



Original Research

Temporal Dynamics and Establishment of Breeding Colony of Eurasian Spoonbill (*Platalea leucorodia*) at Therthangal Bird Sanctuary, Tamil Nadu, India

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Abstract

Repeated monitoring of colonial waterbirds provides important insights into breeding habitat quality, colony persistence, and ecological stability. We assessed the breeding dynamics of the Eurasian Spoonbill (*Platalea leucorodia*) at Therthangal Bird Sanctuary (TBS), Tamil Nadu, India, using data from six breeding seasons (2019–2020 to 2025–2026), excluding 2020–2021 because of COVID-19 restrictions. Breeding chronology and reproductive performance were evaluated through monthly surveys from September to February. Courtship began in September, with nest building concentrated in October and peak nesting in November; hatching occurred during December, while fledging extended into January–February. Peak abundance reached 42 individuals in 2022–2023. Peak nest abundance increased from three nests in 2019–2020 to 12 in both 2022–2023 and 2025–2026. A notable finding of the study was the complete breeding failure during 2023–2024. Mann–Kendall tests detected no significant temporal trends in annual peak bird abundance or active nest abundance. Clutch size and nest-level hatching success did not differ significantly among breeding seasons (Kruskal–Wallis $p > 0.05$). Colony-level hatching success ranged from 68.4% (2021–2022) to 85.7% (2024–2025). Nesting occurred predominantly on *Acacia nilotica*, with limited use of *Neltuma juliflora* as a nesting substrate. Overall, our findings establish TBS as a regular breeding site for Eurasian Spoonbill in southeastern India. Sustaining this emerging breeding colony will require maintaining seasonal water hydrology, protecting suitable nesting trees, and minimizing disturbances during breeding seasons through locally compatible wetland management.

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Statement of Sustainability: This study provides the first multi-year assessment of colony establishment and breeding biology of the Eurasian Spoonbill in a Ramsar-designated irrigation wetland in southeastern India. The study highlights the importance of maintaining suitable hydrological conditions, protecting nesting trees, and the role of the surrounding agricultural landscapes that provide complementary foraging habitats during the breeding season. The findings highlight the role of irrigation wetlands in sustaining colonial waterbird populations and provide evidence to support scientific management and the long-term conservation of biodiversity in modified landscapes.

1. Introduction

Multiple-year monitoring plays a major role in the conservation of colonial breeding species and their nesting habitat. Because breeding success is closely linked to habitat health, repeated monitoring of nesting colonies provides valuable indicators of ecosystem health and informs adaptive management of protected wetlands (Fournier et al., 2021). In southern India, sustained monitoring programs in important breeding colonies such as the Melaselvanoor-Kelaselvanoor Bird Sanctuary (MKBS) and Vettangudi Bird Sanctuary (VBS) have demonstrated the value of long-term datasets in assessing breeding populations, habitat changes and conservation priorities (Byju et al., 2025a; Maitreyi et al., 2026 in press).

The Eurasian Spoonbill (*Platalea leucorodia*) is a widespread wetland-dependent waterbird distributed across Europe, West Africa,

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the Mediterranean, the Arabian Peninsula, Central Asia and parts of South and East Asia, including India, Pakistan and China (Triplet et al., 2008; Aspinal, 2010; Zhang et al., 2020; BirdLife International, 2025). Despite its extensive geographic range and Least Concern status (Symes et al., 2015; BirdLife International, 2025), regional populations, particularly in Asia, are influenced by wetland degradation, habitat modification, hunting, human disturbance and egg collection (Triplet et al., 2008; BirdLife International, 2025). Regional studies on population and breeding ecology are essential to support effective evidence-based conservation planning.

The Eurasian Spoonbill is generally a colonial breeding species. Nest sites vary geographically and include reed beds, rocky islands, shrubs and trees within or adjacent to shallow wetlands, where nesting sites may reduce access by terrestrial predators and provide proximity to foraging areas (Jennings, 2010). In the Arabian Peninsula, nests are typically constructed from sticks lined with softer stalks and feathers (Jennings, 2010), whereas tree-nesting colonies are commonly reported from the Indian subcontinent. The sexes are similar in overall plumage. During the breeding season, adult males develop conspicuous plumage, including a yellow neck/breast band and two elongated crest feathers. During courtship, the male shakes these feathers on his head and produces soft whistles to the female. Nest building happens after pairing. After the pair settles down for nesting, the yellow color around the neck slowly diminishes. Across much of its breeding range, clutch size generally varies from three to five eggs, with four eggs being the most frequent (Harrison and Castell, 1998; Jennings, 2010). Breeding phenology is geographically variable, with egg-laying starting from March until June in Kuwait, and commencing slightly later in April in parts of the Red Sea region (Jennings, 2010). In India, the Eurasian Spoonbill occurs as a resident and locally migrant, with breeding phenology varying geographically in relation to rainfall, hydrology and local wetland conditions (Grimmett et al., 2011; Jha, 2012). In Tamil Nadu, the breeding season is reported from October to March (Frank et al., 2021; Byju et al., 2025b).

Although breeding records of the Eurasian Spoonbill are available from several regions of India, including Tamil Nadu where 12 heronries were identified (Frank et al., 2021), quantitative information on breeding phenology, nest-site characteristics, nest survival and reproductive success remains scarce. Most published reports are limited to distributional records or general breeding observations, with relatively few studies examining the ecological factors influencing nesting success or reproductive output. Therthangal Bird Sanctuary (TBS), Tamil Nadu, is an important inland breeding wetland supporting mixed-species colonies of resident waterbirds. However, information on the breeding ecology of the Eurasian Spoonbill at this site has remained unavailable. We therefore evaluated its nesting ecology and reproductive performance at TBS to provide site-specific evidence for long-term monitoring and habitat management, while supporting sustainable wetland management through the maintenance of suitable breeding habitats and ecological conditions for colonial waterbirds and to enhance broader understanding of breeding ecology in large wetland-dependent birds.

2. Materials and Methods

2.1. Study Area

TBS, located in Ramanathapuram district, Tamil Nadu (9° 27' 23" N, 78° 46' 18" E), is a seasonal irrigation wetland and was designated as a Ramsar site in 2024 (Therthangal Bird Sanctuary-Ramsar Sites Information Service 2026). The sanctuary covers approximately 122.6 ha, of which around 30 ha constitute the core nesting area for waterbirds. The wetland receives water primarily from the northeast monsoon and remains inundated from October to February depending on rainfall. The habitat consists of shallow open water, mudflats, emergent vegetation, reed beds, and scattered nesting trees dominated by *Acacia nilotica* and *Neltuma juliflora* (synonym *Prosopis juliflora*), which serve as important nesting substrates for colonial waterbirds. The surrounding landscape is agricultural, interspersed with village settlements. TBS supports over 90 species of birds, including several colonial breeders such as Painted Stork *Mycteria leucocephala*, Asian Openbill *Anastomus oscitans*, Spot-billed Pelican *Pelecanus philippensis*, Black-crowned Night Heron *Nycticorax nycticorax*, and various egrets and ibises (Byju et al., 2024a).

2.2. Field Surveys and Monitoring

Field surveys were conducted at TBS from 2019–2020 to 2025–2026 breeding seasons (September to February), excluding 2020–2021 due to COVID-19-related restrictions. Although breeding activity, including courtship displays, pair formation, nest construction, incubation, chick rearing and fledging behaviour, was monitored throughout the breeding period, systematic nest count data were regularly collected from November to February. The overall field effort was approximately 85–110 field days across all the breeding seasons.

2.3. Population Estimation

Population estimation was carried out using a fixed point-count design (Bibby et al., 2000). Birds were counted by the same observers at seven vantage points, based on the water distribution and visibility of breeding colonies, using binoculars (10 x 50 Nikon) and spotting scopes (14 x 70 Vanguard) (Figure 1). Each point was surveyed for 20–30 minutes per visit. Counts from all vantage points were combined to estimate total colony abundance; as the numbers were small and the counts were made simultaneously, there was no double-counting.

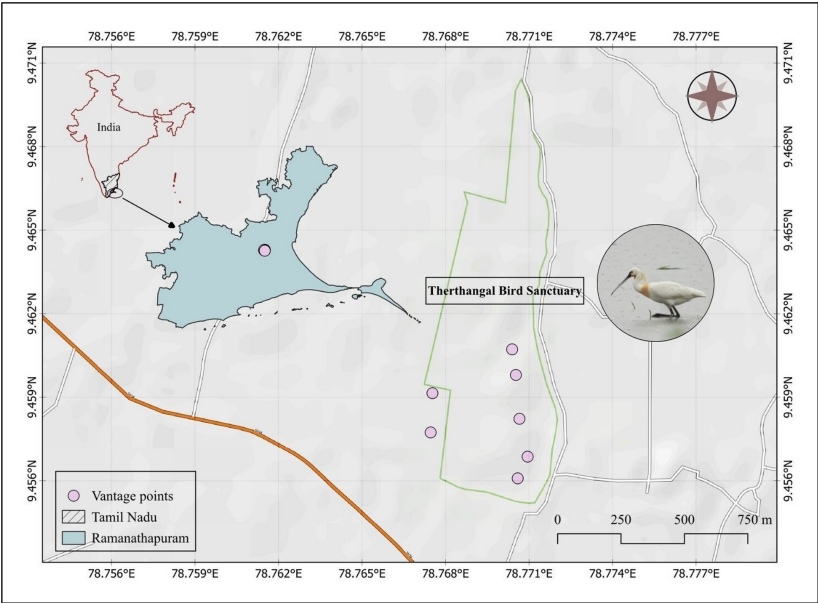


Figure 1. Map showing the vantage points in Therthangal Bird Sanctuary in Ramanathapuram district.

2.4. Nest Monitoring

Peak active nest abundance was assessed through direct nest counts whenever colonies were accessible. For completely inaccessible colonies, perimeter counts were used, based on counts of visible nests and observations of foraging flights from the colony edge (Dodd and Murphy, 1995). Breeding activity, including courtship displays, nest construction, incubation, and nest counts, was monitored along with detailed breeding parameters, including nesting substrate (tree species), clutch size, hatching success, and patterns of adult attendance (Table 1). Hatching success was calculated as the number of eggs that hatched divided by the total number of eggs laid, multiplied by 100, both for individual nests and at the colony level, representing the combined egg count and hatchling count across all the nests in each breeding season. Nests were monitored from a distance of 50 to 100 m using the equipment mentioned, following standardized nest-monitoring protocols (Gibbs et al., 1988).

Table 1. General breeding characteristics of Eurasian Spoonbill observed at TBS.

Nesting season	September - February
Nest material	Twigs, sticks, leaves
Nest trees	<i>Acacia nilotica</i> , <i>Neltuma juliflora</i>
Clutch size	2-5 eggs observed
Incubation period	20-24 days observed
Fledging period	36-42 days
Parental care	Biparental
Colony type	Colonial

2.5. Data Analysis

Temporal trends in annual peak bird counts and active nest counts were analysed using the Mann–Kendall trend test (Mann, 1945; Kendall, 1975) for the six breeding seasons including the zero-nesting season of 2023–2024. Annual peak abundance was the maximum count recorded during any survey within each breeding season. Peak active nest abundance was the maximum number of active nests recorded during a breeding season. Differences in clutch size and nest-level hatching success among breeding seasons were assessed using the Kruskal–Wallis test (Kruskal and Wallis, 1952). Only the five breeding seasons with active nests were included in the analysis, hence excluding the zero-nesting season of 2023–2024. The relationship between annual peak bird counts and active nest counts was evaluated using Spearman’s rank correlation coefficient (Spearman, 1904). All analyses were performed in R version 4.5.1 (R Core Team, 2026), and statistical significance was assessed at $p < 0.05$.

3. Results



3.1. Breeding Phenology

Breeding phenology was remarkably consistent throughout the study. Courtship behaviour commenced during the second week of September in all breeding seasons. Nest construction began in October and peaked during November. Hatching was concentrated in December while fledging occurred primarily during January and February. Nests were made initially with large sticks and small sticks thereafter. In the centre of the nest, the birds placed leaves as a cushion. Eggs were white, sparingly spotted and blotched with deep reddish brown.

3.3. Population Trends

The highest peak bird abundance ($n = 42$) and peak active nest abundance ($n = 12$) were recorded during 2022–2023, whereas no breeding occurred during 2023–2024 (Figure 2). The Mann-Kendall test including the zero nesting year showed no significant temporal trend in peak annual bird abundance ($\tau = 0.276$, $z = 0.574$, $p = 0.566$) and peak annual nest abundance ($\tau = 0.414$, $z = 0.956$, $p = 0.339$), while the sensitivity analysis excluding the zero-nesting season of 2023–2024 also showed no significant trend ($\tau = 0.738$, $z = 1.516$, $p = 0.129$). Nest numbers increased threefold from three nests during 2019–2020 to 12 nests during 2022–2023 and again in 2025–2026. Annual peak bird counts were strongly associated with peak active nest abundance (Spearman's rank correlation, $\rho = 0.971$, $p = 0.0013$, $n = 6$). However, due to the small sample size leading to low statistical power, these tests should be interpreted cautiously.

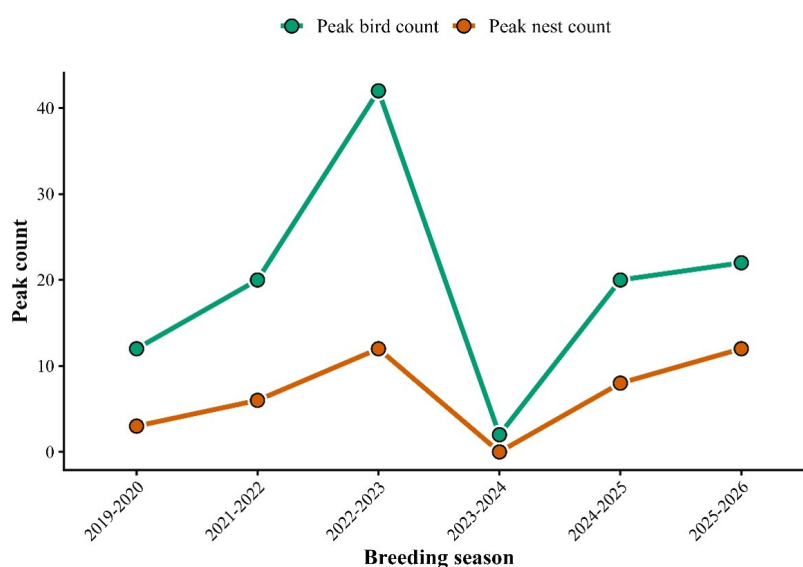


Figure 2. Peak bird count and peak active nest count of Eurasian Spoonbill during the breeding seasons from 2019–2020 to 2025–2026 in TBS.

3.3. Breeding Parameters

The number of nests monitored in each season was as follows: 2019–2020: $n = 3$; 2021–2022: $n = 6$; 2022–2023: $n = 12$; 2023–2024: $n = 0$; 2024–2025: $n = 8$; 2025–2026: $n = 12$. Breeding parameters remained relatively consistent across breeding seasons (Figure 3). The mean incubation period ranged from 20.3 ± 0.6 days in 2019–2020 to 21.1 ± 1.3 days in 2022–2023 and 2025–2026. The mean fledging period (age at first flight) varied between 37.3 ± 1.2 and 40.0 ± 1.3 days across breeding seasons. Across the five breeding seasons with active nests, individual clutch size ranged from 2 to 5 eggs, with three-egg clutches being most frequent (22 nests out of 41), followed by two-egg (13 nests), four-egg (5 nests), and five-egg clutches (1 nest) (Table 1). Season-wise mean clutch size ranged from 2.7 ± 0.6 to 3.2 ± 0.8 eggs, while the mean number of hatchlings varied from 1.9 ± 0.3 to 2.3 ± 0.5 . Colony-level total hatching success was highest in 2024–2025 (85.7%), followed by 2019–2020 and 2022–2023 (75.0% each), 2025–2026 (69.7%), and 2021–2022 (68.4%) (Table 2). Nesting occurred predominantly on *A. nilotica* throughout the study period (Figure 4). All nests were built on *A. nilotica* during 2019–2020 and 2021–2022, whereas *N. juliflora* was first used during 2022–2023 and accounted for approximately 17–18% of nests in 2022–2023, 2024–2025, and 2025–2026. Based on the Kruskal–Wallis test for nest-level data, neither clutch size ($\chi^2 = 2.63$, $df = 4$, $p = 0.621$) nor hatching success ($\chi^2 = 3.16$, $df = 4$, $p = 0.532$) differed significantly among breeding seasons.



Table 2. Colony-level total number of eggs, total number of hatchlings, and total hatching success (%) of Eurasian Spoonbill across breeding seasons (2019–2020 to 2025–2026).

Year	Total number of eggs	Total hatchling	Hatching success (%)
2019–2020	8	6	75
2021–2022	19	13	68.4
2022–2023	36	27	75
2023–2024	0	0	0
2024–2025	21	18	85.7
2025–2026	33	23	69.7

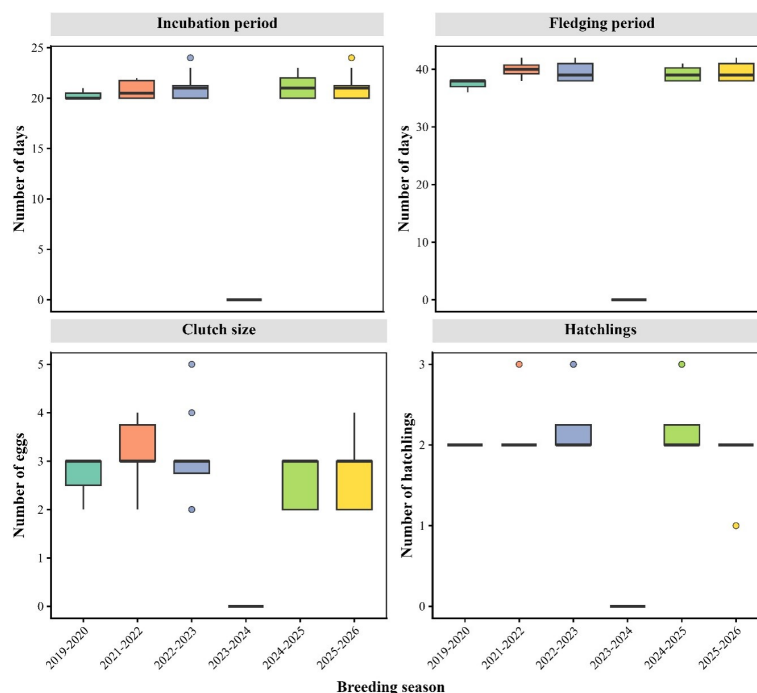


Figure 3. Distribution of incubation period, fledging period, clutch size, and number of hatchlings among Eurasian Spoonbill nests across breeding seasons (2019–2020 to 2025–2026) in TBS.

4. Discussion

The present study is one of the few comprehensive assessments of the breeding ecology of the Eurasian Spoonbill in peninsular India, and documents the recently declared Ramsar site TBS as a regular breeding site. Although the Mann–Kendall analysis detected no significant temporal trend in bird abundance or nest numbers, these results should be interpreted with caution due to the relatively short monitoring period. Sensitivity analysis excluding the zero-nesting year also showed no significant trend. Ecologically, the increase from three active nests during 2019–2020 to twelve nests during both 2022–2023 and 2025–2026 indicates gradual colony establishment. Similar patterns have been reported in colonial waterbirds, where breeding populations frequently fluctuate between years while exhibiting long-term site fidelity once suitable nesting conditions become established (Triplet et al., 2008). The reproductive parameters recorded at TBS are broadly similar to other published records. Clutch size of two to five eggs, with three eggs predominating, agrees closely with previous reports from India and other parts of the species' range (Ali and Ripley, 1987; Harrison and Castell, 1998; Jha, 2012; Jennings, 2010). Likewise, the incubation period of approximately three weeks and fledging period of about five to six weeks closely resemble published breeding biology of Eurasian Spoonbills (Jha, 2012; AlRashidi et al., 2021).

Courtship began during September, nesting peaked in November, hatching occurred primarily during December, and fledging continued until February. This schedule coincides with the seasonal rainfall regime of the northeast monsoon, when increasing water levels support abundant fish, amphibians and aquatic invertebrates required by breeding spoonbills. The monsoon period also coincides with the commencement of seasonal agricultural activities, and partially inundated paddy fields created during cultivation provide productive foraging habitats for spoonbills and other large wading birds (Byju et al., 2024b; Byju et al., 2026).

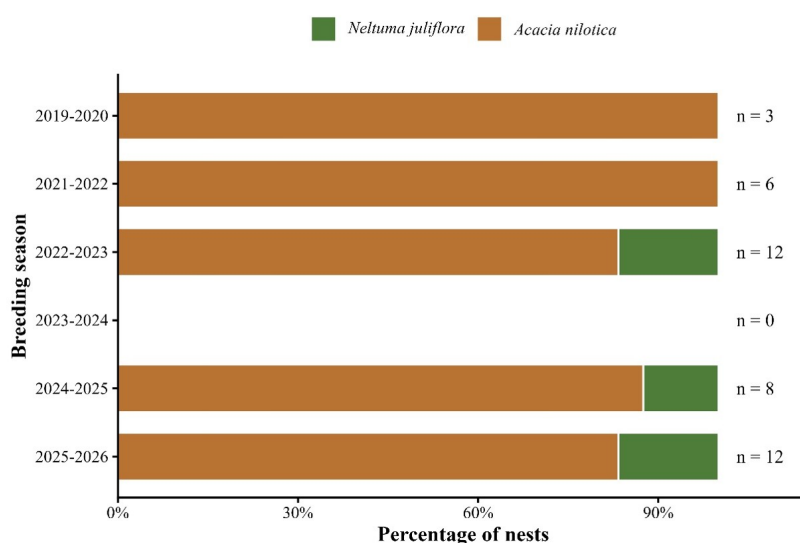


Figure 4. Percentage of Eurasian Spoonbill nests on *Acacia nilotica* and *Neltuma juliflora* across breeding seasons (n represents the peak number of nests in the respective season).

This temporal correspondence therefore suggests that the breeding cycle of Eurasian Spoonbills at TBS is closely aligned with predictable seasonal changes in the local wetland environment (O'Brien and McGinness, 2019). However, because prey availability and hydrological variables were not directly measured in the present study, this relationship should be regarded as an ecological association rather than evidence of a direct causal mechanism.

Despite annual variation in colony size, the breeding parameters remained consistent throughout the study. No statistically significant differences were detected in clutch size or nest-level hatching success among breeding seasons. Stable reproductive performance despite fluctuating colony size has been reported in several colonial waterbirds. One possible explanation is that adults may adjust nesting decisions only when environmental conditions are favourable (Ritenour et al., 2022; Brandis et al., 2024), although such mechanisms were not tested in the present study. Thus, colony size at TBS may be more sensitive to annual environmental variation. The relatively consistent breeding phenology throughout the study further suggests that Eurasian Spoonbills may respond to seasonal environmental cues that remain relatively predictable despite annual variation in rainfall intensity.

Nesting occurred predominantly on *A. nilotica*, with *N. juliflora* being occupied only after colony expansion during later breeding seasons. Tree architecture is known to play an important role in nest-site selection by colonial waterbirds because strong horizontal branches provide stable nesting platforms while dense thorny canopies reduce predator access and offer protection from weather (Roshnath and Sinu, 2017). *A. nilotica* has long been recognized as one of the principal nesting trees for colonial waterbirds in southern India (Frank et al., 2021). The increasing usage of *N. juliflora* as a secondary nesting substrate suggests some flexibility in nest-site selection as colony size increased.

The study showed a strong positive relationship between annual peak bird abundance and peak active nest abundance. Similar relationships between breeding abundance and colony size have been reported for other colonial waterbirds, where annual breeding populations closely track habitat suitability and local resource availability (Fournier et al., 2021).

One of the most notable findings of this study was the complete breeding failure during the 2023–2024 season, followed by successful recolonization in 2024–2025. Temporary breeding failures are characteristic of colonial waterbirds occupying seasonal wetlands because breeding decisions are strongly influenced by annual hydrological conditions (Narayanan and Vijayan, 2007; Thomas et al., 2026). At TBS, a monsoon-fed irrigation wetland, the hydroperiod contributes to interannual variation in breeding suitability (Byju et al., 2024a). Seasonal wetland breeders are sensitive to variations in rainfall, water depth, prey availability and inundation, which affect access to nesting areas and the vulnerability of colonies to terrestrial predators (Lorenz, 2014). Insufficient inundation of nesting trees may expose them to disturbance and predators, or reduce the availability of feeding habitats required by the species during incubation and chick rearing. Similar hydrological influences on breeding success have been documented in Eurasian Spoonbill populations elsewhere within their range as well as in other colonial waterbirds inhabiting seasonal wetlands (Triplet et al., 2008; Jennings, 2010; Zhang et al., 2020). The recovery of breeding during 2024–2025 further indicates that the failure probably reflected temporary environmental conditions rather than permanent habitat degradation. Nevertheless, hydrological conditions, prey availability, disturbance and predator activity were not quantified during the failed season, and the precise cause of breeding failure cannot be established from the present data. However, multi-year monitoring is essential to understand the



association between breeding occurrence and breeding success with habitat quality, hydrology and food availability, providing a reliable indication of wetland health (Kingsford et al., 2017). Thus, the present findings establish an important baseline for evaluating future changes in breeding populations of Eurasian Spoonbill within this recently designated Ramsar site.

Overall, TBS supports a recurring Eurasian Spoonbill breeding colony; breeding phenology is relatively consistent; reproductive parameters show limited detectable interannual variation; colony size varies substantially among years; and one complete nesting failure was followed by renewed breeding.

4.1. Conservation Implications

Management priorities at the sanctuary should include protection of nesting trees, maintenance of appropriate seasonal water retention, prevention of tree cutting and habitat alteration, regulation of human disturbance during the breeding season and continued long-term annual monitoring of the breeding colony. Given the observed interannual variation in colony size and nesting activity, continued annual monitoring is also important for detecting changes in colony persistence and habitat use. As a Ramsar site, TBS has significant conservation potential for sustaining breeding populations of large colonial waterbirds in southeastern India.

5. Conclusion

The findings indicate that TBS has emerged as a consistent breeding site for Eurasian Spoonbills, supporting active nesting in five of six monitored breeding seasons. The study underscores the importance of seasonal irrigation wetlands in supporting the breeding of Eurasian Spoonbill and other colonial waterbirds. These findings provide a baseline for continued ecological monitoring, sustainable wetland management and conservation planning in Tamil Nadu and southern India.

Author Contributions

H. Byju: Conceptualization, Data curation, Methodology, Writing – original draft, Writing – review & editing. Maitreyi: Data analysis, Visualization, Writing – original draft, Writing – review & editing. Raveendran N: Data curation and review.

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Declarations

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