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continued on the back inside cover

Cover: A male Scarlet Skimmer perching on vegetation by the banks of a waterbody. Ink and watercolour illustration by Anandita Pascal.

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ARTICLE

Avian composition and distribution in the bird sanctuary planning zone of Can Gio Mangrove Biosphere Reserve, Ho Chi Minh City, Vietnam

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Abstract: Six field surveys were conducted from July 2024 to May 2025 in six sessions (three during dry and three during wet seasons) along 10 fixed transects (five in the core zone and five in the buffer zone) to assess the bird species composition and spatial distribution in the bird sanctuary planning zone of the Can Gio Mangrove Biosphere Reserve, after 47 years of restoration (1978–2025). A total of 57 bird species, representing 11 orders, 32 families, and 45 genera were recorded, including 18 waterbird species. Four species are listed as threatened and prioritized for conservation by the IUCN Red List: *Porzana paykullii* as Near Threatened, Vietnam Red List Book: *Anhinga melanogaster* and *Mycteria leucocephala as* Vulnerable, and Vietnamese law: *Milvus migrans and Anhinga melanogaster* as prioritized for conservation. The order Passeriformes was the most species-rich (21 species), while Pelecaniformes had the highest number of individual encounters (2,427). Overall, bird diversity in the area was relatively high (Shannon-Wiener index H' = 2.60 ± 0.34), with a moderate level of dominance (Simpson D = 0.12 ± 0.06). Species abundance was uneven across seasons and transects, with higher diversity and abundance during the wet season, although the differences were not statistically significant. Only the transect L8 in the buffer zone showed statistically significant differences in diversity and abundance, representing a newly recorded breeding area dominated by waterbird species such as *Nycticorax nycticorax*, *Egretta garzetta*, *Ardea intermedia*, and *Microcarbo niger*. Compared to a 2019 study, the number of breeding species in the core zone declined to seven species with approximately 1,000 individuals, while a new breeding area in the buffer zone was identified with eight breeding species and approximately 1,500 individuals. Continuous monitoring and conservation efforts are necessary to sustain and manage avian biodiversity in this critical wetland ecosystem.

KEYWORDS: Species diversity, biological index, breeding ecology, habitat use, core and buffer zones, conservation priority species, seasonal variation, waterbirds, avifauna.

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Competing interests: The authors declare no competing interests.

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INTRODUCTION

Waterbirds are key indicators of wetland health and play critical ecological roles as predators, seed dispersers, and contributors to nutrient cycling (Byju et al. 2025a). Across Asia, particularly along coastal zones, wetlands support rich avifaunal diversity but are increasingly threatened by habitat loss, pollution, and human disturbance. Long-term monitoring in India has revealed marked declines in the abundance and breeding success of both migratory and resident waterbirds due to anthropogenic pressures (Byju et al. 2025b,c). These findings underscore the urgent need to assess and monitor waterbird communities in other Asian coastal ecosystems, where comparable data remain scarce.

Vietnam is one of the 22 countries along the East Asian-Australasian Flyway Partnership (EAAFP), which supports the diversity of migratory birds and hosts about 40% of the world's migratory bird species (Yamaura et al. 2017). Vietnam's avifauna is highly diverse, with over 900 species documented (Le 2020), including 53 species listed as threatened in the country (Ministry of Science and Technology 2007) and 10 endemic species (Tran 2020). However, despite Vietnam's strategic importance along the flyway, comprehensive site-based assessments of waterbird communities remain limited.

The Can Gio Mangrove Biosphere Reserve (CGMBR) in southern Vietnam represents the largest rehabilitated mangrove forest in southeastern Asia and serves as a critical breeding and stopover site for numerous waterbird species. Previous surveys documented 164 bird species across 51 families and 15 orders (Le 2021), including five nationally protected and 16 globally threatened species (IUCN 2025). Yet, these studies were spatially and temporally restricted, focusing mainly on the core zone (Huynh et al. 2019). Consequently, current knowledge about the distribution and composition of waterbirds across the broader bird sanctuary planning zone—including both core and buffer zones—remains incomplete.

Given the ongoing coastal development and mounting anthropogenic pressures on mangrove ecosystems, updated information is urgently needed to evaluate the outcomes of nearly five decades of forest restoration and to guide effective conservation management. This study aims to (1) document the current species composition and distribution of waterbirds in the bird sanctuary planning zone of CGMBR, and (2) provide baseline data for long-term monitoring and habitat management.

MATERIALS AND METHODS

Can Gio Mangrove Biosphere Reserve (CGMBR) is Vietnam's first UNESCO Biosphere Reserve, recognized on 21 January 2000 and is part of the "discontinuous biodiversity corridor" planning initiative for the 2020–2030 period under decision no. 1250/QD-TTg of the Vietnam Prime Minister on 31 July 2013 (Can Gio District Forest Protection Management Board 2025). As part of CGMBR, the bird sanctuary planning zone, located at Vam Sat in subzone 15a, encompasses 602.5 ha buffer zone and 126.2 ha in the core zone. The entire bird sanctuary planning zone was designated for protection by Decision No. 27/QD-UB on 06 January 2004 (Chairman of Ho Chi Minh City People's Committee 2004).

Ten fixed transects were established across the bird sanctuary planning zone, covering different habitat types: natural forest (4 transects), plantation forest (3 transects), and other land types, including pond banks, and salt fields adjacent to forested areas (3 transects) (Figure 1). Five transects were in the core zone in the same area as Huynh et al. (2019) (L1–5), and five in the buffer zone (L6–10). Each transect was 500 m in length with a 20 m observation radius.

Field surveys were conducted in six sessions: three in the dry season (November 2024–April 2025) and three in the wet season (May–October 2025), with monthly intervals. Observations were carried out from 0700 h to 1130 h. Birds were identified based on morphology, size, plumage, and vocalizations. Unidentified species were documented with photographs and sound recordings for later verification using field guides (Vo 1981; King et al. 1997; Nguyen et al. 2000; Koshiyama & Asano 2019) and the Birds of South East Asia website (Vietnam Wildlife Photography Club 2025). Taxonomy followed the Avibase.

Collected data were analysed using BioDiversity Professional 2.0 (McAleece et al. 1997) and Statgraphics XIX (Nguyen 2009). Three biodiversity indices were used to assess community structure, including Shannon-Wiener index (H', to evaluate species diversity) (Shannon & Wiener 1963), Simpson's dominance index (D, to measure species dominance) (Simpson 1949), and Sorensen similarity index (SI, to compare species similarity among transects) (Shannon & Wiener 1963). Diversity categories followed standard classifications: $H' < 0.6$ = low diversity; $0.6 \leq H' \leq 1.5$ = moderate; $1.5 < H' \leq 2.5$ = high; $2.5 < H' \leq 3.5$ = very high; $H' > 3.5$ = extremely high diversity. The lower the Simpson's D, the higher the diversity. Sorensen Index was used to classify pairwise similarity from very low (<20%) to very high (≥80%).

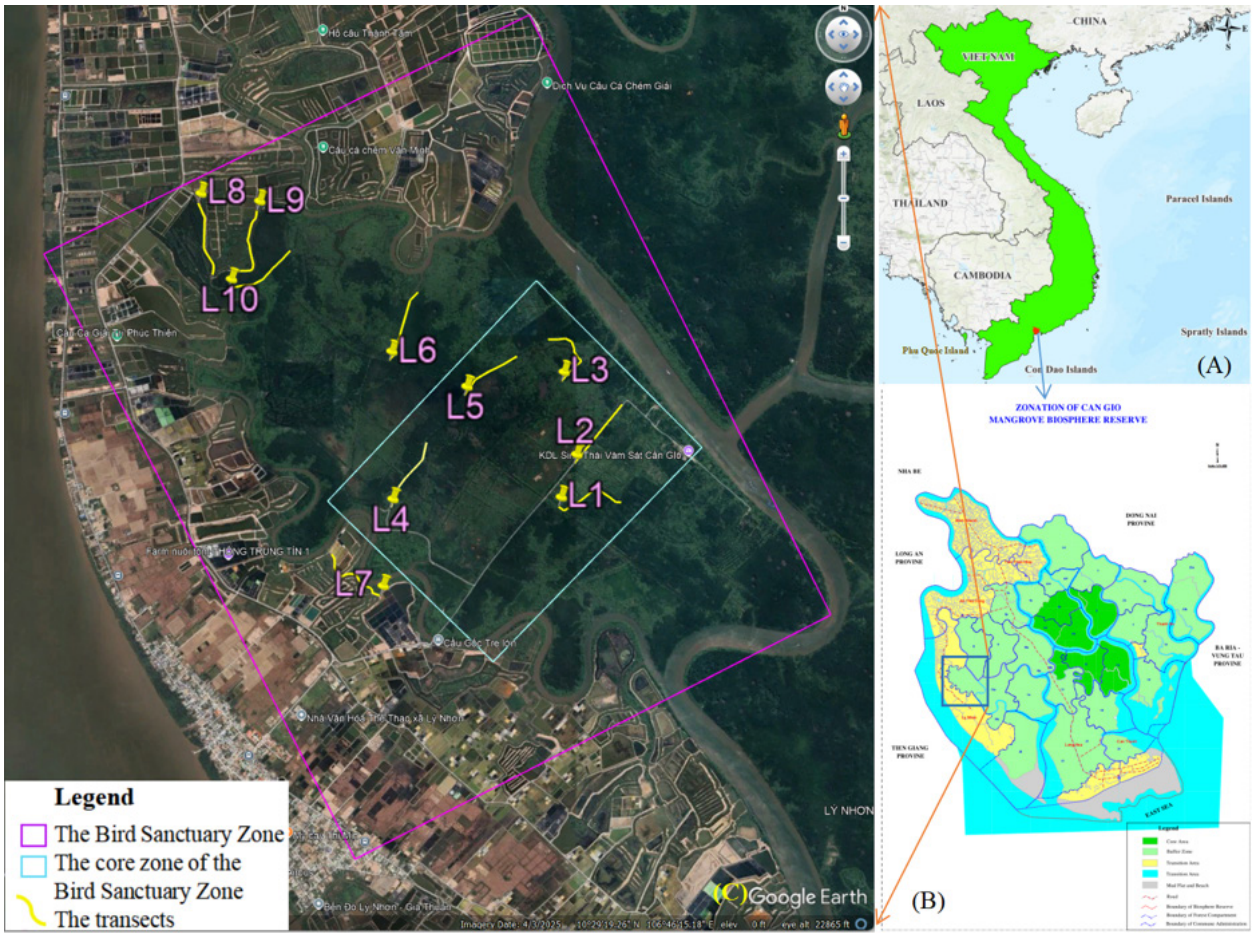

Image 1. Map of the study area: A—Location of Can Gio Mangrove Biosphere Reserve on a map of Vietnam | B—the study area on the Can Gio Mangrove Biosphere Reserve, the map was provided by Can Gio Mangrove Biosphere Reserve | C—ecosystems and survey areas within Can Gio Mangrove Biosphere Reserve. The map was created with QGIS software version 3.34.11. The ecosystem layer data for Google Earth Pro version 7.3.6.10201. The base map of Vietnam was sourced from GADM (Global Administrative Areas). https://gadm.org/download_country.html

In addition, biodiversity indices were compared between the wet and dry seasons to examine temporal variation in bird communities. Differences among habitat types (core zone vs. buffer zone; mixed vegetation, waterbody, and edge habitats) were also analysed to evaluate spatial patterns in avian diversity and composition. This allowed us to assess not only overall community structure but also seasonal and habitat-specific differences that may influence waterbird assemblages. Breeding bird populations were assessed by comparing current observations with data from a 2019 study.

RESULTS AND DISCUSSION

Avian composition

A total of 57 bird species belonging to 45 genera, 32 families, and 11 orders were recorded across the bird sanctuary planning zone in the Can Gio Mangrove Biosphere Reserve (CGMBR) during six surveys from July 2024 to May 2025 (July, September 2024 and May 2025 represent wet season and November 2024 and January, March 2025 represent dry season) (Table 1). The wet season (July, September 2024, and May 2025) had more species and showed higher individual encounters than the dry season (November 2024, January and March 2025), with 54 vs. 42, and 2.779 vs. 1.899, respectively (Appendix 1). Among all recorded species, 18 species were waterbirds, including four of conservation concern—*Anhinga melanogaster*, *Milvus migrans*, *Mycteria leucocephala*, and *Porzana paykullii*—listed as Near Threatened or Vulnerable by the IUCN Red List, the Vietnam Red Data Book, and Vietnamese law (Prime Minister of Vietnam 2019, 2021). Their presence underscores the ecological and conservation importance

Table 1. Bird species composition in the bird sanctuary planning area.

	Scientific name	Dry season	Rainy season	Conservation status		
				1	2	3
	I. ACCIPITRIFORMES					
	1. Accipitridae					
1	*Milvus migrans* (Boddaert, 1783)	-	1	-	LC	IIB
	II. ANSERIFORMES					
	2. Anatidae					
2	*Anas platyrhynchos* Linnaeus, 1758*	-	2	-	LC	-
	III. APODIFORMES					
	3. Apodidae					
3	*Aerodramus germani* Oustalet, 1876	278	232	-	-	-
	IV. CHARADRIIFORMES					
	4. Laridae					
4	*Chlidonias hybrida* (Pallas, 1811)*	-	2	-	LC	-
5	*Chroicocephalus ridibundus* (Linnaeus, 1766)*	1	-	-	LC	-
	5. Recurvirostridae					
6	*Himantopus himantopus* (Linnaeus, 1758)*	43	16	-	LC	-
	6. Scolopacidae					
7	*Tringa glareola* Linnaeus, 1758*	16	2	-	LC	-
8	*Tringa nebularia* (Gunnerus, 1767)*	-	2	-	LC	-
	V. COLUMBIFORMES					
	7. Columbidae					
9	*Streptopelia chinensis* (Scopoli, 1786)	33	41	-	-	-
10	*Streptopelia tranquebarica* (Hermann, 1804)	2	4	-	LC	-
11	*Treron bicinctus* (Jerdon, 1840)	2	1	-	LC	-
12	*Treron vernans* (Linnaeus, 1771)	2	11	-	-	-
	VI. CORACIIFORMES					
	8. Alcedinidae					
13	*Alcedo atthis* (Linnaeus, 1758)	9	13	-	LC	-
14	*Halcyon smyrnensis* (Linnaeus, 1758)	-	3	-	LC	-
15	*Todiramphus chloris* (Boddaert, 1783)	61	98	-	LC	-
	9. Meropidae					
16	*Merops superciliosus* Linnaeus, 1766		4	-	LC	-
	VII. CUCULIFORMES					
	10. Cuculidae					
17	*Centropus sinensis* (Stephens, 1815)	9	30	-	LC	-
18	*Cuculus micropterus* Gould, 1837	1	-	-	LC	-

	Scientific name	Dry season	Rainy season	Conservation status		
				1	2	3
	VIII. GRUIFORMES					
	11. Rallidae					
19	*Amaurornis phoenicurus* Pennant, 1769	3	3	-	LC	-
20	*Porzana fusca* Linnaeus, 1766	2	1	-	LC	-
21	*Porzana paykullii* (Ljungh, 1813)	2	-	-	NT	-
22	*Rallus striatus* (Linnaeus, 1766)	4	5	-	-	-
	IX. PASSERIFORMES					
	12. Acanthizidae					
23	*Gerygone sulphurea* Wallace, 1864	78	121	-	LC	-
	13. Cisticolidae					
24	*Orthotomus ruficeps* (Lesson, 1830)	-	2	-	LC	-
25	*Orthotomus sepium* Horsfield, 1821	73	97	-	LC	-
26	*Prinia inornata* Sykes, 1832	-	2	-	LC	-
	14. Corvidae					
27	*Crypsirina temia* (Daudin, 1800)	13	36	-	LC	-
	15. Dicaeidae					
28	*Dicaeum cruentatum* (Linnaeus, 1758)	-	16	-	LC	-
29	*Dicaeum ignipectus* (Blyth, 1843)	-	3	-	LC	-
	16. Estrildidae					
30	*Lonchura punctulata* (Linnaeus, 1758)	13	32	-	LC	-
	17. Motacillidae					
31	*Motacilla alba* Linnaeus, 1758	34	30	-	LC	-
	18. Muscicapidae					
32	*Copsychus malabaricus* (Scopoli, 1786)	-	1	-	LC	-
33	*Copsychus saularis* (Linnaeus, 1758)	50	65	-	LC	-
	19. Paridae					
34	*Parus minor* Temminck & Schlegel, 1848	7	5	-	-	-
	20. Passeridae					
35	*Passer flaveolus* Blyth, 1845	13	15	-	LC	-
36	*Passer montanus* (Linnaeus, 1758)	5	4	-	LC	-
	21. Pellorneidae					
37	*Graminicola bengalensis* Jerdon, 1863	-	5	-	LC	-
	22. Phylloscopidae					
38	*Phylloscopus fuscatus* (Blyth, 1842)	-	6	-	LC	-
	23. Ploceidae					

	Scientific name	Dry season	Rainy season	Conservation status		
				1	2	3
39	*Ploceus philippinus* (Linnaeus, 1766)	3	2	-	LC	-
	24. Pycnonotidae					
40	*Pycnonotus goiavier* (Scopoli, 1786)	62	80	-	LC	-
	25. Rhipiduridae					
41	*Rhipidura javanica* (Sparrman, 1788)	66	49	-	LC	-
	26. Sturnidae					
42	*Acridotheres grandis* Moore, 1858	-	17	-	LC	-
	27. Zosteropidae					
43	*Zosterops palpebrosus* (Temminck, 1824)	30	27	-	LC	-
	X. PELECANIFORMES					
	28. Anhingidae					
44	*Anhinga melanogaster* Pennant, 1769*	4	3	-	NT	IB
	29. Ardeidae					
45	*Ardea alba* Linnaeus, 1758*	105	12	-	LC	-
46	*Ardea cinerea* Linnaeus, 1758*	1	10	-	LC	-
47	*Ardea intermedia* Wagler, 1829*	180	194	-	LC	-
48	*Ardea purpurea* Linnaeus, 1766*	1	6	-	LC	-
49	*Ardeola bacchus* (Bonaparte, 1855)*	-	5	-	LC	-
50	*Ardeola speciosa* (Horsfield, 1821)*	1	9	-	LC	-
51	*Butorides striata* (Linnaeus, 1758)*	3	14	-	LC	-
52	*Egretta garzetta* (Linnaeus, 1766)*	370	585	-	LC	-
53	*Nycticorax nycticorax* (Linnaeus, 1758)*	247	645	-	LC	-
	30. Ciconiidae					
54	*Mycteria leucocephala* (Pennant, 1769)*	-	39	VU	LC	-
	31. Phalacrocoracidae					
55	*Microcarbo niger* (Vieillot, 1817)*	60	142	-	LC	-
	XI. PICIFORMES					
	32. Picidae					
56	*Chrysocolaptes lucidus* (Scopoli, 1786)	1	11	-	LC	-
57	*Picus vittatus* Vieillot, 1818	11	18	-	LC	-

Note: -—unrecorded/not listed in IUCN or Vietnamese law | Conservation status: 1—in Vietnam Red List Book (2007) | 2—in IUCN Red List (2025): VU—Vulnerable | NT—Near Threatened | LC—Least Concern | 3—according to Decree 06/2019/ND-CP dated 22 January 2019 and updated by Decree 84/2021/ND-CP dated 22 September 2021 of the Government | *—waterbird.

of this wetland.

Species richness and diversity indices varied significantly across transects and between seasons (Table 2; Figures 2–3). Shannon–Wiener diversity index (H') ranged from 1.77–2.93, indicating moderate to high diversity. The highest diversity occurred in the core zone (L10, H' = 2.93), while the lowest was in buffer zone (L8, H' = 1.77). In contrast, Simpson's dominance index (D) ranged 0.06–0.16, with highest dominance also observed at L8, where bird communities were strongly dominated by *Nycticorax nycticorax* (827 individuals), *Egretta garzetta* (664), *Ardea intermedia* (283), and *Microcarbo niger* (143). This indicates that while the buffer zone (L8) had fewer species, it supported larger populations of a few dominant waterbird species.

Breeding data further support this pattern. The transect L8 recorded eight breeding bird species with approximately 1,500 individuals, while the core zone supported only seven breeding species with around 1,000 individuals–a decline from 2,000 breeding individuals recorded in 2019 (Huynh Duc Hoan et al. 2019). The Sorensen similarity index also indicated the lowest overlap between transect L8 with others sites (Figure 4), suggesting that L8 represents a distinct habitat type now more suitable for breeding. The shift in breeding activity from the core to the buffer zone may reflect localized habitat changes, possibly linked vegetation structure, prey availability, or anthropogenic disturbance.

Similar spatial and seasonal shifts in waterbird assemblages have been reported in other Asian wetlands, where breeding colonies relocate or decline under human pressure (Byju et al. 2025a,c). For instance, studies from India have shown that lagoon and estuarine with high bird abundance are often sensitive to disturbance, resulting in temporal declines in breeding success (Byju et al. 2024, 2025a,b). In CGMBR, the emergence of transect L8 as a new breeding hotspot reflects the dynamic adaptation of waterbird populations to changing habitat conditions within restored mangrove systems.

Overall, our findings highlight both the resilience and vulnerability of avian communities in the bird sanctuary planning zone. The persistence of threatened species and the establishment of new breeding colonies emphasize the conservation value and ecological recovery potential of restored mangroves. However, the decline of core zone breeders indicates emerging habitats stress. Continuous, long-term monitoring, similar to those conducted in other Asian wetlands (Byju et al. 2025b), is therefore essential to evaluate restoration outcomes,

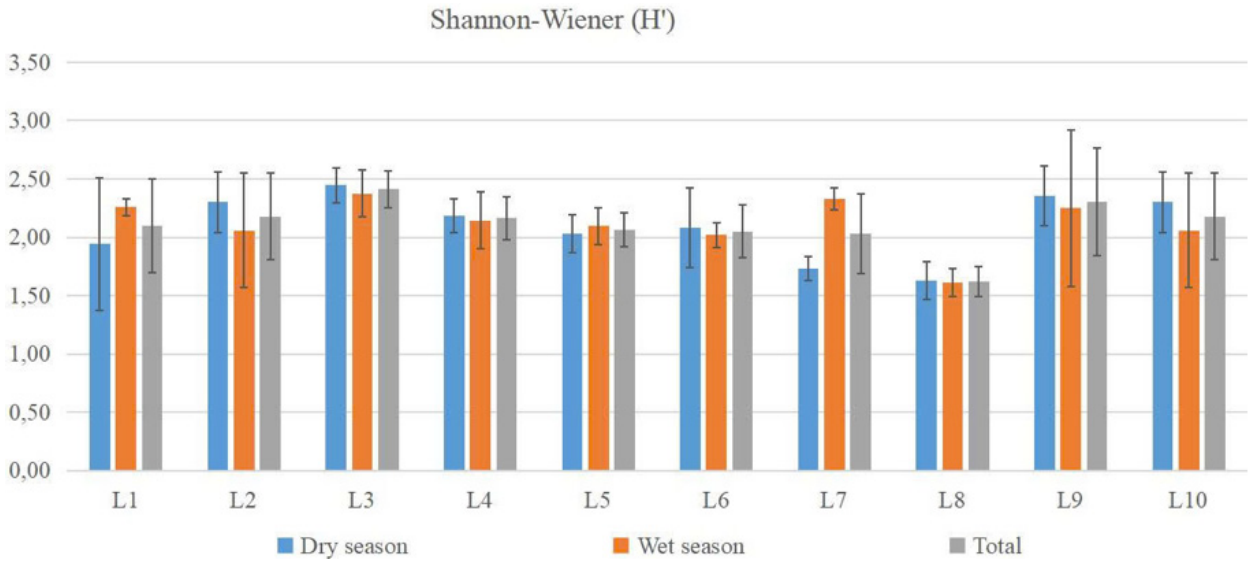

Figure 1. Shannon-Wiener (H') calculated from transect L1–12.

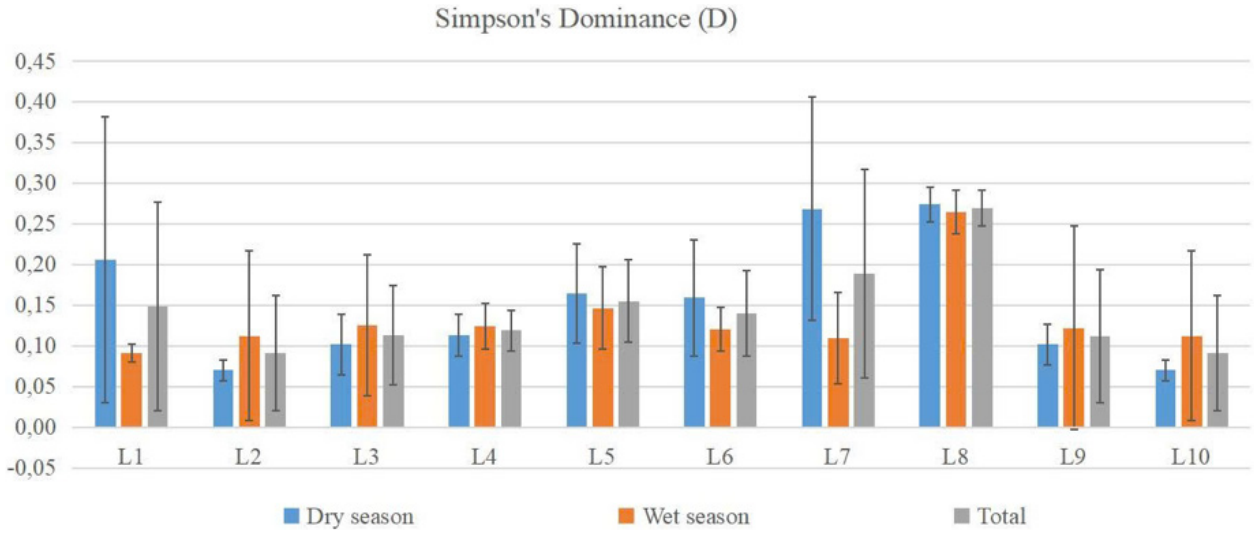

Figure 2. Simpson's dominance (D) calculated from transect L1–12.

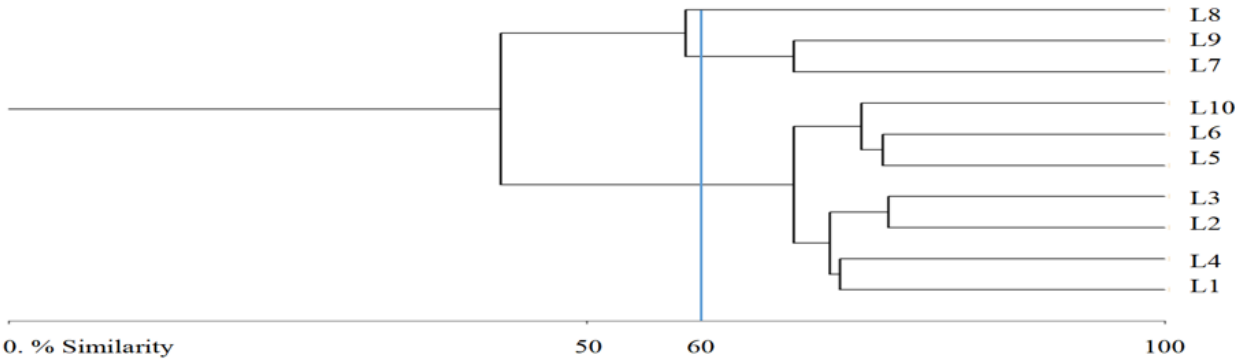

Figure 3. Similarity diagram of bird species composition among 10 transects.

detect ecological shifts, and guide adaptive conservation management in this UNESCO-designated biosphere reserve.

CONCLUSION

The bird sanctuary planning zone within the Can Gio Mangrove Biosphere Reserve supports a relatively high diversity of bird species including four globally and nationally threatened taxa. The discovery of a new breeding area in the buffer zone (transect L8) and the decline in species abundance in the core zone emphasize the need for adaptive management and continuous monitoring.

Preserving the ecological integrity of this wetland is vital for sustaining its role as a key habitat for waterbirds, especially during the breeding season. Future conservation efforts should prioritize habitat protection, environmental education, and the mitigation of anthropogenic pressures to maintain avian biodiversity in this region.

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Appendix 1. Species counts (SC) and individual encounters (IE) in survey transects.

Transect		L1	L2	L3	L4	L5	L6	L7	L8	L9	L10	Total
All transects	IE	204	256	387	219	242	188	327	2,197	515	143	**4,678**
	(%)	4.4	5.5	8.3	4.7	5.2	4.0	7.0	47.0	11.0	3.1	**100.0**
	SC	21	28	32	29	25	24	35	33	36	25	**57**
	(%)	36.8	49.1	56.1	50.9	43.9	42.1	61.4	57.9	63.2	43.9	**100.0**
Dry season	IE	91	135	162	70	83	81	122	726	383	46	**1,899**
	(%)	4.8	7.1	8.5	3.7	4.4	4.3	6.4	38.2	20.2	2.4	**100.0**
	SC	17	20	22	19	16	14	24	22	23	15	**42**
	(%)	41.5	48.8	53.7	46.3	39.0	34.1	58.5	53.7	56.1	36.6	**100.0**
Rainy season	IE	113	121	225	149	159	107	205	1,471	132	97	**2,779**
	(%)	4.1	4.4	8.1	5.4	5.7	3.9	7.4	52.9	4.7	3.5	**100.0**
	SC	20	23	28	23	22	21	27	29	32	23	**54**
	(%)	37.7	43.4	52.8	43.4	41.5	39.6	50.9	54.7	60.4	43.4	**100.0**

Vietnamese abstract: Trong giai đoạn từ tháng 7 năm 2024 đến tháng 5 năm 2025, sáu đợt khảo sát được tiến hành theo định kỳ hai tháng trên 10 tuyến cố định (năm tuyến trong vùng lõi và năm tuyến trong vùng đệm) nhằm đánh giá thành phần loài và sự phân bố của chim tại Khu Quy Hoạch Sân Chim thuộc Khu Dự trữ sinh quyển Rừng ngập mặn Cần Giờ, sau 47 năm phục hồi (1978–2025). Kết quả ghi nhận 57 loài chim thuộc 11 bộ, 32 họ và 45 chi, trong đó có 18 loài chim nước. Bốn loài được xếp vào nhóm nguy cấp, cần ưu tiên bảo tồn theo Danh lục Đỏ IUCN, Sách Đỏ Việt Nam và pháp luật hiện hành, bao gồm: *Porzana paykullii* (Sắp nguy cấp), *Anhinga melanogaster* và *Mycteria leucocephala* (Sẽ nguy cấp), cùng *Milvus migrans* và *Anhinga melanogaster* (được bảo vệ theo pháp luật hiện hành). Bộ Sẻ (Passeriformes) đa dạng loài nhất (21 loài), trong khi bộ Chim điên điển (Pelecaniformes) ghi nhận số cá thể nhiều nhất (2.427 cá thể). Chỉ số đa dạng Shannon-Wiener đạt mức tương đối cao (H' = 2,60 ± 0,34) và chỉ số ưu thế Simpson ở mức trung bình (D = 0,12 ± 0,06). Sự phong phú và đa dạng loài có sự biến động theo mùa và giữa các tuyến khảo sát, trong đó mùa mưa có xu hướng cao hơn, nhưng không khác biệt có ý nghĩa thống kê. Riêng tuyến L8 thuộc vùng đệm thể hiện sự khác biệt rõ rệt, được ghi nhận như một khu sinh sản mới với tám loài chim và khoảng 1.500 cá thể, chủ yếu có sự hiện diện của các loài chim nước như *Nycticorax nycticorax*, *Egretta garzetta*, *Ardea intermedia* và *Microcarbo niger*. So với nghiên cứu năm 2019, số loài chim sinh sản trong vùng lõi giảm xuống còn bảy loài với khoảng 1.000 cá thể, trong khi vùng đệm lại xuất hiện một khu sinh sản mới với quy mô lớn hơn. Kết quả này cho thấy sự thay đổi về phân bố sinh sản của chim trong Khu Quy Hoạch Sân Chim, đồng thời nhấn mạnh sự cần thiết của việc giám sát lâu dài và áp dụng các biện pháp bảo tồn để duy trì và quản lý tính đa dạng chim tại hệ sinh thái đất ngập nước quan trọng này.

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