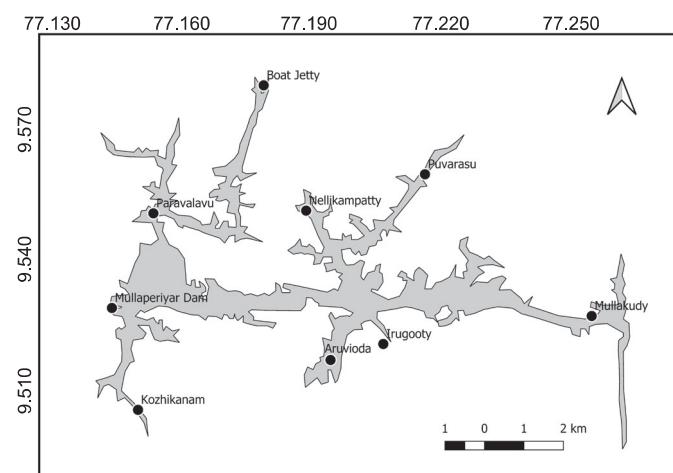


Fig. 1: Extent of Periyar Lake and the areas surveyed for waterbirds

## STUDY AREA

Periyar Lake ( $9^{\circ} 28' N$ ;  $77^{\circ} 10' E$ ) is a large inland freshwater body (area 26 sq. km) formed after the construction of the Mullaperiyar dam in 1895. It is located within the boundaries of Periyar Tiger Reserve (PTR), Kerala (Fig. 1). The lake largely comprises open water (maximum depth 40 m), and is surrounded by forest. Small islands emerge when the water level recedes. The margins of the lake leading up to the forest have grassy meadows and short, steep mud banks. Due to the construction of the dam, a vast portion of the forest was submerged, and snags of dead trees project above the water surface. The lake is a major tourist attraction and boats carrying tourists travel for a distance of 7 km (up to Paravalavu) from the Thekkady Jetty. However, forest department boats travel up to Mullakudy (20 km from the Thekkady Jetty), which is the confluence of Mullayar and Periyar rivers.

## METHODS

The main boating stretch of the lake from the Thekkady Jetty to Mullakudy was surveyed for waterbirds once a month from October 2016 to February 2019. The northern (Nellikampatty and Puvarasu) and southern (Kozhikanam, Aruvioda, and Irugooty) zones of the lake were surveyed alternately along with the main stretch. Each survey covered half the entire expanse of the lake. For instance, in June if the main stretch and northern zone were covered, in July the main stretch and southern zone were covered. In this way, 100% of the lake was covered in the two surveys.

During the surveys, birds seen in the open water, at the margins of the lake, and those in flight over the lake were counted. We assume that we counted the majority of the birds, and those missed would comprise the smaller species foraging along the lake margins (the lake is  $>100$  m wide at places), such as sandpipers and wagtails, and the shy, cryptically coloured, and secretive species such as crakes and the smaller herons.

## RESULTS AND DISCUSSION

In all, 37 species of waterbirds were recorded during the surveys in Periyar Lake (Table 1). Additionally, 30 other species were recorded by us at sites near Periyar Lake, or by other birders in the lake or its vicinity (Table 4). The 37 bird species recorded by us comprise i) Breeding Residents, ii) Non-breeding Residents, iii) Non-resident Breeders, iv) Winter Migrants, and v) Species with Uncertain Status (Table 1).

### Breeding Residents

Thirteen species of birds are breeding residents in Periyar Lake. Evidence of breeding of five species, Great Cormorant *Phalacrocorax carbo*, White-breasted Kingfisher *Halcyon smyrnensis*, Asian Woollyneck *Ciconia episcopus*, Red-wattled Lapwing *Vanellus indicus*, and White-browed Wagtail *Motacilla maderaspatensis* was obtained during our surveys. Four more species, Oriental Darter *Anhinga melanogaster*, Brahminy Kite *Haliastur indus*, Lesser Fish-eagle *Icthyophaga humilis*, and Green-backed Heron *Butorides striata*, were reported to breed by Robertson & Jackson (1992) and Jafer *et al.* (1997). We assume that the remaining four species, Pied Kingfisher *Ceryle rudis*, Common Kingfisher *Alcedo atthis*, Stork-billed Kingfisher *Pelargopsis capensis*, and Brown Fish-owl *Ketupa zeylonensis*, also breed here as there are suitable nesting habitats around the lake.

**Great Cormorant:** is the most prominent breeder in Periyar Lake; it uses emergent snags as nesting sites and as perches when foraging. The species was not reported by Sálim Ali (hereafter SA) in Periyar Lake (Ali and Whistler 1935–37). Robertson and Jackson (1992, hereafter R&J) did not sight the species up to 1972, nor was it encountered by Nair and his team from 1977–82 (Nair *et al.* 1985). Hence, it is possible that the species colonized Periyar Lake only after 1982 (Table 2). R&J reported 10 nests in 1989. Jafer Palot reported 50 nests in the lake (Jafer *et al.* 1997). During our survey we counted 40 nests in 2016–17 and 36 nests in 2018–19; they started nesting in August and it lasted till January. This is contrary to what was reported by Jafer *et al.* (1997), who observed breeding from November till May, and none in the monsoon season.

We regularly counted between 20–40 individuals of Great Cormorant in each survey (Table 3), with a maximum count of 76 birds. The maximum count by Jafer *et al.* (1997) was 196 birds. This may indicate a population decline of the species in the lake. Jafer *et al.* (1997) report that the number of stumps in the lake were decreasing due to decay, and this may be a reason for low counts during our surveys.

**Oriental Darter:** was sighted regularly by R&J, and also reported by SA (Table 2). Nesting was reported by R&J, Nair and Nair (1973) and Jafer *et al.* 1997. We regularly counted up to 10 birds in each survey with a maximum count of 13 birds in April 2018. The species was recorded in breeding plumage during our surveys, but nesting was not recorded. R&J had hypothesized that nesting of this species could be low due to competition from Great Cormorant. Jafer *et al.* (1997) also reported low counts.

WATERBIRDS OF PERIYAR LAKE

**Table 1:** Status, occurrence and abundance of waterbirds in Periyar Lake

S. No.	Species	Status	Frequency of Sighting (%) (n=28 surveys)	Mean no. of birds (with SD and range)
1	Cotton Pygmy-goose <i>Nettapus coromandelianus</i>	Uncertain	3.57	1.00 ±0.18 (0–1)
2	Indian Spot-billed Duck <i>Anas poecilorhyncha</i>	Uncertain	3.57	1.00 ±0.18 (0–1)
3	Little Grebe <i>Tachybaptus ruficollis</i>	Non-breeding Resident	28.57	2.75 ±1.47 (0–5)
4	Painted Stork <i>Mycteria leucocephala</i>	Uncertain	3.57	2.00 ±0.37 (0–1)
5	Asian Openbill <i>Anastomus oscitans</i>	Uncertain	21.43	2.00 ±0.51 (1–2)
6	Black Stork <i>Ciconia nigra</i>	Winter Migrant	7.14	2.00 ±0.37 (0–2)
7	Asian Woollyneck <i>Ciconia episcopus</i>	Breeding Resident	92.86	9.54 ±11.27 (0–48)
8	Green-backed Heron <i>Butorides striata</i>	Breeding Resident	25	1.57 ±0.78 (0–3)
9	Black-crowned Night-heron <i>Nycticorax nycticorax</i>	Uncertain	3.57	1.00 ±0.18 (0–1)
10	Indian Pond-heron <i>Ardeola grayii</i>	Non-breeding Resident	67.86	6.71 ±7.99 (0–23)
11	Grey Heron <i>Ardea cinerea</i>	Non-breeding Resident	78.57	3.23 ±2.20 (0–7)
12	Cattle Egret <i>Bubulcus ibis</i>	Uncertain	21.43	35.17 ±17.11 (0–66)
13	Great White Egret <i>Ardea alba</i>	Non-breeding Resident	53.57	1.18 ±1.63 (0–7)
14	Intermediate Egret <i>Ardea intermedia</i>	Non-breeding Resident	50.00	1.46 ±2.56 (0–11)
15	Little Egret <i>Egretta garzetta</i>	Non-breeding Resident	53.57	9.82 ±17.52 (0–76)
16	Western Reef-egret <i>Egretta gularis</i>	Winter Migrant	14.29	1.00 ±0.35 (0–1)
17	Oriental Darter <i>Anhinga melanogaster</i>	Breeding Resident	96.43	5.93 ±3.98 (0–13)
18	Little Cormorant <i>Microcarbo niger</i>	Non-Breeding Resident	96.43	88.67 ±94.05 (0–350)
19	Indian Cormorant <i>Phalacrocorax fuscicollis</i>	Non-Breeding Resident	21.43	4.33 ±2.22 (0–8)
20	Great Cormorant <i>Phalacrocorax carbo</i>	Breeding Resident	100	35.89 ±18.39 (9–76)
21	Osprey <i>Pandion haliaetus</i>	Winter Migrant	64.29	1.14 ±1.14 (0–4)
22	Brahminy Kite <i>Haliastur indus</i>	Breeding Resident	82.14	2.48 ±1.45 (0–5)
23	Lesser Fish-eagle <i>Icthyophaga humilis</i>	Breeding Resident	21.43	1.00 ±0.41 (0–1)
24	Red-wattled Lapwing <i>Vanellus indicus</i>	Breeding Resident	85.71	5.13 ±4.09 (0–13)

**Table 1:** Status, occurrence and abundance of waterbirds in Periyar Lake (*contd*)

S. No.	Species	Status	Frequency of Sighting (%) (n=28 surveys)	Mean no. of birds (with SD and range)
25	Common Sandpiper <i>Actitis hypoleucus</i>	Winter Migrant	32.14	0.61 ±0.99 (0–3)
26	Green Sandpiper <i>Tringa ochropus</i>	Winter Migrant	7.14	1.00 ±0.26 (0–1)
27	Little Pratincole <i>Glareola lactea</i>	Non-resident Breeder	3.57	8 ±1.51 (0–8)
28	River Tern <i>Sterna aurantia</i>	Non-resident Breeder	35.71	2.45 ±2.56 (0–12)
29	Whiskered Tern# <i>Chlidonias hybrida</i>	Winter Migrant	3.57	1.00 ±0.26 (0–1)
30	Brown Fish-owl <i>Ketupa zeylonensis</i>	Breeding Resident	17.86	1.40 ±0.58 (0–2)
31	Stork-billed Kingfisher <i>Pelargopsis capensis</i>	Breeding Resident	21.43	1.00 ±0.44 (0–1)
32	White-breasted Kingfisher <i>Halcyon smyrnensis</i>	Breeding Resident	100	13 ±6 (3–33)
33	Common Kingfisher <i>Alcedo atthis</i>	Breeding Resident	32.14	1.00 ±0.47 (0–1)
34	Pied Kingfisher <i>Ceryle rudis</i>	Breeding Resident	96.43	3.63 ±2.18 (0–9)
35	Western Yellow Wagtail <i>Motacilla flava</i>	Winter Migrant	17.86	2.20 ±1.06 (0–4)
36	Grey Wagtail <i>Motacilla cinerea</i>	Winter Migrant	28.57	0.61 ±1.31 (0–6)
37	White-browed Wagtail <i>Motacilla maderaspatensis</i>	Breeding Resident	89.29	5.36 ±2.97 (0–13)

**Note:**

# Identification not absolutely certain

Bird names follow HBW and BirdLife International *digital checklist* of the Birds of the World. Version 6.**Status***Breeding Resident:* Movement is mainly within the lake and its environs, and there is record of breeding or a high probability that it breeds in the lake*Non-breeding Resident:* Common in the lake, but absent during a particular season/months, especially during its breeding season. The lake serves as its regular feeding ground, but it breeds elsewhere (as in egrets and herons).*Winter Migrant:* Long-distance migrant from temperate and arctic regions.*Non-resident Breeder:* Uses the lake for breeding, but is not a resident in the area.*Uncertain Status:* Very rare visitor to the lake, recorded only on few occasions.

**White-breasted Kingfisher:** is another common breeding resident in Periyar Lake. It is usually seen perched on emergent snags or on tree branches along the lake margin. We regularly counted between 10–20 birds during the surveys. The species was reported by both SA and R&J. It breeds in the mud banks along the margins of the lake in February and March.

**Pied Kingfisher:** was not reported by SA. According to R&J, the population had steadily increased since the 1950s. We regularly counted between 1–5 birds.

**Common and Stork-billed Kingfisher:** are also residents but the sighting frequency was low due to the small size of the former (making detection difficult) and preference for forested streams (rather than open water) in the latter.

**Other common breeders:** Asian Woollyneck *Ciconia episcopus*, Brahminy Kite *Haliastur indus*, Red-wattled Lapwing *Vanellus indicus*, and White-browed Wagtail *Motacilla maderaspatensis* are the other common breeders in Periyar Lake. The Asian Woollyneck which is listed as Near Threatened by IUCN (2021) had a high sighting frequency

**Table 2:** Trends in some avian species of Periyar Lake

Species	Sálim Ali	Robertson and Jackson	Present Survey
Little Cormorant	Not Recorded	Occasional visitor. Present in small numbers	Regular visitor. Huge flocks of >300 birds
Great Cormorant	Not Recorded	Not recorded by Jackson. Seen after 1982	Flourishing breeding population.
Indian Cormorant	Not Recorded	Not Recorded	A few birds sighted occasionally
Oriental Darter	Recorded	A few individuals. Nesting	Common. Nesting not recorded
Pied Kingfisher	Not Recorded	Regularly seen in the lake	Common
Asian Woollyneck	Not Recorded	First recorded in 1961. Nesting	Common. Nesting
Red-wattled Lapwing	Not Recorded	Recorded rarely	Common. Nesting
River Tern	Not Recorded	Not Recorded	Nesting

(93%), with a maximum count of 48 birds in February 2017. High counts were observed during the dry months, most likely as a result of influx of population from adjacent areas. Three nests were recorded in September, October, and November, respectively. This species was first seen by R&J in 1961 with two nests in Thekkady Jetty and Manakavala.

White-browed Wagtail and Red-wattled Lapwing were sighted regularly in small numbers. SA did not record the latter. R&J recorded both the species, but sighted the latter only rarely. However, R&J mentioned that Red-wattled Lapwing numbers had increased since the early 1980s and that they were nesting in the area. During our study, the Red-wattled was sighted regularly (sighting frequency 87%) and was also recorded in a small check dam in the vast open grasslands of Uppupara at a height of 1,200 m. Four chicks were recorded in April 2018 during our survey. Nesting of White-browed Wagtail was recorded on emergent islands from February to May, 2019.

Among the raptors, the Brahminy Kite was commonly seen. R&J report sporadic nesting between January and March, while Srivastava *et al.* (1995) reported nesting in the PTR area. Though we could not locate nests, we recorded juveniles from April till July. Lesser Fish-eagle *Icthyophaga humilis* was sighted only occasionally, due to its preference for perching on tree branches over quiet waters along the lake's branches rather than in the main stretch. However, there seems to be confusion regarding the identity of the species as SA, R&J, and subsequent workers report Grey-headed Fish-eagle *Icthyophaga ichthyaetus*, not *humilis*. Bird surveys conducted recently with the help of professional birdwatchers have recorded only the Lesser Fish-eagle (David *et al.* 2017; Sreekumar *et al.* 2018). Sightings of Lesser Fish-eagle, Brown Fish-owl and Green-backed Heron *Butorides striata* were few.

#### Non-breeding Residents

The major non-breeding residents in the lake are the Little Cormorant *Microcarbo niger*, egrets and herons. Little

Cormorant was reported occasionally in the lake in small numbers (R&J). Nowadays, large flocks of up to 350 birds can be seen foraging in the lake waters and they are no longer "occasional visitors". Egrets and herons are present in high numbers during the dry season, but are absent or found in small numbers during the southwest monsoon. Their disappearance, or occurrence in only small numbers in the lake, coincides with their breeding season, since the species' breeding range extends over several sites in Kerala, Kumarakom being the closest (<100 km as the crow flies) and in the adjacent plains of Tamil Nadu.

Little Egret *Egretta garzetta* is relatively more abundant than the Intermediate Egret *Ardea intermedia* and Great White Egret *A. alba*. Among the herons, sightings of Grey Heron *A. cinerea* were more frequent than Indian Pond-heron *Ardeola grayii*, but this could be because the latter is a small, drab species and is more likely to be missed. A similar trend was reported by R&J. SA only reported the occurrence of the Indian Pond-heron.

**Table 3:** Frequency of occurrence of common species under various abundance classes

Species	0–5	6–10	11–20	21–50	51–100	>100
Great Cormorant	0	1	5	16	6	0
Little Cormorant	2	2	3	6	7	8
Oriental Darter	13	12	3	0	0	0
White-breasted Kingfisher	4	5	18	1	0	0
Pied Kingfisher	23	5	0	0	0	0
Brahminy Kite	28	0	0	0	0	0
Asian Woollyneck	19	1	4	4	0	0
Red-wattled Lapwing	20	4	4	0	0	0
White-browed Wagtail	18	9	1	0	0	0

## WATERBIRDS OF PERIYAR LAKE

**Table 4:** Species recorded in habitats near Periyar Lake by present authors, and by others in the lake and its vicinity

S. No.	Species	Robertson & Jackson Records	Present Author Records	Other Workers
1	Bar-headed Goose <i>Anser indicus</i>	Not Recorded	Not Recorded	Flock of 10 birds recorded by Ajithkumar, Manoj, and Anzal of Travancore Natural History Society in November 2016
2	Garganey <i>Spatula querquedula</i>	Very rarely seen in the lake	Not Recorded	Reported by Srivastava <i>et al.</i> (1993) and Jafer <i>et al.</i> (1997)
3	Common Teal <i>Anas crecca</i>	Not Recorded	Not Recorded	Recorded by tribal guides as reported in Veeramani <i>et al.</i> (2005)
4	Lesser Whistling-duck <i>Dendrocygna javanica</i>	Not Recorded	Not Recorded	Reported by Srivastava <i>et al.</i> (1993)
5	Lesser Adjutant <i>Leptoptilos javanicus</i>	Not Recorded	Not Recorded	Photograph taken in Jan. 2015 provided by Thadi Kannan, a forest watcher to the first author of this article.
6	Black-headed Ibis <i>Threskiornis melanocephalus</i>	Not Recorded	First author recorded a pair in March–April 2017	Recorded by tribal guides, as reported in Veeramani <i>et al.</i> (2005)
7	Yellow Bittern <i>Ixobrychus sinensis</i>	Not Recorded	Not Recorded	Recorded by Lalitha Vijayan (in R&J)
8	Cinnamon bittern <i>Ixobrychus cinnamomeus</i>	Recorded between October and mid May	Recorded by third author in January 2017	Reported by Srivastava <i>et al.</i> (1993)
9	Black Bittern <i>Ixobrychus flavicollis</i>	Observed occasionally along forested streams, January–May	Not Recorded	Reported by Srivastava <i>et al.</i> (1993) and Jafer <i>et al.</i> (1997)
10	Malay Night-heron <i>Gorsachius melanolophus</i>	Recorded by Robertson in November in Thekkady; by Jackson in Peermade	Not Recorded	Recorded during bird surveys in March 2017 and May 2018. Reported by Srivastava <i>et al.</i> (1993)
11	Purple Heron <i>Ardea purpurea</i>	Not Recorded	Recorded by first author in marsh behind Kumily town, November 2016, July 2017, November 2017. Also reported in Veeramani <i>et al.</i> (2005)	Recorded in wetland near checkpost, July 15, 2002, as reported in Veeramani <i>et al.</i> (2005)
12	Spot-billed Pelican <i>Pelecanus philippensis</i>	Not Recorded	Not Recorded	Recorded by Elias in January 2000, as reported in Veeramani <i>et al.</i> (2005)
13	White-bellied Sea-eagle <i>Haliaeetus leucogaster</i>	Sighted by Robertson in Thekkady, February 1991.	Not Recorded	Recorded by Karoor and Lalitha Vijayan (R&J). Reported by Srivastava <i>et al.</i> (1993, 1995)
14	White-tailed Sea-eagle <i>Haliaeetus albicilla</i>	Not Recorded	Not Recorded	Reported by Srivastava <i>et al.</i> (1993, 1995)
15	Slaty-legged Crake <i>Rallina eurizonoides</i>	Present throughout the year	Not Recorded	Recorded during bird surveys in March 2017 and May 2018
16	Ruddy-breasted Crake <i>Zapornia fusca</i>	Occasional resident, as reported by Jackson. Recorded by Robertson in Thekkady, January 1992	Not Recorded	Reported by Srivastava <i>et al.</i> (1993)
17	White-breasted Waterhen <i>Amaurornis phoenicurus</i>	Fringes of Kumily	Regularly seen by first author along canal supplying water to Tamil Nadu	Recorded during bird survey's in March 2017 and May 2018. Reported by Srivastava <i>et al.</i> (1993)

**Table 4:** Species recorded in habitats near Periyar Lake by present authors, and by others in the lake and its vicinity (*contd*)

S. No.	Species	Robertson & Jackson Records	Present Author Records	Other Workers
18	Watercock <i>Gallicrex cinerea</i>	Recorded by Jackson in Kumily in December 1953	Not Recorded	Not Recorded
19	Purple Swamphen <i>Porphyrio porphyrio</i>	Not Recorded	Not Recorded	Recorded in wetland near checkpost on July 15, 2002 as reported in Veeramani <i>et al.</i> (2005)
20	Common Moorhen <i>Gallinula chloropus</i>	Not Recorded	Not Recorded	Recorded by tribal guides, as reported in Veeramani <i>et al.</i> (2005)
21	Pheasant-tailed Jacana <i>Hydrophasianus chirurgus</i>	Not Recorded	Not Recorded	Recorded in wetland near checkpost on July 15, 2002 as reported in Veeramani <i>et al.</i> (2005)
22	Common Coot <i>Fulica atra</i>	Not Recorded	Recorded by first author in August 2016 and July 2019	Not Recorded
23	Little Ringed Plover <i>Charadrius dubius</i>	Recorded by Jackson in April	Not Recorded	Reported by Srivastava <i>et al.</i> (1993) and Jafer <i>et al.</i> (1997)
24	Greater Painted-snipe <i>Rostratula benghalensis</i>	Not Recorded	Recorded by first author in April 2019 near canal supplying water to Tamil Nadu	Reported by Srivastava <i>et al.</i> (1993)
25	Snipe spp	Specimens of Pintail Snipe <i>Gallinago</i> <i>stenura</i> and Jack Snipe <i>Lymnocryptes minimus</i> were acquired from Kumily. Snipes generally occur from September to April	Unidentified snipe species recorded by first author	Common Snipe <i>Gallinago gallinago</i> reported by Srivastava <i>et al.</i> (1993)
26	Common Greenshank <i>Tringa nebularia</i>	Not Recorded	Not Recorded	Reported by Veeramani <i>et al.</i> (2005)
27	Wood Sandpiper <i>Tringa glareola</i>	Recorded in paddyfields near Kumily	Recorded by first author in March 2019, near canal supplying water to Tamil Nadu	Reported by Srivastava <i>et al.</i> (1993). Recorded during bird survey in May 2018
28	Black-winged Stilt <i>Himantopus himantopus</i>	Not Recorded	Not Recorded	Recorded during bird survey in May 2018
29	Black-capped Kingfisher <i>Halcyon pileata</i>	Not Recorded	Not Recorded	Reported by Srivastava <i>et al.</i> (1993)
30	Common Tern <i>Sterna hirundo</i>	Not Recorded	Not Recorded	Reported by Jafer <i>et al.</i> (1997)

**Note:** The bird survey in 2017 was jointly conducted by Periyar Tiger Conservation Foundation and Travancore Natural History Society (David *et al.* 2017). The bird survey in May 2018 was jointly conducted by Periyar Tiger Conservation Foundation and Kerala Agricultural University (Sreekumar *et al.* 2018)

Indian Cormorant *Phalacrocorax fuscicollis* was reported from Periyar Lake by R&J and SA. Jafer *et al.* (1997) recorded it sporadically. The 2009 survey did not record the species (Sashikumar *et al.* 2011b). It was first seen by us in June 2018, when some individuals were in breeding plumage.

#### Non-resident Breeders

Two species of waterbirds which are not resident in Periyar Lake were recorded breeding on emergent islands:

River Tern *Sterna aurantia* and Little Pratincole *Glareola lactea*. River Tern was first reported in the lake in 1987 (Shantaram 1989). Since then it has been a regular visitor to the lake, usually recorded from November till May, but breeding was not reported, till eggs were seen in April 2019 and subsequently chicks and juveniles in May (David *et al.* 2020). Little Pratincole was spotted for the first time in the lake in May 2017 (Sreekumar *et al.* 2018), and thereafter in large numbers (up to 30 birds) from February to May 2019 during our survey. Eggs and chicks were recorded in April

and May 2019. Both River Tern and Little Pratincole are known to breed at several sites in Kerala (Sashikumar *et al.* 2011a).

### **Winter Migrants**

Eight species of winter migrants were recorded during the survey. The Osprey *Pandion haliaetus* was the most frequently sighted (frequency of sighting 64%), and was recorded even during the non-breeding season. Similar observations were reported by Srivastava *et al.* (1995). Common Sandpiper *Actitis hypoleucus* and Grey Wagtail *Motacilla cinerea* were also frequently sighted around the lake. They were also seen in suitable habitats close to the lake, especially the canal and the wet grassy meadows bordering it. Both the species were sighted from September till April. Similar observations were reported by R&J. Black Stork *Ciconia nigra* was sighted only once during our survey and also by R&J (in February 1987). Other winter migrants recorded by us were Green Sandpiper *Tringa ochropus*, Western Yellow Wagtail *Motacilla flava*, Western Reef-egret *Egretta gularis*, and an unconfirmed sighting of Whiskered Tern *Chlidonias hybrida*.

### **Uncertain Status**

The status of six species of waterbirds may be considered as uncertain as they were recorded only a few times. Asian Openbill *Anastomus oscitans* was mainly sighted during the initial months of the survey from November 2016–February 2017. Subsequently, it was recorded only twice. A similar trend was observed in Cattle Egret *Bubulcus ibis*. Black-crowned Night-heron *Nycticorax nycticorax* and Painted Stork *Mycteria leucocephala* were recorded only once during the survey, in December 2016 and August 2017 respectively. A single Indian Spot-billed Duck *Anas poecilorhyncha* was recorded in November 2016, and one Cotton Pygmy-goose *Nettapus coramandelianus* in December 2016.

### **Probable Disturbances/Threats**

The protected area status of Periyar Lake ensures that waterbirds are not threatened by poaching, but the plying of tourist boats is an issue. Tourist boats regularly travel up to Paravalavu, and PWD boats up to Mullaperiyar Dam. Forest department boats travel up to Thanikudy Machan. However, despite the regular movement of boats, various waterbirds seem undisturbed and continue foraging. Oil spill from poorly maintained boats is an issue. In one instance, we noticed an oil slick on the water surface in a small portion of the lake.

A possible threat to waterbirds in the lake are fishing nets left unattended in the waters during the day (against the

guidelines), and at sites where the fishermen rest at night. Two instances of death of waterbirds by entanglement in the nets were recorded during our survey. Fishermen should be restricted from using the islands from February to May, when ground-nesting birds are breeding. Presently, it is unclear whether competition with fishermen for fish resources is affecting the resident species, especially Great Cormorant.

### **CONCLUSION**

The aquatic bird assemblage in Periyar Lake is dominated by the piscivorous guild (cormorants, kingfishers, egrets, storks and herons). Other piscivorous birds that are common in the lake are Brahminy Kite, Osprey, and Brown Fish-owl, these occurring in much smaller numbers. Most of the species seem to have been present earlier in the area, and have significantly increased in numbers after the reservoir was formed. The formation of the reservoir, the protected area status, and low disturbance (except for boats and some fishing activity) may have favoured the establishment of these species. When the dam was constructed, the water level was initially high, but with the increase in drawing of water by Tamil Nadu, it is reduced, resulting in favourable habitats for nesters (kingfishers, River Tern, Small Pratincole) and shallow water feeders (egrets and herons).

However, due to its homogenously open deep water lacking aquatic vegetation, the lake is not a preferred habitat for waders and ducks, which are usually found in high numbers in the irrigation tanks of Tamil Nadu and in wetlands along the coastal plains of Kerala (Abhisheka *et al.* 2013; Sivaperuman and Jayson 2000). Also, there are no wetlands nearby that support high waterbird populations, which could spill over into the lake. Hence, the lake does not support large waterbird congregations.

### **ACKNOWLEDGEMENTS**

We are extremely thankful to the staff of Periyar Tiger Reserve, who accompanied the team during the survey. Special thanks to Manivel Pandian, Kuttan, and Ponnappan of Tiger Cell and to the boat drivers. We are indebted to the Range Forest Officers Mr Anuraj and Mr Jogie John who gave us permission to use the forest department boats for the survey. Dr P.S. Easa provided very useful comments on the first draft that greatly enhanced the quality of the manuscript. We are also thankful to C. Sashikumar and Praveen Jeyadevan for providing us with useful references. And lastly, sincere thanks to all the staff of Periyar Tiger Conservation Foundation.

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## Recommended Citation

David, J.P., C. Sivakumar & Ranjit Manakadan (2022): Status and abundance of waterbirds in Periyar Lake, Kerala, India. *J. Bombay Nat. Hist. Soc.* 119(2): 125–133. doi: 10.17087/jbnhs/2022/v119/152350

