



Original Research

Waterbirds of Atrangarai Estuary, Southeastern India: A First Baseline Assessment with Emphasis on Breeding Waterbirds at a Traditional Fishing Center

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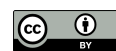
central Asian flyway
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Abstract

Estuarine ecosystems provide important feeding, roosting and breeding habitats for waterbirds, yet many smaller coastal wetlands remain poorly documented. Atrangarai Estuary, a traditional fishing center on the southeastern coast of India, has received no systematic ornithological attention. We conducted monthly surveys (August 2025 to July 2026) to document the composition, richness, abundance and breeding activity of waterbirds. A total of 40 waterbird species were recorded, comprising 20 shorebirds, 12 gulls and terns and 8 large waders and others. Total annual waterbird abundance was 9291, with gulls & terns being the highest ($n = 5029$), followed by shorebirds ($n = 3738$). Monthly analysis showed peak total abundance ($n = 2650$) in February and January 2026 ($n = 2179$). Waterbird richness reached a maximum of 22 species in January and April 2026. Lesser Crested Tern, Greater Crested Tern, Tibetan Sand Plover, and Greater Sand Plover were the most abundant species. Breeding was documented for Little Tern, with 26 nests recorded in June 2026 and a further six nests in July. In addition, Great Stone-curlew juveniles and Hanuman Plover chicks were observed, providing strong evidence of local breeding. These observations demonstrate that Atrangarai is not only used as a seasonal foraging habitat but also as a breeding site for coastal waterbirds. Waterbird habitat, especially the nesting area, spatially overlaps with regular human use, with disturbances from stray dogs. The findings provide the first baseline assessment of the waterbird assemblage of Atrangarai and highlight the ecological significance of estuarine habitats within traditional fishing landscapes.

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Statement of Sustainability: This study provides baseline assessment of waterbirds for the sustainable management of Atrangarai Estuary, an under-documented coastal wetland, supporting diverse migratory and resident waterbirds and local fishing activities, contributing to the UN Sustainable Development Goals (SDG) like Sustainable Cities and Communities, Life Below Water and Life on Land. The documentation of foraging, roosting and breeding habitats highlights the need to conserve intertidal mudflat habitats and vegetation while minimizing disturbance at nesting sites. Regular waterbird monitoring, protection of breeding areas, and community-based management can support both biodiversity conservation and the long-term sustainability of this valuable coastal wetland in Central Asian Flyway

1. Introduction

Waterbirds, important components of coastal wetland ecosystems, occupy habitats like estuaries, mudflats, lagoons, beaches, salt-marshes and shallow coastal waters (Amano et al., 2018, Celik, 2026), providing feeding opportunities, refuge for resident species and support seasonal movements of migratory waterbirds (Dias et al., 2017). Estuaries are dynamic, highly productive ecosystems characterized by tidal exchange, fluctuating salinity and sediment deposition (Kennish et al., 2023), supporting diverse flora and fauna including benthic organisms, fishes, phytoplankton and reptiles (Partha et al., 2024) and diverse waterbird communities as

well (Elphick et al., 2023). Seasonal changes in waterbird abundance and composition in wetlands can therefore reflect variations in food availability, hydrology and habitat conditions (Bipitha et al., 2026).

The southeastern coast of India contains numerous estuaries, lagoons, salt pans, mudflats and fishing-associated wetlands that support diverse coastal birds (Kasambe, 2012; Byju et al., 2026). However, many smaller estuarine systems remain poorly studied compared to well-known bird sanctuaries and major wetlands. Embedded within traditional fishing landscapes where human livelihoods and wildlife use occur simultaneously (Birdlife International, 2026), these sites can retain ecological importance despite the absence of formal conservation recognition, making baseline biodiversity documentation particularly important.

Atrangarai Estuary, a lesser-known estuary in Ramanathapuram district on the southeast coast of Tamil Nadu, and comprises a seasonally open estuarine channel with associated intertidal mudflats, sandbars and sandy coastal habitats (Rao et al., 1987). Few ecological studies have examined oyster distribution (Rao et al., 1983, 1987), and fish diversity (Mogalekar et al., 2017) in the estuary. However, its waterbird assemblage has not been systematically documented, particularly its use as a breeding habitat. Here, we provide the first baseline assessment of waterbirds at Atrangarai, aiming to (1) document composition, richness and abundance of the waterbird assemblage; and (2) document breeding activity of waterbirds and emphasize the significance of Atrangarai as a breeding habitat within a traditional fishing landscape.

2. Methods

2.1. Study Area

Atrangarai Estuary ($9^{\circ}20'47.28''$ N, $78^{\circ}59'44.94''$ E) is where the Vaigai River joins the Palk Bay, covering approximately 24 Ha area (Figure 1). The estuary has sandy shores and mudflats with *Neltuma juliflora* bordering the shores. The first layer of *N. juliflora* was removed during our study period as per the Madras high court order to remove this invasive plant throughout Tamil Nadu (Kumar and Chakravarthy, 2026). The estuarine landscape is used by local fisher communities, with daily access to the intertidal and sandy areas overlapping spatially with waterbird habitat. Fishermen use mechanized small wooden boats and traditional cast netting and gill netting methods.

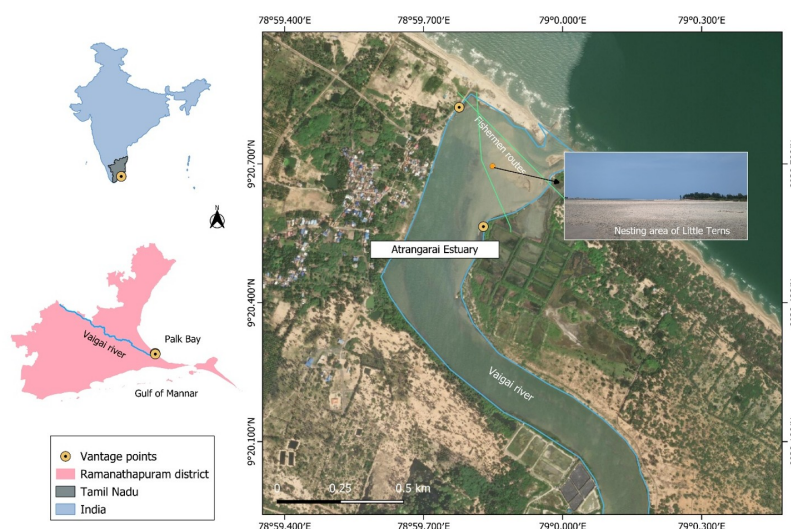


Figure 1. Map of Atrangarai Estuary with vantage points and the nesting area of Little Terns.

2.2. Data Collection and Compilation

The bird survey was carried out from August 2025 to July 2026 with three observers. Monthly field visits were carried out from 07.00–12.00 hours through direct visual count (Howes and Bakewell, 1989; Bibby et al., 2000). Birds were counted from two fixed vantage points based on the visibility of the waterbird congregation area. To minimise double-counting, bird movement, flock direction, and the timing of flights between points were carefully monitored. Any bird coming from behind the enumerator was not counted. Observations were made through a Nikon binocular (10×42) and Vanguard spotting scope (14×70), and photographs were taken using a Nikon P950. Species were identified with our field experience and the standard field guide (Grimmett et al., 2011).



The waterbird assemblage was classified into three major guilds: Shorebirds, Others, and Gulls and Terns. Others include large wading species (e.g., egrets, herons, and other species such as cormorants). For full details of the species included in each guild, see Table 1. The migratory status of each waterbird species was classified based on duration of occurrence or breeding as resident breeding (R/B), resident non-breeding (R/NB) or winter visitor (WV) (Grimmett et al., 2016; Byju et al., 2023a, 2025). Global Conservation status was evaluated based on the IUCN RedList (2026), as Least Concern (LC), Near Threatened (NT), Vulnerable (VU), Endangered (EN) and Not Evaluated (NE). Species richness and abundance were calculated as the number of species and total number of individuals recorded during each monthly survey, respectively. Mean monthly abundance for each waterbird group was calculated as the arithmetic mean of the total abundance of all species in each month in respective groups recorded across the 12 monthly surveys. Data were analyzed and graphs were prepared using R version 4.5.1 (R Core Team, 2026).

2.3. Breeding Observation

Behavioral observations like the incubating adults of Little Tern *Sternula albifrons* and their distraction displays, chasing the predators, and carrying fish to the partner gave the cue of the breeding of the species and nest locations in the estuary. From the encountered nests, the GPS location, description of nesting habitat characteristics, clutch size and the colony size were also recorded.

3. Results

3.1. Overall Waterbird Assemblage

During the 12-month survey, 40 species of waterbirds were recorded at Atrangarai Estuary, among which shorebirds accounted for the highest richness (n = 20), followed by gulls and terns (n = 12) and other waterbirds (n = 8). Annual total abundance calculated as sum of monthly abundance across all waterbird guilds was 9291. Cumulative annual counts showed that gulls and terns were the most abundant guild overall (n = 5029), compared to shorebirds (n = 3738) and others (n = 524). Gulls and terns also had the highest mean monthly abundance (419.1), while shorebirds had a lower mean abundance (311.5), followed by others (43.6).

Among all the waterbird species, 33 species (82.5%) were listed as Least Concern, four species Great Stone-curlew *Esacus recurvirostris*, Eurasian Curlew *Numenius arquata*, Dunlin *Calidris alpina*, Ruddy Turnstone *Arenaria interpres* were Near Threatened, two species Curlew Sandpiper *Calidris ferruginea* and Grey Plover *Pluvialis squatarola* were Vulnerable, and one species, Hanuman Plover *Anarhynchus seebohmi* was Not Evaluated under the IUCN Red List categories. Based on migratory status, 24 species (60%) were winter visitors, 12 were resident/non-breeding, three species, Hanuman Plover, Great Stone-curlew and Little Tern, were resident/breeding, and one species Western Reef Egret *Egretta gularis* was a local migrant (Table 1).

Table 1. Checklist of waterbirds recorded in Atrangarai Estuary with respective IUCN status, migratory status and one-time peak counts.

Guild	Order	Family	Common Name	Scientific Name	IUCN Status	Migratory Status	One-time Peak Count
Shorebirds	Charadriiformes	Scolopacidae	Whimbrel	<i>Numenius phaeopus</i>	LC	WV	6
			Eurasian Curlew	<i>Numenius arquata</i>	NT	WV	3
			Curlew Sandpiper	<i>Calidris ferruginea</i>	VU	WV	32
			Common Sandpiper	<i>Actitis hypoleucos</i>	LC	WV	2
			Terek Sandpiper	<i>Xenus cinereus</i>	LC	WV	1
			Common Redshank	<i>Tringa totanus</i>	LC	WV	22
			Common Greenshank	<i>Tringa nebularia</i>	LC	WV	15
			Little Stint	<i>Calidris minuta</i>	LC	WV	6
			Dunlin	<i>Calidris alpina</i>	NT	WV	1
			Ruddy Turnstone	<i>Arenaria interpres</i>	NT	WV	16
			Ruff	<i>Calidris pugnax</i>	LC	WV	10
			Sanderling	<i>Calidris alba</i>	LC	WV	8
		Charadriidae	Grey Plover	<i>Pluvialis squatarola</i>	VU	WV	60
			Tibetan Sand Plover	<i>Anarhynchus atrifrons</i>	LC	WV	800
			Greater Sand Plover	<i>Anarhynchus leschenaultii</i>	LC	WV	520

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Table 1. continued...

Gulls & Terns			Kentish Plover	<i>Anarhynchus alexandrinus</i>	LC	WV	130
			Hanuman Plover	<i>Anarhynchus seebohmii</i>	NE	R/B	16
			Red-wattled Lapwing	<i>Vanellus indicus</i>	LC	R/NB	8
		Burhinidae	Great Stone-curlew	<i>Esacus recurvirostris</i>	NT	R/B	12
		Recurvirostridae	Black-winged Stilt	<i>Himantopus himantopus</i>	LC	R/NB	2
		Laridae	Little Tern	<i>Sternula albifrons</i>	LC	R/B	120
			Saunders's Tern	<i>Sternula saundersi</i>	LC	R/NB	2
			Greater Crested Tern	<i>Thalasseus bergii</i>	LC	R/NB	320
			Lesser Crested Tern	<i>Thalasseus bengalensis</i>	LC	WV	1100
			Gull-billed Tern	<i>Gelochelidon nilotica</i>	LC	WV	50
			Roseate Tern	<i>Sterna dougallii</i>	LC	R/NB	1
			Caspian Tern	<i>Hydroprogne caspia</i>	LC	WV	68
			Common Tern	<i>Sterna hirundo</i>	LC	WV	15
			Black-headed Gull	<i>Chroicocephalus ridibundus</i>	LC	WV	22
			Brown-headed Gull	<i>Chroicocephalus brunicephalus</i>	LC	WV	40
Others	Pelecaniformes	Phalacrocoracidae	Lesser Black-backed Gull	<i>Larus fuscus heuglini</i>	LC	WV	64
			Pallas's Gull	<i>Ichthyiaetus ichthyiaetus</i>	LC	WV	4
		Ardeidae	Little Cormorant	<i>Microcarbo niger</i>	LC	R/NB	56
			Indian Cormorant	<i>Phalacrocorax fuscicollis</i>	LC	R/NB	40
			Little Egret	<i>Egretta garzetta</i>	LC	R/NB	35
			Intermediate Egret	<i>Ardea intermedia</i>	LC	R/NB	40
			Large Egret	<i>Ardea alba</i>	LC	R/NB	8
			Indian Pond Heron	<i>Ardeola grayii</i>	LC	R/NB	12
			Grey Heron	<i>Ardea cinerea</i>	LC	R/NB	12
			Western Reef Egret	<i>Egretta gularis</i>	LC	LM	2

Migratory Status: WV – Winter Visitor, R/B – Breeding resident, R/NB – Non-breeding resident; IUCN status: LC – Least Concern, NT – Near Threatened, VU – Vulnerable, NE – Not Evaluated.

3.2. Seasonal Pattern of Species Richness and Abundance

Overall monthly species richness across all guilds ranged from 9 species in September to 22 species in both January and April. Shorebirds showed highest monthly richness in March (n = 12), followed by January, February and April (n = 10 in each month) and a decline during June–July (n = 6 in each month). Gulls and terns reached highest richness in January (n = 9), whereas others reached highest richness in June and July (n = 6 each) (Figure 2).

Monthly total abundance peaked in February 2026 (n = 2650), followed by January 2026 (n = 2179) and lowest in October 2025 (n = 107), in which gulls & terns dominated the assemblage (January n = 1564 and February n = 1395) (Figure 3).

Shorebirds were the highest in February (n = 1235), followed by March (n = 605) and January (n = 601). Notably, July, being the summer month, showed a substantial abundance of gulls and terns (n = 352), compared to shorebirds (n = 77) and others (n = 95) (Figure 3).

Species-wise cumulative annual abundance analysis of the most abundant waterbird species showed that Lesser Crested Tern *Thalasseus bengalensis* was the most abundant (n = 3135), followed by Tibetan Sand Plover (n = 1840), Greater Sand Plover *Anarhynchus leschenaultii* (n = 1146) and Greater Crested Tern *Thalasseus bergii* (n = 1007). Tibetan Sand Plover peak count was in February (n = 800), Greater Sand Plover in March (n = 520), Lesser Crested Tern in January (n = 1100), and Greater Crested Tern in December (n = 320) (Figure 4). Among the other species, Little Cormorant *Microcarbo niger* was the most abundant with cumulative annual abundance (n = 160) and a one-time peak count of 56 individuals in July.

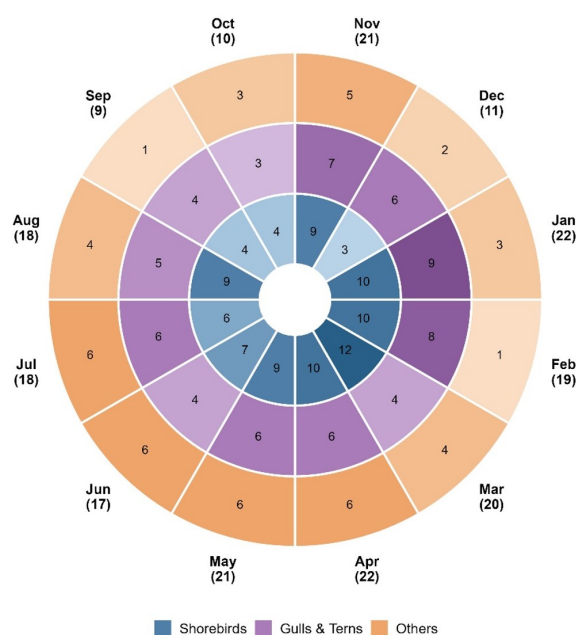


Figure 2. Monthly species richness of each waterbird guild with total richness in the parentheses below the respective months (August 2025 to July 2026).

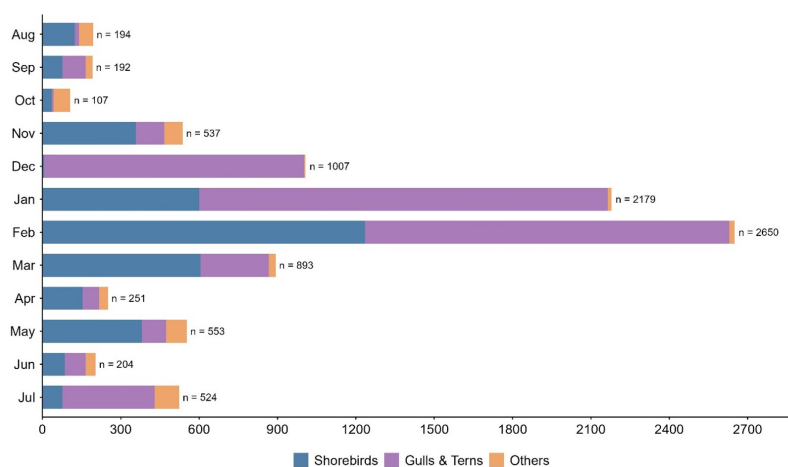


Figure 3. Monthly abundance of each waterbird guild, where 'n' represents the total monthly abundance across all guilds (August 2025 to July 2026).

3.3. Breeding Waterbirds

Six Great Stone-curlew juveniles were observed in July 2026 and one chick of Hanuman Plover in April 2026. Little Tern breeding was recorded in June and July 2026 with 26 and 6 nests respectively. Nests were mostly on the elevated sand area as shallow scrapes in the ground, approximately 30 m from the water source. Three nests had a few days-old chicks. A few broken eggs were also observed. Little Terns were chasing away the House Crows *Corvus splendens* and Black Kites *Milvus migrans* approaching the nesting area. Fishermen's movement and presence of fishing gear were noted opportunistically during the breeding season; however, these observations were not quantitatively assessed. In some instances, stray dogs were also recorded in the nesting area (Figure 5).

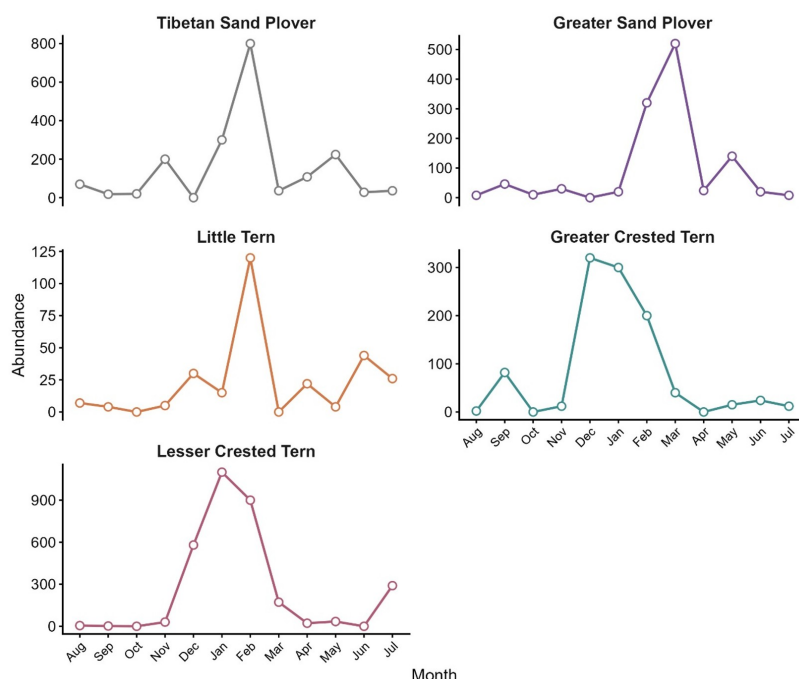


Figure 4. Monthly abundance of the five most abundant species recorded in Atrangarai (August 2025 to July 2026).

4. Discussion

Atrangarai Estuary supported 40 waterbird species, demonstrating that this relatively small estuary retains considerable value within the southeast Indian coastal landscape. Shorebirds contributed the highest species richness, whereas gulls and terns accounted for the greatest abundance, indicating that different components of the estuarine habitat are exploited differently by various waterbird guilds. This pattern aligns with other estuaries such as Kaliveli on the east coast (Islam and Rahmani, 2004), Sabarmati and Poovar on the west coast (Anand et al., 2018; Bipitha et al., 2026), consisting of heterogeneous habitats of mudflats, reed beds, marshes, sandy shore and saltpans, supporting diverse waterbirds including shorebirds (Islam and Rahmani, 2004).

The increase in waterbird abundance during January and February further indicates that Atrangarai functions as an important seasonal foraging habitat. Similar winter concentration has been documented across other estuaries, where waterbird community structure, richness and abundance increased seasonally (Li et al., 2021; Rao et al., 2022). Exposed mudflats, sandbars and shallow tidal waters provide enhanced access to benthic prey, although prey availability and tidal exposure were not quantified in the present study (Anand et al., 2018; Miotto et al., 2023).

Major record of the present study was the presence of breeding waterbirds. Active Little Tern nests containing eggs and chicks, together with Great Stone-curlew juveniles and Hanuman Plover chicks, demonstrate that Atrangarai is used as an active breeding habitat, rather than solely as a feeding or roosting ground. Suitable breeding conditions of Great Stone-curlews may include the sparse vegetation and *N. juliflora* trees on the estuary edges. Hanuman Plover prefers the sparse vegetation and mudflats with proximity to water (Byju et al., 2023a). Little Terns breed typically on exposed sandbars and sandy substrates, and proximity to shallow feeding areas (Panagoda et al., 2020; Maitreyi et al., 2026). The importance of such substrates for breeding coastal terns was demonstrated by recent observations from Adam's Bridge in the Gulf of Mannar, where five tern species Greater Crested Tern, Roseate Tern *Sterna dougallii*, Saunders's Tern *Sternula saundersi*, Bridled Tern *Onychoprion anaethetus* and Little Tern were recorded breeding on sandbars (Byju et al., 2025).

These records are particularly notable because Atrangarai supports active traditional fishing activity. The breeding colonies are potentially exposed to both natural and human-associated disturbances. During the breeding period, fishermen were observed using an access route through the nesting area to dry nets or to reach the village on the other side of the nesting area. Sometimes broken fishing gear was present around one Little Tern nest. These observations indicate potential interaction between humans and breeding species; however, disturbances were not quantified in detail to conclude their impacts with certainty. House crows and raptors represented potential predators, and Little Terns were observed actively chasing them away. Stray dogs and fishing-related disturbance were additional potential pressures.



Figure 5. Images of A. Little Tern incubating adult; B. Little Tern nest and eggs; C. Tern breeding habitat; D. Great Stone-curlew adults with juvenile and Gull-billed Terns; E. Lesser Crested Tern flock; F. Fishermen movement near to waterbird habitat.

4.1. Conservation Significance and Recommendations

The coexistence of waterbirds and traditional fishing is an important feature of several Indian estuarine systems (Subhash Chandran et al., 2014; Mogalekar et al., 2017; Byju et al., 2023b). Conservation at Atrangarai should therefore focus on targeted management. Continued monitoring is required for seasonal identification and protection of active nesting patches, control of stray dogs in the nesting area, maintenance of open sandy substrates and reduction of disturbance during incubation and chick-rearing could protect breeding birds while allowing fishing to continue in the estuary. Phased removal of *N. juliflora* with proper replacement strategy with native trees must be carried out to ensure nesting habitat availability for Great Stone-curlew. Involving local fishers in identifying and monitoring nesting areas could further support site-level protection.

5. Conclusion

The present study provides the first systematic assessment of waterbirds at the lesser-known Atrangarai Estuary, highlighting its importance for migratory and breeding species. Notably, Little Tern, Great Stone-curlew and Hanuman Plover were recorded breeding within this traditional fishing landscape. Continued monitoring, especially during the breeding season, together with locally appropriate measures to minimize disturbance at nesting sites, would help maintain the ecological value of Atrangarai Estuary while supporting traditional livelihoods.



Author Contribution

Maitreyi H: Investigation, Writing – original draft, Formal analysis, Visualization; Byju H: Investigation, Conceptualization, Writing – original draft, Writing – review & editing; Raveendran N: Investigation; Rajesh M: Writing – review & editing.

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Declarations

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