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Research Article

FISH SPECIES COMPOSITION AND LONGITUDINAL DISTRIBUTION ALONG THE PHAN RIVER, LAM DONG PROVINCE, VIETNAM, DURING THE 2025 DRY SEASON

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ABSTRACT

This study investigates the fish species composition and spatial distribution in the Phan River basin, Lam Dong Province (formerly part of Binh Thuan Province), during the dry season from February to April 2025. Fish specimens were systematically collected at three representative sites corresponding to the upper, middle, and estuary of the river, in conjunction with measurements of environmental parameters such as salinity and pH. The results identified a total of 92 species, belonging to 77 genera, 57 families, 24 orders, and 2 classes. The occurrence of Elasmobranchii and numerous marine families within Perciformes reflects the distinctive estuarine ecosystem of the estuary, where freshwater, brackish, and migratory marine fishes converge. The distribution of species among orders exhibited marked unevenness, with certain orders dominating in species richness, while many others contributed only a limited number of species. Perciformes was the most species-rich order, comprising 18 species (19.57%), followed by Carangiformes and Cypriniformes, each with 11 species (11.96%). In terms of fish distribution within the river basin, the upstream and midstream sections exhibited similar species compositions: 28 species (30.43% of the total) were recorded in both sections, indicating that species occurring upstream can also inhabit the midstream. The highest species richness was observed in the estuary, with 64 species (69.57%). The survey also recorded several fish species listed in the Vietnam Red Data Book (2007) and the IUCN Red List (2025), underscoring the biodiversity value and the importance of conserving aquatic resources in this region.

Keywords: distribution; fish assemblages; Perciformes; Phan River

1. Introduction

Historically, the Phan River was part of Binh Thuan Province; however, following an administrative boundary adjustment that officially took effect on July 1, 2025, the river basin is now under the jurisdiction of Lam Dong Province. The Phan River features a narrow and

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steep upper reach, while its lower reach gradually narrows before flowing southward and discharging into the sea at the Ba Dang estuary. At its headwaters lies a reservoir with a capacity of 2.17 million m^3, which functions both in regulating water flow and in preserving ecological values (People's Committee of Binh Thuan Province).

Socio-economic activities in Binh Thuan Province have exerted considerable pressure on surface water resources for domestic use, industrial and agricultural production, aquaculture, and tourism. However, untreated or inadequately treated wastewater from residential areas, industrial zones, livestock farms, and seafood processing facilities has led to the pollution of major rivers, including the Phan River. Analytical results indicate that the Phan River, along with several other catchments, is contaminated with NH_4^+, Fe, DO, BOD_5, NO_2^-, CN^-, and As, with concentrations exceeding the permissible limits specified in QCVN 08:2023/BTNMT (Huynh et al., 2024)

Freshwater fish play a pivotal role in the livelihoods and food security of riparian communities: they provide a vital source of protein and micronutrients, while also serving as an important income stream through small-scale fishing and trade in local markets (FAO, 2024; Gurung, 2016). Although several studies have examined fish assemblages in other river basins of southern Vietnam, there has been no detailed research on the species composition and distribution characteristics of fishes in the Phan River. Filling this gap is essential for understanding its ichthyofaunal diversity and supporting future conservation efforts. This study provides the first documentation of fish species composition in the Phan River, contributing baseline data for future ecological research and conservation planning in the region. Such information will not only enhance scientific understanding of aquatic ecology but also support the formulation of sustainable management policies for local fisheries resources.

2. Materials and methods

2.1. Study period and sampling sites

Sampling was conducted during three campaigns in the dry season, from February to April 2025, at three sites representing the upstream, midstream, and downstream sections of the Phan River, with each sampling campaign lasting 3–5 days (Table 1).

Table 1. *Coordinates of sampling sites*

Area	Location	Coordinates
1	The area near the Phan River reservoir, Ham Thuan Nam Commune, Lam Dong Province	10°54′37.81″ N, 107°45′52.42″ E
2	Phan River Bridge, Ham Thuan Nam Commune, Lam Dong Province	10°50′32.19″ N, 107°48′57.56″ E
3	Ba Dang Estuary, Tan Hai Commune, Lam Dong Province	10°43′2.43″ N, 107°52′26.26″ E

2.2. Methods

2.2.1. Field sampling method

Qualitative sampling: Fish samples were collected by purchasing them from fishermen and fishing alongside them. For upstream and midstream sampling sites, we used barrier nets

and cast nets to trap fish, whereas at estuarine sites, gill nets and small trawl nets were employed to collect fish samples.

Quantitative sampling: All individuals caught with each type of fishing gear were recorded, and the data were used to estimate their frequency of occurrence.

2.2.2. Methods for water sampling and quality assessment

Water sampling and processing were carried out in strict accordance with QCVN 08:2023/BTNMT – National Technical Regulation on Surface Water Quality, promulgated under Circular No. 01/2023/TT-BTNMT, effective from September 12, 2023 (Ministry of Natural Resources and Environment, 2023). At each survey site within the study area, surface water samples were collected in clean plastic bottles. For pH and salinity measurements, a calibrated electronic meter (5-in-1) was used, with the electrode immersed directly into the water sample. Measurements were taken three consecutive times at three different positions, and the mean value was subsequently calculated.

2.2.3. Laboratory analysis

Taxonomic identification: The fish specimens were classified according to the taxonomic system of Nelson (Nelson et al., 2016) due to its global prevalence and effectiveness in Vietnam.

Frequency-of-occurrence assessment: Following the convention of Nguyen Huu Duc and Tong Xuan Tam (2009) (Table 2.1), we calculated frequency by dividing the total number of individuals recorded for each species by (i) the total number of fishing gears used and (ii) the total number of catch events per day. Because catchability varies with fish size, species were further grouped into three size categories (small, medium, and large) to determine the level of frequency.

Table 2. *Fish frequency assessment scale*

Level	Symbol	Group 1 ($L_o \leq 10$ cm)	Group 2 ($10 < L_o \leq 20$ cm)	Group 3 ($L_o > 20$ cm)
Not encountered	–	–	–	–
Very little	+	3–5	1–2	0–1
Little	++	6–9	3–5	2–3
Common	+++	10–30	6–10	4–5
Very common	++++	> 30	> 10	> 5

Note: L_o: standard length of fish (excluding caudal fin).

3. Results and discussion

3.1. Salinity and pH of the Phan River

During the sampling conducted in the Phan River over three dry-season months (February, March, and April), these parameters were measured at three representative zones: upstream, midstream, and estuary. Table 3 below presents the mean values of pH and salinity (‰) for each zone, reflecting the variation in environmental conditions along the longitudinal gradient of the river basin.

Table 3. *Seasonal variation in key water-quality parameters (mean ± SD)*

Zone	pH	Salinity (‰)	Environmental characteristics
Upstream	7.67 ± 0.084	0.041 ± 0.012	Completely freshwater, neutral pH
Midstream	7.29 ± 0.093	0.284 ± 0.045	Freshwater with slight fluctuations, transitional zone
Estuary	7.9 ± 0.125	8.810 ± 0.775	Brackish water, slightly alkaline pH

During the dry season, monitoring of pH and salinity along the upstream, midstream, and estuary sections revealed pronounced longitudinal variation within the Phan River. In the upstream region, salinity was nearly zero (0.041‰), and pH remained neutral to slightly alkaline (7.67), indicating a typical freshwater environment with minimal influence from seawater intrusion.

At the midstream site, salinity increased slightly (0.284‰) compared to the upstream, whereas pH decreased to 7.29. This decline can be attributed to the accumulation and decomposition of organic matter in the midstream zone, including leaf litter, detritus, and natural sediments, as well as organic inputs from domestic, agricultural, and aquaculture effluents. Microbial decomposition of these materials produces dissolved CO_2, which reacts with water to form carbonic acid and various organic acids, thereby increasing water acidity and lowering pH.

In contrast, at the estuary, salinity rose sharply to 8.81‰ due to marine intrusion, resulting in a subsequent increase in pH to 7.9. However, this value remained slightly lower than that of typical seawater (approximately 8.1–8.2), reflecting the brackish nature of estuarine waters, a dynamic mixture of freshwater and seawater, further influenced by biogeochemical processes such as organic matter decomposition and biological photosynthesis.

3.2. Fish species composition and diversity

Through field sampling, specimen analysis, and taxonomic verification, the fish species composition was standardized based on FishBase (Froese & Pauly, 2025) and Fishes of the World (Nelson, 2016), with synonym names corrected accordingly. The composition of the ichthyofauna reflects the distinctive ecological gradient of the Phan River system, where freshwater, brackish, and migratory marine species converge, particularly in the estuary. The occurrence of cartilaginous fishes, such as class Elasmobranchii, together with several marine families within Perciformes: notably Carangidae, Lutjanidae, and Serranidae, as well as typical freshwater families such as Cyprinidae and Clariidae, highlights this ecological diversity.

The fish assemblage recorded in the Phan River during the dry season was highly diverse and abundant, comprising 92 species distributed across 24 orders, 57 families, and 77 genera. Perciformes had the highest number of species, with 18 species (19.57%), followed by Carangiformes and Cypriniformes, each with 11 species (11.96%). Siluriformes accounted for seven species (7.61%), Clupeiformes for six species (6.52%), Scombriformes for five species (5.43%), and Anabantiformes for four species (4.35%). The remaining orders were represented by only 1 to 3 species (1.09–3.26%, respectively).

3.3. Spatial distribution of fish in the Phan River basin

Table 4 presents the distribution of fish species along the Phan River basin across the three study areas.

Table 4. *Distribution of fish species by basin in the Phan River*

Distribution Area	Number of Species	Proportion (%)
Upstream	28	30.43
Midstream	28	30.43
Estuary	64	69.57
Present in all three zones	0	0.00
Restricted to freshwater (upstream and midstream)	28	30.43

The data collected from the Phan River basin revealed that among the 92 fish species recorded, 28 species were found in the upstream and midstream sections (30.43%), while the estuary harbored 64 species (69.57%), indicating substantially higher species diversity compared to the other areas. This discrepancy clearly reflects the influence of environmental conditions on the structure of fish assemblages along the river continuum.

In the upstream and midstream regions, environmental conditions are characterized by freshwater, fast-flowing currents, high dissolved oxygen levels, and substrates dominated by gravel or sand, habitats favorable for typical freshwater species adapted to strong currents. In contrast, the estuary represents a transitional environment between freshwater and marine systems, where salinity fluctuates, water flow is weaker, and nutrient availability is high. Such conditions promote the occurrence of brackish-water, coastal marine, and migratory spawning species.

Consequently, the estuary functions as an "ecotone," an ecological transition area integrating multiple environmental factors, thereby enhancing overall species diversity. The absence of any species occurring across all three zones further underscores the marked ecological differentiation among regions and highlights the narrow ecological niches of most fish species inhabiting the Phan River basin.

3.4. Frequency of fish species in Phan River

The assessment of the occurrence frequency of 92 fish species in the Phan River showed that most species had a low to common frequency of occurrence. Three species (3.26%) were classified as "very common," including *Oxyeleotris marmorata*, *Osteochilus vittatus*, and *Cyclocheilichthys apogon*. In addition, 18 species (19.57%) were recorded as "common," while the "little" group accounted for the largest proportion, with 54 species (58.7%), and 17 species (18.48%) were recorded as "very little."

3.5. Status of Fish Species Listed in the Red Data Book and Conservation

The list of fish species recorded in the Phan River basin was compared with the Vietnam Red Data Book (2007), the Vietnam Red List (2024), and the IUCN Red List (2025) to determine their conservation status, thereby identifying species that should be prioritized for protection and monitoring.

Table 5. *Fish species of conservation value in the Phan River*

No.	Scientific Name	Vietnam Red Data Book (2007)	Vietnam Red List (2024)	IUCN Red List (2025)
1	*Gymnura japonica* (Temminck & Schlegel, 1850)	-	VU	VU
2	*Himantura walga* (Müller & Henle, 1841)	-	-	NT
3	*Anodontostoma chacunda* (Hamilton, 1822)	VU	-	LC
4	*Chanos chanos* (Forsskål, 1775)	VU	-	LC

Note: VU – Vulnerable; NT –Near Threatened; LC –Least Concern.

Analysis of fish species of conservation value in the Phan River (Table 5) revealed notable changes in threat status across the Vietnam Red Data Book (2007), the Vietnam Red List (2024), and the IUCN Red List (2025). *Anodontostoma chacunda* and *Chanos chanos*, previously listed as VU in the Vietnam Red Data Book (2007), no longer appear in the 2024 Vietnam Red List and are currently classified as LC by the IUCN (2025), suggesting population recovery or data re-evaluation. In contrast, *Gymnura japonica* appears in both the Vietnam Red List (2024) and the IUCN Red List (2025) as VU, while *Himantura walga* is listed as NT in both sources. These updates highlight ongoing changes in population status, improved data accuracy, and the growing importance of monitoring for conservation planning in the Phan River basin.

Most fish species in the study area are of natural origin, with only a few introduced through aquaculture activities. Local communities primarily exploit these fish resources for daily subsistence, while a portion is sold in local markets and neighboring areas. The region hosts several economically valuable species, such as Barbonymus gonionotus, Cyclocheilichthys apogon, Osteochilus vittatus, Mugil cephalus, Lates calcarifer, Lutjanus argentimaculatus, and Epinephelus areolatus, among others. However, current fishing practices have exceeded sustainable levels. Some species have been listed in the Vietnam Red Data Book (2007), the Vietnam Red List (2024), and are subject to government regulations prohibiting harvest during spawning seasons. Despite these measures, their populations continue to decline, and local fishers increasingly report rare encounters with these species. This trend has significantly affected regional biodiversity, altered the ecological characteristics of the area, and disrupted the local ecosystem balance.

Fish resources in the Phan River basin are being impacted by multiple factors. First, overfishing—including the use of prohibited fishing gears such as electric shock devices, fine-mesh nets, and explosives—has severely depleted fish populations, particularly those of high economic value. Additionally, water pollution from untreated effluents discharged by seafood processing facilities has degraded water quality, directly threatening fish habitats and growth. The construction of reservoirs and hydraulic structures has further altered river flow patterns, disrupted migratory routes, and reduced spawning grounds for many species. Finally, limited management capacity and low community awareness have facilitated destructive fishing practices, leading to ecological imbalance, and emphasizing the urgent need for integrated and sustainable conservation efforts.

To ensure the sustainable protection and development of fish resources in the Phan River, a combination of management, technical, and community-based solutions is required. Strengthening enforcement of fishing regulations is essential to prevent destructive exploitation. In parallel, the development of sustainable aquaculture models based on high-value native species, integrated with VAC (garden–pond–livestock) systems, can help reduce pressure on natural populations and improve local livelihoods (Dang, 2021). Moreover, enhancing community awareness and education on fishery resource conservation is crucial for effective management. Finally, increasing efforts in fish stock monitoring and research, applying biodiversity indicators and environmental impact assessments, will provide a scientific foundation for long-term planning and conservation in the Phan River basin.

4. Conclusion

The survey results indicate that the ichthyofauna of the Phan River exhibits a relatively high level of diversity, encompassing numerous species characteristic of freshwater, brackish, and estuarine. The occurrence of taxa representing multiple orders and families reflects the transitional nature and habitat richness of the Phan River, spanning from freshwater headwaters to tide-influenced estuary. The presence of several economically valuable species, as well as species listed in the Vietnam Red Data Book (2007), Vietnam Red List (2024), and the IUCN Red List (2025), raises concerns regarding exploitation pressures and potential population declines. Factors such as overfishing, habitat alteration, and water pollution are considered major drivers influencing fish community structure. We recommend continued monitoring of species composition dynamics, coupled with in-depth studies on the biology and ecology of key species, to provide a scientific basis for effective conservation measures aimed at the sustainable management of aquatic resources in the region.

❖ ***Conflict of Interest:*** *Authors have no conflict of interest to declare.*

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THÀNH PHẦN LOÀI CÁ VÀ PHÂN BỐ KHÔNG GIAN Ở SÔNG PHAN, TỈNH LÂM ĐỒNG, VIỆT NAM, TRONG MÙA KHÔ NĂM 2025

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TÓM TẮT

Nghiên cứu này khảo sát thành phần loài và phân bố cá ở lưu vực sông Phan, tỉnh Lâm Đồng (trước đây thuộc tỉnh Bình Thuận) vào mùa khô từ tháng 2 đến tháng 4 năm 2025. Mẫu cá được thu thập tại 3 khu vực nghiên cứu: thượng lưu, trung lưu và cửa sông, kết hợp ghi nhận các yếu tố môi trường như độ mặn và độ pH. Kết quả xác định tổng số 92 loài, thuộc 77 giống, 57 họ và 24 bộ và 2 lớp. Sự xuất hiện của lớp cá mang tấm Elasmobranchii và nhiều họ cá biển trong bộ Cá Vược (Perciformes) phản ánh hệ sinh thái đặc thù vùng hạ lưu – cửa sông có sự giao thoa giữa cá nước ngọt, nước lợ và cá biển di cư. Sự phân bố loài giữa các bộ thể hiện sự không đồng đều rõ rệt, với một số bộ chiếm ưu thế về số lượng loài, trong khi nhiều bộ khác chỉ đóng góp số loài hạn chế. Bộ Perciformes (cá Vược) có số loài nhiều nhất với 18 loài (19,57%). Tiếp theo là Bộ Carangiformes (cá Khế) và Bộ Cypriniformes (cá Chép), mỗi bộ 11 loài (11,96%). Về mặt phân bố cá trong lưu vực sông, các đoạn thượng lưu và trung lưu có thành phần loài tương tự nhau: 28 loài (chiếm 30,43%), cho thấy các loài sống ở thượng lưu cũng có thể sống ở trung lưu. Vùng cửa sông có độ phong phú loài cao nhất, với 64 loài (chiếm 69,57%). Khảo sát cũng ghi nhận một số loài cá xuất hiện trong Sách Đỏ Việt Nam (2007), Danh lục Đỏ Việt Nam (2024) và IUCN (2025), phản ánh sự đa dạng sinh học và tầm quan trọng của việc bảo tồn nguồn tài nguyên thủy sản tại khu vực này.

Từ khóa: phân bố; quần xã cá; bộ cá Vược; sông Phan