CIBTech Journal of Zoology ISSN: 2319–3883
Online, International Journal, Available at http://www.cibtech.org/cjz.htm
2026 Vol.15, pp.44-53/Ramya and Malathi
***Research Article** (Open Access)*

DIVERSITY, COMMUNITY SHIFTS, AND ECOLOGICAL TRENDS OF OVER-SUMMERING SHOREBIRDS FROM LONG-TERM MONITORING AT MUTTUKADU BACKWATERS, SOUTHEAST COAST OF INDIA

Ramya Shree N and Malathi E*
Department of Zoology, Queen Mary's College,
Affiliated to University of Madras, Chennai, 600004, Tamil Nadu, India
**Author for Correspondence: malathi_zool@queenmaryscollege.edu.in*

ABSTRACT
Coastal wetlands in India serve as crucial habitats for migratory shorebirds and diverse benthic communities. Shorebirds that remain at their nonbreeding sites during the breeding season at coastal wetlands exhibit a phenomenon termed as over-summering behaviour. This study documents the diversity and seasonal presence of over-summering shorebirds at the Muttukadu backwaters on the southeast coast of India. Over-summering shorebirds were monitored during the over-summering period from July 2021 to July 2024. The pooled data was used to calculate three biodiversity indices: (i) Margalef's Species Richness, (ii) Shannon Diversity Index (H′), and (iii) Simpson's Dominance Index (D). To explore compositional shifts across years, Non-metric Multidimensional Scaling (NMDS) was performed using Bray–Curtis dissimilarity, with statistical significance set at ($p < 0.05$). A total of nine shorebird species were recorded over-summering at the study site during the period 2021–2024. Analysis of biodiversity indices for over-summering shorebirds at the study site revealed clear interannual variation during the study period. The Non-metric Multidimensional Scaling (NMDS) analysis based on Bray–Curtis dissimilarities revealed clear year-to-year variation in the composition of over-summering shorebird communities between 2021 and 2024. The Lorenz curve assessment of over-summering shorebird assemblages revealed a marked inequality in species abundance distribution. The results underscore the value of long-term monitoring in detecting ecological trends within coastal wetlands.

***Keywords**: Migratory, Muttukadu backwaters, Biodiversity, Over-summering, Shorebirds*

INTRODUCTION
Coastal wetlands in India serve as crucial habitats for migratory shorebirds and diverse benthic communities. These birds primarily gather in extensive coastal wetlands and intertidal zones that lie between their breeding and wintering grounds (Goss-Custard, 1985; Morrison & Ross, 1989). To exploit seasonal resource hotspots across regions, shorebirds undertake long and demanding migrations spanning thousands of kilometres (Winkler *et al.,* 2018). Such journeys expose them to adverse weather and force them to balance rapid energy acquisition with the constant risk of predation (Lank *et al.,* 2003; Buehler & Piersma, 2008). Given the high energetic costs and risks, some individuals may forego migration altogether. Shorebirds that remain at their nonbreeding (wintering) sites during the breeding season exhibit a phenomenon termed as over-summering behaviour (Aarif *et al.,* 2020). This strategy is often observed in sexually immature birds (McNeil *et al.,* 1994; Soto-Montoya *et al.,* 2009), though adults in poor condition lacking sufficient energy reserves or resilience may also over-summer (McNeil *et al.,* 1994; Vieira, 2016). Protecting such sites is therefore vital, as they support recruitment and long-term sustainability of migratory populations (Aarif *et al.,* 2020).
The over-summering phenomenon has been studied in species such as the Red Knot (*Calidris canutus rufa*), where factors like feather condition and physiological status influence the decision to remain in

nonbreeding areas, as shown in Argentina (Martinez Curzi *et al.,* 2020). Over-summering often reflects a trade-off between migration risks and reproductive success (O'Hara *et al.,* 2002; Reneerkens *et al.,* 2020). Empirical evidence suggests that yearlings are particularly prone to over-summering due to the high energetic demands, time investment, and exposure to threats associated with long-distance migration (Alerstam & Lindström, 1990; Tavera *et al.,* 2016; Verhoeven *et al.,* 2016). Adults may also remain behind due to illness, injury, or parasitic infections (Gutierrez, 2017). Although common, over-summering has received far less attention compared to other phases of the migratory cycle (Gutierrez, 2017). In species such as the Red Knot and Bar-tailed Godwit, this behaviour is not limited to yearlings; comparable proportions have been observed among both juveniles and adults (Battley *et al.,* 2020; Martinez Curzi *et al.,* 2020).

Overall, over-summering represents a strategic balance between migration risks and the prospects of successful breeding, either immediately or in the future (Summers *et al.,* 1995; O'Hara *et al.,* 2002, 2005; Reneerkens *et al.,* 2020). Studies indicate that younger shorebirds are less likely to migrate over longer distances, reflecting the increasing demands of energy, time, and safety (Alerstam & Lindström, 1990; Tavera *et al.,* 2016; Verhoeven *et al.,* 2016). Documented across 15 shorebird families in Asia and Australasia (Chowdhury, 2012), over-summering is most prevalent in Charadriidae and Scolopacidae (McNeil *et al.,* 1994). However, distribution and population patterns of over-summering shorebirds along India's coastline remain poorly understood (Aarif *et al.,* 2020). This study therefore seeks to document the diversity and seasonal presence of over-summering shorebirds at the Muttukadu backwaters on the southeast coast of India. This study provides new insights into the underexplored dynamics of shorebird use in tropical coastal habitats and offers valuable guidance for conservation and monitoring in the region.

MATERIALS AND METHODS

Study Area

The present study was conducted at the Muttukadu backwaters, a tropical coastal wetland located along the southeast coast of India near Chennai, Tamil Nadu. Positioned within the Central Asian Flyway, this site

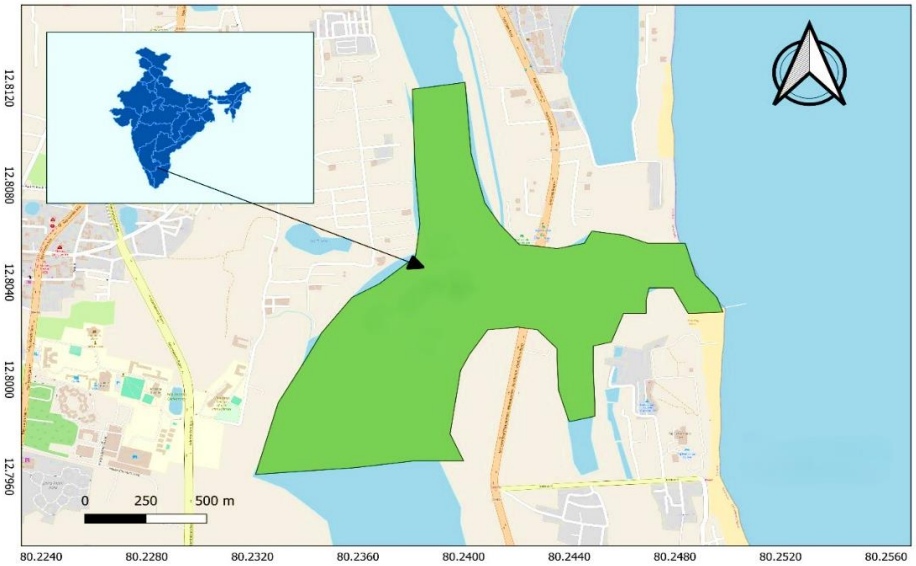

Figure 1 Map showing the location of Muttukadu backwaters, Tamil Nadu, India

lies at approximately 12.8006°N latitude and 80.2363°E longitude (Figure 1). The estuarine system is characterized by mudflats, shallow lagoons, and patches of mangroves, which together create diverse microhabitats that serve as critical foraging and roosting grounds for migratory shorebirds. Despite its

ecological importance, Muttukadu remains relatively underexplored in terms of systematic monitoring of shorebird populations. Documenting species diversity and seasonal patterns of over-summering behaviour here is particularly valuable, as tropical coastal wetlands are increasingly threatened by urban expansion, aquaculture, and habitat degradation.

Survey of Shorebirds

Migratory shorebirds generally arrive at their wintering grounds along the southeast coast of India by August and remain until their departure between March and May. To assess the assemblages of over-summering shorebirds, systematic field surveys were conducted from July 2021 to May 2025. Observations followed the direct visual count method outlined by Howes and Bakewell (1989), focusing on migratory shorebirds utilizing the study site. Survey duration varied according to species presence, typically involving two to four hours of observation per day, carried out on two to three days each month. Counts were performed during both low and high tide conditions to capture variation in shorebird activity. Birds were observed using 10×50 binoculars, while photographic documentation was obtained with a Nikon DSLR camera fitted with a 55–300 mm lens. Species identification was conducted following the standard guidelines of Hayman et al. (2011).

Data Analysis

Abundance data for over-summering shorebirds was compiled across the study period from 2021 to 2024, and both univariate diversity measures and multivariate techniques were employed to evaluate community structure and interannual variation. Three biodiversity indices were calculated to describe assemblage patterns: Margalef's Species Richness Index, which quantified species richness relative to overall abundance (Death, 2008); the Shannon Diversity Index (H′), which incorporated both richness and evenness to reflect the balance of species distribution (Shannon, 1948); and Simpson's Dominance Index (D), which measured dominance concentration to determine whether the community was disproportionately represented by a few abundant taxa (Simpson, 1949). To assess temporal shifts in species composition, Non-metric Multidimensional Scaling (NMDS) was performed using Bray–Curtis dissimilarity, with statistical significance tested at $p < 0.05$. Additionally, Lorenz curves were constructed to illustrate species distribution and dominance by plotting cumulative species percentages against cumulative abundance (Camargo, 2019). All statistical analyses were conducted using R software version 4.2.1 (R Core Team, 2022) and Microsoft Excel (2019).

Results

Abundance of Over-summering shorebirds

A total of nine shorebird species were recorded over-summering at the study site during the period 2021–2024 (Figure 3). Abundance varied across species and years (Figure 2), with some showing regular presence and others occurring more sporadically. The Little Ringed Plover displayed a steady but fluctuating occurrence throughout the study, with peaks in 2022 and 2024 suggesting favourable conditions during those years. Whimbrel exhibited irregular but notable over-summering, rising sharply in 2021, peaking in 2023, and declining in 2024, whereas Eurasian Curlew remained consistently scarce, showing only a slight increase in 2022 before stabilizing at low numbers. Black-tailed Godwit recorded a pronounced increase in 2023 followed by a decline in 2024, indicating episodic over-summering. Common Sandpiper and Marsh Sandpiper showed moderate abundance, peaking in 2022 and 2023 respectively, before declining in 2024. Wood Sandpiper increased steadily until 2023 and then decreased in 2024. Common Redshank maintained relatively high abundance across the study period but showed a gradual decline in 2024. Overall, species such as Little Ringed Plover, Common Sandpiper, Marsh Sandpiper, and Common Redshank demonstrated regular over-summering at the site.

The abundance values for the nine species revealed distinct differences in site use between 2021 and 2024. Common Redshank consistently recorded the highest mean abundance, over-summering in large numbers throughout the study. Black-tailed Godwit also showed strong presence, with a peak in 2022 followed by gradual declines. Moderate abundances were observed for Common Sandpiper, Marsh Sandpiper, and Wood Sandpiper, all of which fluctuated annually but remained regular visitors. Little Ringed Plover

maintained a modest yet steady presence, alternating between increases and decreases across years. Whimbrel displayed episodic over-summering, peaking in 2023 before declining, while Eurasian Curlew remained scarce throughout. Little Stint was the least abundant species, occurring only sporadically.

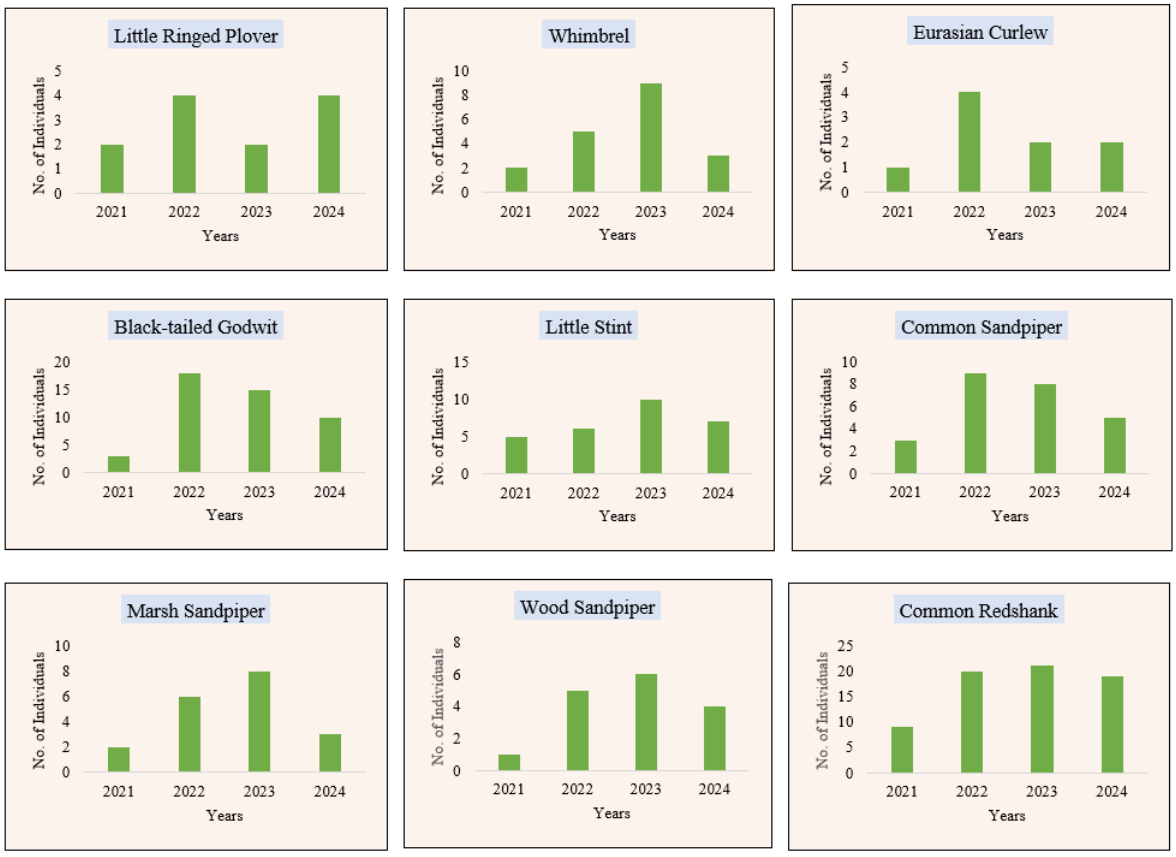

Figure 2. Abundance of nine over-summering shorebirds in the study site from 2021 to 2024.

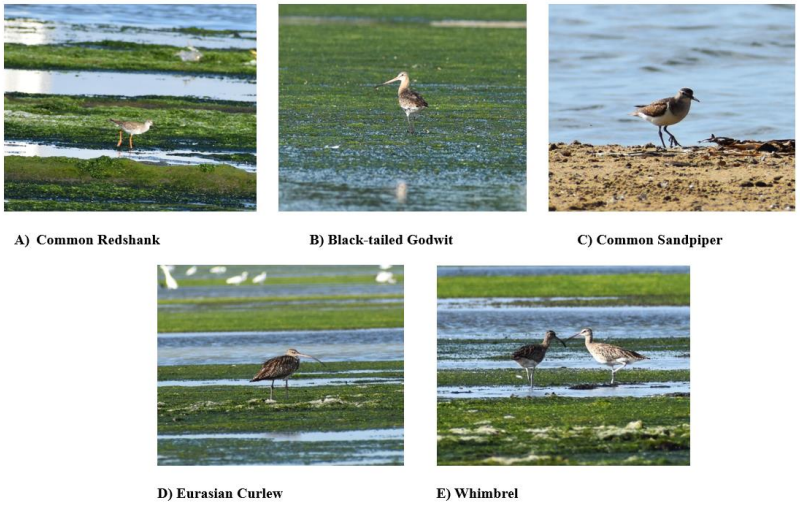

Figure 3. Over-summering shorebirds observed at the study site during the study period

Interannual Variation in Biodiversity Indices

Analysis of biodiversity indices for over-summering shorebirds at the study site revealed clear interannual variation between 2021 and 2024 (Figure 4). The Shannon Diversity Index (H′) reached its peak in 2021, reflecting greater species diversity and evenness, but showed a steady decline in subsequent years, indicating reduced diversity within the assemblage. A similar trend was observed in Margalef's Species Richness Index, which was highest in 2021, suggesting broader species representation early in the study period, followed by a gradual decrease in richness across later years. In contrast, the Simpson Dominance Index (D) remained consistently low and relatively stable throughout the four years, indicating that no single species disproportionately dominated the community.

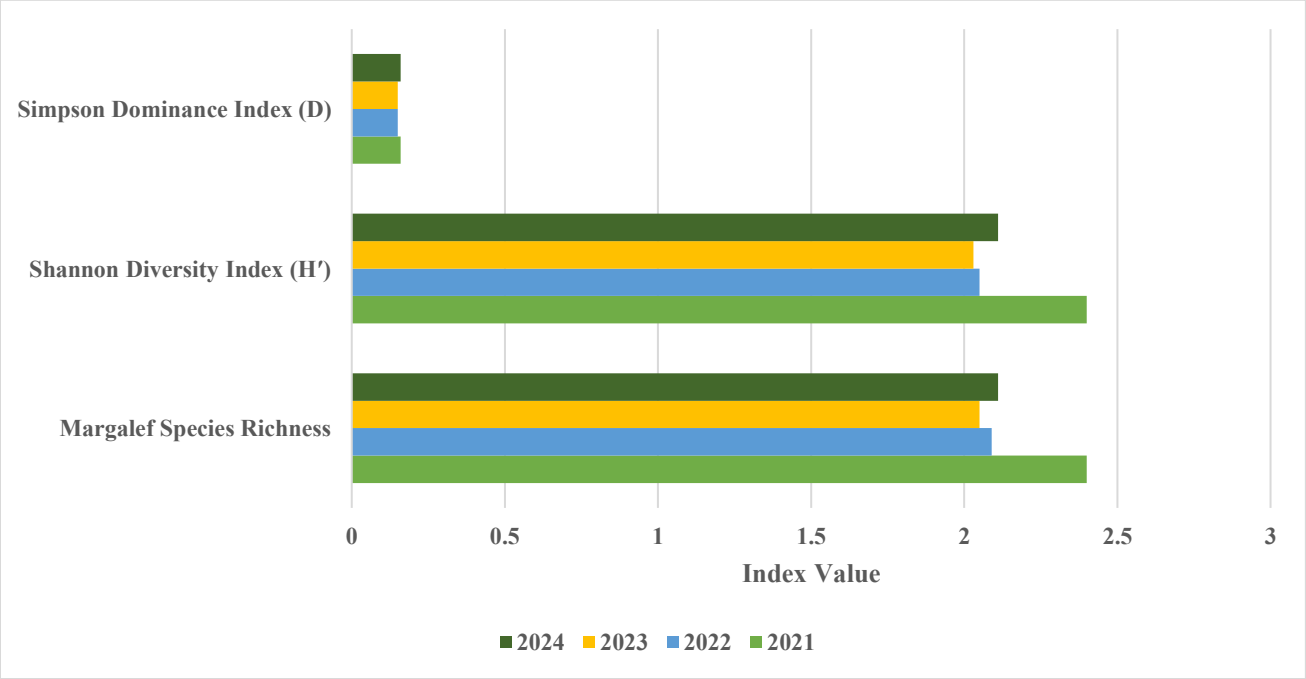

Figure 4. Interannual variation in biodiversity indices of over-summering shorebirds at the study site from 2021 to 2024.

Community Composition Shifts of Over-summering Shorebirds

The Non-metric Multidimensional Scaling (NMDS) analysis based on Bray–Curtis dissimilarities revealed clear year-to-year variation in the composition of over-summering shorebird communities between 2021 and 2024 (Figure 5). The ordination plot displayed distinct clustering patterns, with each year occupying a separate position in the two-dimensional space. In 2021, the community was located on the negative side of NMDS Axis 1, reflecting higher diversity and richness. By 2022, the assemblage shifted toward the lower region of Axis 2, indicating a structural change compared to the previous year. In 2023, the community separated along the positive side of Axis 1, suggesting further divergence in species composition, while in 2024 the cluster moved closer to the origin, representing a relatively balanced but reduced assemblage. The spatial distribution of species points demonstrated that these interannual differences were driven by changes in the relative abundance of key taxa rather than dominance by a single species. Overall, the ordination highlights the dynamic nature of over-summering shorebird communities, with 2021 emerging as the most diverse and species-rich year, followed by progressive shifts and contractions in subsequent years.

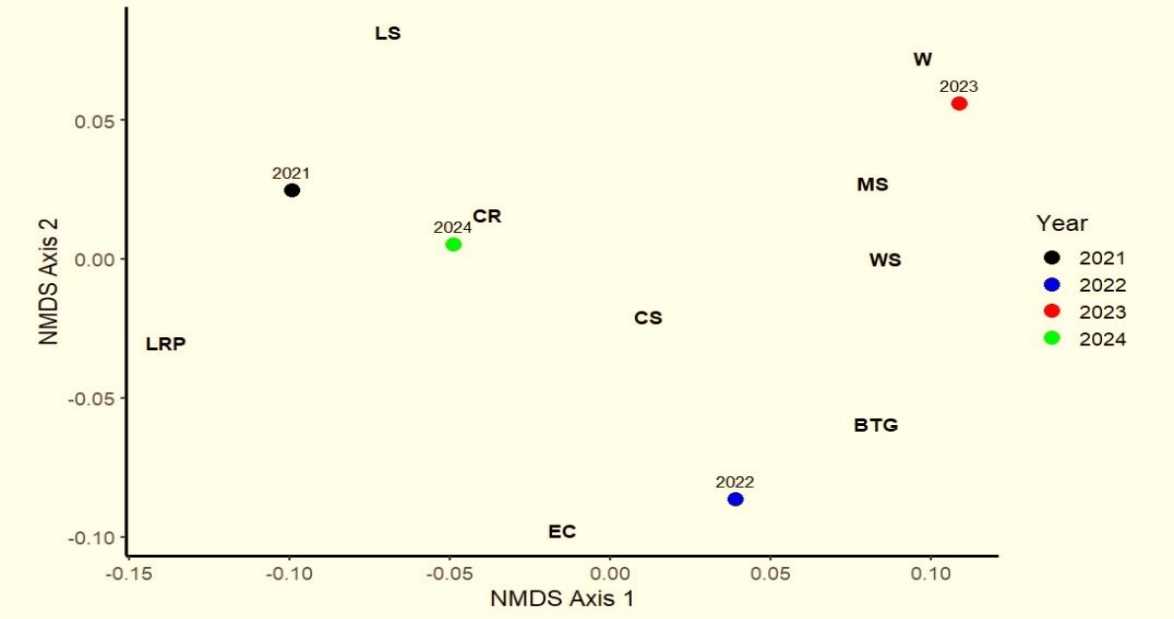

Figure 5. Non-metric Multidimensional Scaling (NMDS) ordination illustrating temporal variation in shorebird community composition across four years.
BTG- Black-tailed Godwit, CR- Common Redshank, CS- Common Sandpiper, EC- Eurasian Curlew, LRP- Little Ringed Plover, LS- Little Stint, MS- Marsh Sandpiper, WS- Wood Sandpiper, W- Whimbrel

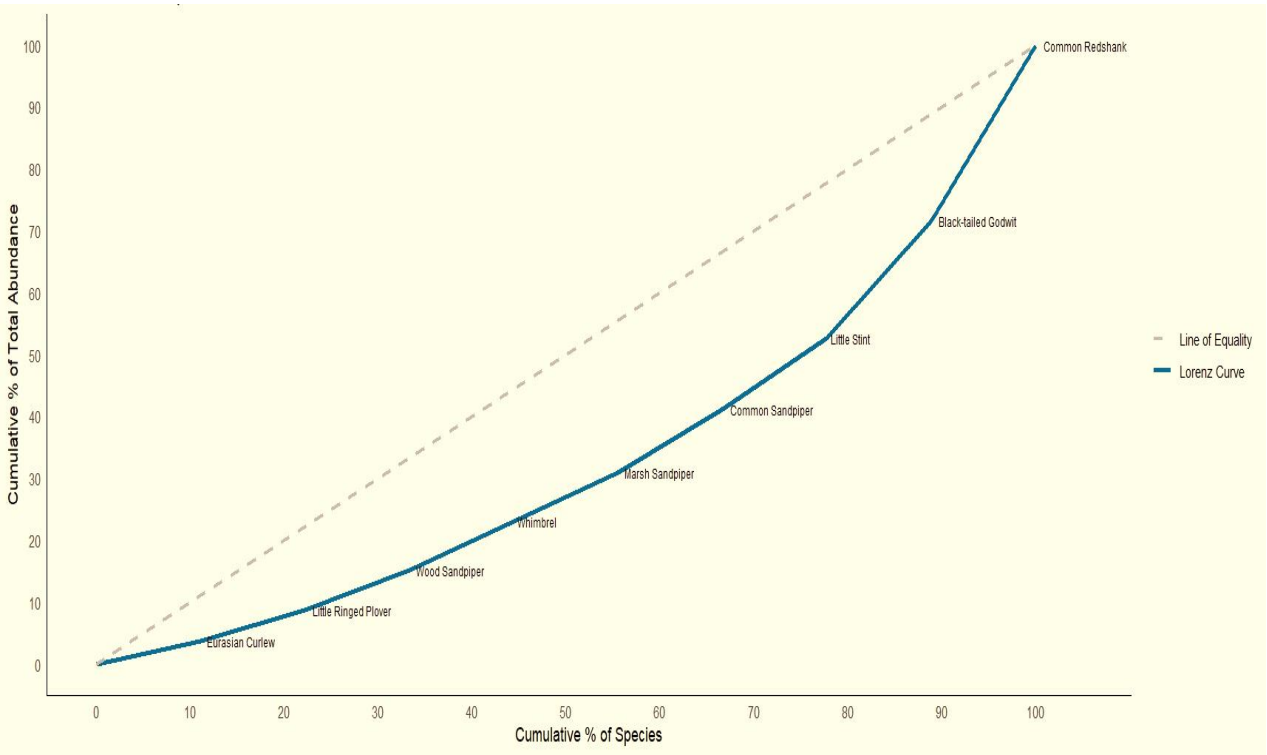

Figure 6. Lorenz Curve depicting unequal distribution of Shorebirds dominance within the study area

The Lorenz curve assessment of over-summering shorebird assemblages revealed a marked inequality in species abundance distribution (Figure 6). The curve showed a clear deviation from the line of equality, indicating that a small number of species contributed disproportionately to overall abundance. Dominant species such as the Common Redshank and Black-tailed Godwit were positioned toward the upper end of the curve, reflecting their significant share in the community. In contrast, species like the Little Ringed Plover, Eurasian Curlew, and Wood Sandpiper appeared near the lower portion of the curve, underscoring their relatively minor representation within the assemblage.

DISCUSSION

The ecological role of over-summering as a life-history strategy in migratory shorebirds remains only partially understood (McNeil *et al.,* 1994). This study documented the diversity and temporal patterns of over-summering shorebirds along the southeastern coast of Tamil Nadu between 2021 and 2024. Previous research along India's east coast has revealed regional variation in species occurrence: Balachandran et al. (2009) recorded five species at Chilika Lake in Odisha, while Balachandran and Thirunavakarasu (2009) reported ten species at Point Calimere in Tamil Nadu. In contrast, Daniel et al. (2007) observed higher richness, with twelve species, in the Gulf of Mannar. On the west coast, sites such as the Kadalundi-Vallikkunnu Community Reserve and Kerala's sandy beaches have also proven important. Aarif et al. (2020) documented seven species persisting through summer, with mudflats supporting the greatest diversity, though declines accelerated after 2010. Similarly, Shifa (2023) recorded six species across Kerala beaches, noting reduced abundance between 2021 and 2022. These regional differences suggest that habitat conditions, resource availability, and site-specific ecological factors strongly influence over-summering, highlighting the need for comparative studies across coastal landscapes.

Annual schedules of long-distance migrants vary among species (Rogers *et al.,* 2025). Over-summering refers to individuals remaining at nonbreeding sites rather than migrating to breeding grounds, though this definition can be complex for species moving between hemispheres (Rogers *et al.,* 2025). The persistence of shorebirds at poorly documented and inadequately protected sites has been identified as a potential driver of population declines (Ntiamoa-Baidu, 1991). For species breeding in Arctic and temperate regions but wintering in the southern hemisphere, delayed maturity often results in immatures remaining in nonbreeding plumage during their first potential breeding season, migrating north only in subsequent years (Shifa, 2023). Biological and ecological factors proposed to explain over-summering include sexual immaturity, low social status within flocks, limited foraging experience, and reduced prey availability (Gutierrez, 2017). Physiological conditions such as sterility, injury, illness, age-related decline, or hormonal imbalances may also prevent individuals from undertaking migration (Gutierrez, 2017).

Recent studies on India's west coast have shown that shorebirds increasingly recruit into non-traditional habitats, particularly agroecosystems, during the over-summering phase (Athira *et al.,* 2025). Between 2016 and 2023, thirteen migrant species were documented, with demographic patterns indicating that immatures and subdominant individuals are more likely to remain in these modified landscapes. While this adaptive habitat use demonstrates ecological plasticity, it raises concerns about long-term viability, given limited protection and high exposure to human pressures (Athira *et al.,* 2025). Compared with the southeastern coast of Tamil Nadu, where over-summering occurs mainly in coastal wetlands, these findings suggest region-specific responses to habitat availability and disturbance regimes (Byju *et al.,* 2024).

Ydenberg (2025) emphasizes that over-summering, partial migration, and intermittent breeding represent adaptive strategies shaped by life-history trade-offs, where individuals weigh the costs of migration against reproductive benefits. Over-summering by yearlings and partial over-summering by adults can significantly influence population dynamics, reducing the proportion of individuals breeding in a given season and thereby lowering overall productivity (Ydenberg, 2025). In most species, one-year-olds show a stronger tendency to remain at nonbreeding sites, reflecting delayed maturity and limited readiness for migration, while adults may skip breeding seasons altogether through intermittent reproduction (Martínez-Curci *et al.,* 2020).

Community-level analyses in this study, including NMDS ordination and Lorenz curve assessment, revealed dynamic assemblages shaped by shifts in relative abundance rather than dominance by a single species. Common Redshank and Black-tailed Godwit contributed disproportionately to overall abundance, whereas Eurasian Curlew and Little Stint remained marginal. The limited documentation of over-summering sites poses a major conservation challenge, leaving strategies incomplete even for species already experiencing global declines (Navedo & Ruiz, 2020). When such habitats are spatially distinct from traditional nonbreeding grounds yet serve as critical links in the migratory cycle, they become vulnerable nodes in the broader ecological network (Navedo & Ruiz, 2020).

CONCLUSION

This study documented and analysed the temporal variation in the composition and diversity of over-summering shorebird assemblages over a four-year period (2021–2024). The results underscore the value of long-term monitoring in detecting ecological trends within coastal wetlands. Preserving the structural complexity of these habitats, which provide critical support for shorebirds during migration and over-summering phases, is essential for maintaining ecosystem integrity and enhancing resilience to environmental change. Integrating long-term monitoring with habitat-level assessments will be vital for identifying the ecological drivers behind observed patterns. Furthermore, the findings highlight the importance of high-resolution phenological data in advancing our understanding of migration timing and behavioural plasticity among shorebirds.

ACKNOWLEDGMENTS

The authors would like to thank Mr. Baskar, boatman, for his assistance in field surveys. The authors are grateful to the reviewers for their insightful comments in improving the quality of the manuscript.

Credit authorship contribution statement

Ramya Shree N: Conceptualization, Methodology, Software, Formal analysis, Investigation, Writing – original draft, Project administration. Malathi E: Conceptualization, Writing – review & editing, Supervision, Project administration.

Funding

This research was funded by University Grants Commission, India, under Junior Research Fellowship for Life Sciences (Grant number: 480/ (CSIR –UGC NET JUNE 2019).

Data availability

Data will be made available on request.

Conflict of Interest

No potential competing interest was reported by the author(s).

Permits and Ethical protocol

This article does not contain any studies with human participants or animals performed by any of the authors.

Generative AI

The authors did not use generative AI in the preparation of this manuscript.

REFERENCES

Aarif KM, Kaiser SA, Nefla A & AlMaarofi S (2020). Over-summering abundance, species composition and habitat use patterns at a globally important site for migratory shorebirds. *Wilson Journal of Ornithology* **132**(1), 165–172. https://doi.org/10.1676/1559-4491-132.1.165

Alerstam T & Lindström Å (1990). Optimal bird migration: the relative importance of time, energy and safety. *In: Gwinner E (ed.) Bird migration. Springer*, 331–351.

Athira, TR, Babu, MG, Rubeena, KA, Nefla, A, Jobiraj, T, Thejass, P, Reshi, OR, & Aarif, KM (2025). Over-summering shorebird recruitment to unconventional habitats on the west coast of India. *National Academy Science Letters*. https://doi.org/10.1007/s40009-025-00832-3

Balachandran S & Thirunavukarasu V (2009). Field guide to the birds of Point Calimere. *Bombay Natural History Society and Tamil Nadu Forest Department*, 92 pp.
Balachandran S, Sathiyaselvam P & Sudarasan P (2009) Bird atlas of Chilika. Bombay Natural History Society, *Mumbai and Chilika Development Authority, Bhubaneswar*, 325 pp.
Battley PF, Warnock N, Tibbitts TL, Gill RE, Piersma T, Hassell CJ et al. (2012) Contrasting extreme long-distance migration patterns in Bar-tailed Godwits Limosa lapponica. *Journal of Avian Biology* **43**, 21–32. https://doi.org/10.1111/j.1600-048X.2011.05473.x
Buehler DM & Piersma T (2008) Travelling on a budget: predictions and ecological evidence for bottlenecks in the annual cycle of long-distance migrants. *Philosophical Transactions of the Royal Society B* 363, 247–266.
Byju, H, H. Maitreyi, N. Raveendran & S. Ravichandran (2024). Declining trends of over-summering shorebird populations along the southeastern coasts of Tamil Nadu, India. *Journal of Threatened Taxa* **16**(8) 25651–25662. https://doi.org/10.11609/jott.8921.16.8.25651-25662
Camargo JA (2019) A Lorenz curve-based methodology to assess species abundance distribution: A case study with fish communities. Ecological Indicators 98: 440–447. https://doi.org/10.1016/j.ecolind.2018.11.050
Chowdhury, SU, 2012. A survey of over-summering shorebirds at sonadia island, cox's bazar, *bangladesh. Stilt* **61**, 34–36.
Death, RG (2008). *Margalef's index*. In S. E. Jørgensen & B. D. Fath (Eds.), *Encyclopedia of Ecology* (pp. 2209–2210). Elsevier. https://doi.org/10.1016/B978-008045405-4.00117-8
Goss-Custard JD (1985) Foraging behaviour of wading birds on the carrying capacity of estuaries. *In: Sibly M & Smith RH (eds.) Behavioural ecology. Blackwell Scientific Publications, Oxford*, 169–188.
Gutierrez, JS 2017. The mystery of shorebird oversummering: a role for parasites? – *Wader Study* **123**: 164.
Hayman P, Marchant J & Prater T (2011) Shorebirds: an identification guide to the waders of the world. *Christopher Helm, London*, 413 pp.
Howes, JG, & Bakewell, D. (1989). Shorebird studies manual. *AWB Publications*.
Lank DB, Butler RW, Ireland J & Ydenberg RC (2003) Effects of predation danger on migration strategies of sandpipers. *Oikos* 103, 303–319.
Martínez-Curci, N.S., J.P. Isacch, V.L. D'Amico, P. Rojas & G.J. Castresana (2020). To migrate or not: drivers of over-summering in a long-distance migratory shorebird. *Journal of Avian Biology* **51**(10) 1–11.
McNeil R, Díaz MT & Villeneuve A (1994) The mystery of shorebird over-summering: a new hypothesis. *Ardea* 82, 143–152.
Morrison RIG & Ross KK (1989) Atlas of Nearctic shorebirds on the coast of South America. *Canadian Wildlife Service Special Publication* 2, 131–323.
Navedo, J. G., & Ruiz, J. (2020). Oversummering in the southern hemisphere by long-distance migratory shorebirds calls for reappraisal of wetland conservation policies. *Global Ecology and Conservation*, **24**, e01245. https://doi.org/10.1016/j.gecco.2020.e01245
Ntiamoa-Baidu, Y. (1991). Seasonal changes in the importance of coastal wetlands in Ghana for wading birds. *Biological Conservation* **57**(2): 139–158.
O'Hara PD, Fernández G, Becerril F, de la Cueva H & Lank DB (2005) Life history varies with migratory distance in western sandpipers Calidris mauri. *Journal of Avian Biology* **36**, 191–202.
O'Hara PD, Lank DB & Delgado FS (2002) Is the timing of moult altered by migration? Evidence from a comparison of age and residency classes of western sandpipers Calidris mauri in Panamá. *Ardea* **90**, 61–70.
R Core Team (2022) R: A language and environment for statistical computing. *R Foundation for Statistical Computing, Vienna, Austria*.

Reneerkens J, Versluijs TSL, Piersma T, Alves JA, Boorman M, Corse C, Gilg O, Hallgrimsson GT, Lang J, Loos B, Ntiamoa-Baidu Y, Nuoh AA, Potts PM, ten Horn J & Lok T (2020) Low fitness at low latitudes: wintering in the tropics increases migratory delays and mortality rates in an Arctic breeding shorebird. *Journal of Animal Ecology* **89**, 691–703.
Rogers, D. I., Piersma, T., Minton, C. D. T., Boyle, A. N., Hassell, C. J., Rogers, K. G., Silcocks, A., & Gutiérrez, J. S. (2025). Coastal shorebirds delay maturity more than inland ones. Ecology and Evolution, 15, e71679. https://doi.org/10.1002/ece3.71679
Shannon CE (1948) A Mathematical Theory of Communication. *Bell Syst Tech* J **27** 379–423
Shifa, C.T. (2023). Over-summering shorebirds at the Kerala coasts, west-coast of India, *Watershed Ecology and the Environment* **5,** 225–230. https://doi.org/10.1016/j.wsee.2023.09.001
Simpson EH (1949) Measurement of diversity. *Nature* 163:688
Soto-Montoya E, Carmona R, Gómez M, Ayala-Pérez V, Arce N & Danemann GD (2009) Over-summering and migrant Red Knots at Golfo de Santa Clara, Gulf of California, Mexico. *Wader Study Group Bulletin* **116**, 191–194.
Summers RW, Underhill LG & Prŷs-Jones RP (1995) Why do young waders in southern Africa delay their first return migration to the breeding grounds? *Ardea* **83**, 351–357.
Tavera EA, Lank DB & González PM (2016) Effects of migration distance on life history strategies of western and semipalmated sandpipers in Perú. Journal of Field Ornithology **87**, 293–308.
Verhoeven MA, Van Eerbeek J, Hassell CJ & Piersma T (2016) Fuelling and moult in red knots before northward departure: a visual evaluation of differences between ages, sexes and subspecies. *Emu* **116**, 158–167.
Vieira BP (2016) Nearctic-breeding migratory shorebirds over-summering in South America. *In: Annals of the International Wader Study Group Conference, Trabolgan, Ireland,* 36–37.
Winkler DW, Shamoun-Baranes J & Piersma T (2018) Avian migration and dispersal. In: Lovette IJ & Fitzpatrick JW (eds.) The Cornell Lab of Ornithology's handbook of bird biology. 3rd ed. *Princeton University Press,* 453–494.
Ydenberg, RC (2025). Partial migration, oversummering, and intermittent breeding by shorebirds. *The American Naturalist,* **205**(4), 361–370. https://doi.org/10.1086/734101