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Research Article

SPECIES COMPOSITION, SEASONAL VARIATION, AND CONSERVATION STATUS OF FISH ASSEMBLAGES IN THE UPPER TIEN RIVER, DONG THAP PROVINCE, VIETNAM

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ABSTRACT

The present study investigated the species composition and spatial distribution of fish assemblages in the upper reaches of the Tien River in Dong Thap province. Samples were systematically collected at four fixed sites within the headwater basin from March to August 2025. A total of 86 species, representing 59 genera, 36 families, and 14 orders, was recorded. Among these, members of the order Cypriniformes exhibited the greatest species richness (25 species), followed closely by Siluriformes (22 species). Species assemblages displayed marked seasonal shifts, with composition differing between the rainy season and the preceding dry period. Importantly, the survey documented a number of threatened taxa. Several rare species appear on the IUCN Red List (2025) and the Vietnam Red Data Book (2024), underscoring the conservation value of this riverine system. Furthermore, analysis of encounter rates revealed that most species had low to very low frequencies of occurrence, pointing to either naturally sparse populations or anthropogenically induced declines. Overall, these findings provide a baseline for biodiversity monitoring and resource management in the upper Tien River. They highlight the need for integrated conservation strategies that account for seasonal dynamics and protect vulnerable taxa. Continued monitoring is therefore recommended to detect long-term trends and to inform adaptive management in the face of ongoing environmental change.

Keywords: conservation; Cypriniformes; distribution; fish assemblages; Siluriformes

1. Introduction

Rivers of the Mekong basin rank among the most biodiverse freshwater ecosystems in the world, supporting over 1,200 fish species and underpinning the livelihoods of more than 60 million people (Costanza et al., 2011; Kang & Huang, 2022). As one of its two principal Vietnamese branches, the Tien River courses some 250 km from upstream of Phnom Penh

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into the Mekong Delta, where it functions as a critical water-supply artery for domestic and agricultural use, and as a biological corridor for migratory and resident fishes (Le & Tran, 2017; Nguyen et al., 2022). The river's rich ichthyofauna has long sustained capture fisheries and aquaculture operations, contributing substantially to the socio-economic well-being of riparian communities (Chakraborty, 2021). Local fish catches account for most of household protein intake in some districts, while small-scale cage culture and rice–fish systems generate significant income (Nguyen et al., 2021). However, rapid urbanization and intensification of land use in the Mekong Delta have led to escalating pollutant loads (e.g., industrial effluents, untreated municipal wastewater, and nutrient-rich runoff from aquaculture ponds) that compromise water quality and habitat integrity (Tromboni et al., 2021). Concurrently, saline intrusion during the dry season exacerbates stress on freshwater biota, altering species distributions and potentially reducing recruitment success.

Despite these mounting pressures, there remains no systematic baseline for fish community structure in the upper Tien River, which poses a critical gap, given that species composition not only reflects current ecosystem health but also serves as an essential benchmark for detecting change over time. Understanding taxonomic richness and the relative abundance of fish assemblages enables identification of sensitive and keystone species, informs sustainable harvest limits, and guides habitat restoration priorities (Griffin et al., 2025). Moreover, compositional data can reveal early warning signs of ecological degradation, such as shifts toward pollution-tolerant taxa or loss of migratory species, long before population collapses occur (Abajue & Izah, 2024). To address this void, the present study presents the first comprehensive survey of fish species composition and spatial distribution in the upper Tien River basin. Specifically, we quantify taxonomic richness and relative abundance across four representative sites and highlight conservation-priority taxa for targeted management. By integrating ecological data with assessments of environmental pressure, our work aims to establish a robust baseline that will underpin adaptive strategies for sustainable exploitation, biodiversity conservation, and ecosystem restoration in this vital stretch of the Mekong River network.

2. Materials and methods

2.1. Study period and sampling sites

The investigation was carried out at four fixed stations located in the upstream reach of the Tien River (Table 1). Sampling was conducted in five campaigns between March and August 2025, with each campaign lasting 3–5 days. Dry-season collections took place in March and April 2025, whereas rainy-season sampling was conducted from June to August 2025.

Table 1. *Coordinates of sampling stations*

Area	Location	Coordinates
1	An Hoa Commune, Dong Thap rovince, Vietnam	10°43′47.6″ N, 105°21′52.5″ E
2	Binh Thanh Commune, Dong Thap province, Vietnam	10°32′11.3″ N, 105°31′57.7″ E
3	Cao Lanh Ward, Dong Thap province, Vietnam	10°24′55.1″ N, 105°38′18.7″ E
3	My Tho Commune, Dong Thap province, Vietnam	10°23′46.7″ N, 105°43′13.2″ E

2.2. Methods

2.2.1. Field sampling

For qualitative sampling, we employed scheduled trawling using boats fitted with bottom-trawl nets. In addition, specimens were obtained through purchases from artisanal fishers deploying surface seines and bottom nets. Quantitative sampling involved recording all individuals captured by each gear type and counting the number of specimens of each species per haul, thereby allowing estimation of the frequency of occurrence.

2.2.2. Water-Quality sampling

At each station and during each campaign, we measured temperature, pH, and dissolved oxygen (DO) in situ at 0.5 m depth using a calibrated multiparameter probe (YSI ProDSS). Simultaneously, surface water (500 mL) was collected in acid-washed bottles, kept on ice, and filtered (GF/C) within 6 hours. Ammonium (NH_4^+) was quantified by the indophenol blue colorimetric method, and nitrate (NO_3^-) by cadmium-reduction, both using a UV–Vis spectrophotometer (Hach DR3900) in accordance with APHA (2017). All measurements and analyses were conducted in triplicate to ensure reliability.

2.2.3. Laboratory analysis

Taxonomic identification: Specimens were identified following standard references: *Fishes of the Mekong Delta, Vietnam*, *Freshwater Fish of the Mekong Delta*, FishBase (www.fishbase.org), and the Catalog of Fishes (Species by Family/Subfamily) (Tran et al., 2013; Truong & Tran, 1993; Froese & Pauly, 2025; Eschmeyer et al., 2025). **Frequency-of-occurrence assessment:** We calculated occurrence rates according to the protocol of Tong and Nguyen (2009) by dividing the total number of individuals of each species by the product of total gears deployed and total fishing efforts per day (Tong & Nguyen, 2009). Species were then assigned to one of three body-size classes based on standard length (L_0, excluding caudal fin): Group 1 ($L_0 \leq 10$ cm), Group 2 ($10 < L_0 \leq 20$ cm), and Group 3 ($L_0 > 20$ cm).

Table 2. *Frequency-of-Occurrence categories (Individuals/Gears/Hauls)*

Level	Symbol	Group 1 ($L_0 \leq 10$ cm)	Group 2 ($10 < L_0 \leq 20$ cm)	Group 3 ($L_0 > 20$ cm)
Not encountered	–	–	–	–
Very rare	+	3–5	1–2	0–1
Rare	++	6–9	3–5	2–3
Common	+++	10–30	6–10	4–5
Very common	++++	> 30	> 10	> 5

Note: L_0 denotes standard length (cm), exclusive of caudal fin.

Affinity analysis: α-diversity for each sample using the Shannon–Wiener index (H′), defined as equation 1:

$$H' = -\sum_{i=1}^{S} p_i ln p_i$$

where pi is the proportional abundance of species i and S is the total number of species in the sample. For interpretation, we applied commonly used empirical thresholds: $H' < 1$ = low diversity; $1 \leq H' \leq 3$ = moderate diversity; $H' > 3$ = high diversity. Independent-samples t-tests were performed to compare each water-quality parameter (temperature, pH, DO, NH_4^+, NO_3^-) and diversity between seasons. All the statistical analyses were performed on IBM SPSS Statistics version 29 for Windows. Data visualization was performed by OriginPro version 2021 (OriginLab Corporation, Northampton, Massachusetts, USA).

3. Results and discussion

3.1. Environmental parameters in the upper Tien River

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

Parameter	Dry season	Rainy season
Temperature (°C)	29.4 ± 0.41	29.0 ± 0.47
pH	6.85 ± 0.31	6.83 ± 0.17
Dissolved oxygen (mg/L)	6.53 ± 0.42	6.39 ± 0.42
Ammonium (NH_4^+, mg/L)	0.09 ± 0.01	0.46 ± 0.56*
Nitrate (NO_3^-, mg/L)	0.22 ± 0.11	0.67 ± 0.58*

Data were presented as mean ± standard deviation. Asterisk indicates the significance of water quality parameters by Independent T-test analysis ($p < 0.05$)

Water-quality measurements were conducted during both the dry (March–April 2025) and rainy (June–August 2025) seasons at the four upstream sampling sites. As shown in Table 3, mean temperature, pH, and DO did not differ appreciably between seasons, indicating relatively stable thermal and oxidative regimes year-round. In contrast, concentrations of both NH_4^+ and NO_3^- increased markedly during the rainy season, reflecting enhanced nutrient inputs from runoff and diffuse sources under high-flow conditions.

3.2. Fish species composition and diversity

In total, 86 fish species representing 59 genera, 36 families, and 14 orders were recorded in the upper Tien River. Among these, Cypriniformes exhibited the highest species richness (25 species), followed by Siluriformes (22 species), Anabantiformes (8 species), Carangiformes (7 species), Gobiiformes (6 species), and Synbranchiformes (5 species). The remaining orders, such as Osteoglossiformes, Clupeiformes, Characiformes, Cichliformes, Beloniformes, Acanthuriformes, Perciformes, and Tetraodontiformes, each contributed between one and three species.

Comparison of our assemblage with adjacent ichthyofaunal provinces revealed greater similarity to the Hau River system in former Hau Giang Province, albeit with lower overall richness (Le et al., 2018). This discrepancy likely reflects the year-round freshwater conditions and minimal East Sea tidal influence in our study area. Conversely, species composition diverged markedly from that documented in the Tien River stretch through former Tien Giang Province, where estuarine mixing and tidal fluxes foster higher diversity (The IUCN Red List of Threatened Species, 2025).

3.3. Seasonal dynamics

Because the upstream region remains freshwater throughout the year and exhibits relatively stable environmental parameters, spatial variation in species composition among the four sites was negligible. By contrast, seasonal effects were pronounced: 65 species were recorded in the dry season, whereas 83 species were recorded in the rainy season. This increase during the wet period likely results from flood-mediated influxes of Mekong-origin taxa, which enrich and diversify the local fauna.

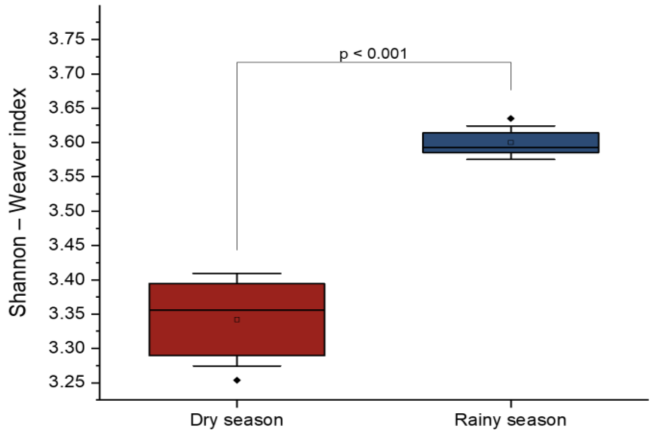

Figure 1. *Seasonal comparison of the Shannon-Weaver index*

The Shannon-Wiener index differed markedly between seasons (Figure 1). Specifically, individuals sampled in the rainy season exhibited substantially higher index values than those sampled in the dry season: the median value in the rainy season was centred around 3.60, whereas the median in the dry season was approximately 3.34. Moreover, the distribution of values in the rainy season was considerably tighter (narrower interquartile range and shorter whiskers), while the dry-season distribution showed greater spread and included a low outlier. Independent T-test further indicated a highly significant seasonal difference ($p < 0.001$).

During the rainy season, increased habitat connectivity and flooding typically expand available niches and access to floodplain resources, which in turn promotes higher species diversity and more even assemblages (Chen et al., 2022; Weiss et al., 2025). In lowland tropical and river-floodplain systems, the so-called “flood-pulse” drives seasonal inflows of water across the landscape and is widely recognized as a principal mechanism that increases habitat complexity, facilitates movements and migrations, and enhances opportunities for feeding and recruitment during the wet period (Chea et al., 2020). Consequently, many fish species show higher occurrence and greater diversity during or immediately after high-water periods.

In addition, water-quality data showed markedly higher dissolved inorganic nitrogen (NH_4^+ increased from 0.09 ± 0.01 mg L^{-1} to 0.46 ± 0.56 mg L^{-1}; NO_3^- increased from 0.22 $\pm$ 0.11 mg L^{-1} to 0.67 ± 0.58 mg L^{-1}, both higher in the rainy season), which is consistent with widespread observations that rainfall and runoff mobilize nitrogen from soils, agricultural areas and urban landscapes into surface waters. Those episodic nutrient pulses during the rainy season can stimulate primary production (phytoplankton, periphyton, and submerged macrophytes) and enhance basal food resources for higher trophic levels, thereby supporting more abundant and diverse consumer assemblages, including fish (Bailey & Moore, 2020; Xie et al., 2021).

3.4. Frequency of occurrence

Of the 86 species recorded, 79 were assigned a frequency of occurrence based on quantitative sampling. The remaining species were recorded from non-standardized samples and were excluded from this specific analysis. Species were categorized into four occurrence classes: "very common" (14 species), "common" (17 species), "rare" (19 species), and "very rare" (29 species). Notably, economically important species such as *Chitala ornata*, *Hypophthalmichthys molitrix*, and *Hampala* spp. were among those encountered very rarely, with only one or two individuals per sampling effort.

3.5. Economic and conservation status

Of the 86 species recorded, 83 hold direct economic value for local communities, with many, such as pangasiids (*Pangasius* spp.), basa (*P. bocourti*), and tilapia (*Oreochromis niloticus*), which are cultured in cages or ponds to bolster household incomes. Moreover, 30 species possess ornamental potential, including *Pterygoplichthys disjunctivus*, *Tetraodon cochinchinensis*, and *Trichopodus* spp. According to the IUCN Red List (2025), 83 species span categories from Data Deficient to Endangered, with two species (*Ompok bimaculatus* and *Hypophthalmichthys molitrix*) listed as Near Threatened and one (*Pangasianodon hypophthalmus*) as Endangered. Additionally, *Chitala ornata* appears in Vietnam's 2024 Red Data Book (Vietnam Academy of Science and Technology, 2024). Finally, eight species are recognized as rare under Vietnam's Decision No. 06/2015/QD-TTg of the Ministry of Agriculture and Rural Development, including two Critically Endangered taxa (*Clarias batrachus* and *O. bimaculatus*), two Endangered (*C. ornata* and *Channa lucius*), and five Vulnerable species (e.g., *Labeo chrysophekadion*, *Hampala macrolepidota*, *Hemibagrus wyckioides*, *Datnioides polota (Datnioides quadrifasciatus)*, and *Toxotes chatareus*).

Given the high proportion of species with direct economic value, the presence of taxa of conservation concern, and the prevalence of data-deficient listings, a combined approach that integrates fisheries management, habitat protection, aquaculture best practices, and targeted research is required. In the short term, priority should be given to reducing direct threats and sustaining livelihoods. Implement and enforce spatially-explicit gear and harvest regulations (for example, seasonal closures during spawning, minimum size limits, and restricted gear in critical habitats), together with community-based co-management arrangements that give local users a clear role and incentive to conserve stocks. Such measures help reduce overexploitation of commercially important species (e.g., pangasiids, basa, tilapia) while maintaining household incomes. Simultaneously, improve traceability and market incentives (certification or grade-labeling for sustainably produced or legally harvested fish) to encourage compliant behavior along value chains.

In addition, because several taxa are rare, nationally listed, or IUCN threatened, dedicated in situ protection of refugia and spawning habitats is essential. Thus, establish or expand freshwater protected areas, seasonal no-take zones, and habitat corridors where hydrological connectivity is important. Complement legal protection of critical sites with active habitat restoration (reinstating riparian vegetation, removing migration barriers, managing sedimentation) and water-quality controls in upstream catchments to limit episodic nutrient and pollutant pulses that alter ecosystem functioning. Given that some threatened species (e.g., *Clarias batrachus*, *Ompok bimaculatus*, *Pangasianodon hypophthalmus*) are particularly vulnerable to habitat loss and fishing pressure, these measures should target areas known to support their life-history stages (nurseries, spawning grounds).

Scale up sustainable aquaculture and ex-situ conservation as complementary strategies. For species already cultured (e.g., *Pangasius* spp., *Oreochromis niloticus*), adopt best-practice husbandry to minimize genetic introgression, disease transfer, and environmental impacts from escape or effluent (e.g., use of native broodstock, biosecure farms, effluent treatment, and polyculture where appropriate). For endangered or rare species with high conservation concern or commercial potential, develop captive-breeding and rearing protocols coupled with scientifically-informed restocking where habitat conditions have been restored. Importantly, restocking should follow rigorous genetic and health-screening protocols to avoid eroding wild gene pools or spreading pathogens.

Address the major knowledge gaps that impede evidence-based management. Because the majority of species are Data Deficient or lack updated assessments, implement a prioritized monitoring and research program: (1) regular standardized fish surveys to detect trends in abundance and diversity; (2) life-history studies for key commercial and threatened species (age, growth, spawning seasonality); (3) population genetics to define management units and to guide captive-breeding; and (4) socio-economic research that quantifies household dependence, market drivers and the ornamental-trade dynamics. These data will permit targeted IUCN reassessments and more refined conservation status listings at national and regional scales. Moreover, regulate and manage the ornamental and live-trade sectors. Because 30 species have ornamental potential and live-trade can both offer livelihood alternatives and create conservation risks, establish permitting, quarantine, and size/collection limits for ornamental harvest. Promote captive propagation for high-demand species and ban wild collection for taxa that are rare or threatened. Where appropriate, develop community-based ornamental hatcheries that supply domestic and export markets while relieving pressure on wild populations.

Integrate watershed-scale water-quality management and climate resilience into conservation planning. Although baseline water-quality parameters (temperature, pH, DO) were broadly stable between seasons, episodic increases in nutrients during the rainy season indicate catchment inputs that should be mitigated through agricultural best practices, riparian buffers, and improved sanitation to reduce runoff. Additionally, incorporate climate-adaptive measures (e.g., protecting floodplain connectivity and shaded stream reaches) to buffer communities and populations against increasingly variable hydrology. On the other hand, strengthen governance, funding, and stakeholder engagement. Successful long-term conservation requires coordinated policy (aligning national species-protection lists with local enforcement), sustainable financing (payment-for-ecosystem-services, conservation trust funds, or public–private partnerships), and capacity building for local stakeholders and agencies. Environmental education and participatory monitoring (citizen science) can raise awareness of rare species and enlist communities as partners.

4. Conclusion

The fish assemblage in the upper Tien River is notably diverse, comprising predominantly freshwater species. It exhibits marked seasonal shifts in composition between the rainy and dry periods, with greater taxonomic richness during the wet season. Economically important taxa underpin local livelihoods, yet most species show low to very low frequencies of occurrence, suggesting naturally sparse populations or emerging anthropogenic pressures. Importantly, several rare and threatened species, spanning multiple IUCN categories, have been documented in this upstream reach, underscoring its conservation value. Consequently, we recommend the development and implementation of targeted conservation and management strategies, both locally in the upper Tien River and more broadly across the Mekong Delta, to safeguard fisheries resources, prioritize the protection and recovery of rare taxa, and promote the sustainable use and long-term resilience of the region's freshwater biodiversity.

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

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THÀNH PHẦN LOÀI, BIẾN ĐỘNG MÙA VỤ VÀ TÌNH TRẠNG BẢO TỒN CỦA QUẦN XÃ CÁ Ở THƯỢNG LƯU SÔNG TIỀN, TỈNH ĐỒNG THÁP, VIỆT NAM

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TÓM TẮT

Nghiên cứu này khảo sát thành phần loài và sự phân bố không gian của quần xã cá ở thượng lưu sông Tiền, tỉnh Đồng Tháp. Mẫu được thu mẫu có hệ thống tại bốn điểm cố định trong lưu vực thượng nguồn từ tháng 3 đến tháng 8 năm 2025. Tổng cộng ghi nhận 86 loài thuộc 59 giống, 36 họ và 14 bộ. Trong số đó, bộ Cypriniformes có độ phong phú loài lớn nhất với 25 loài, tiếp theo là bộ Siluriformes với 22 loài. Thành phần quần xã có sự thay đổi rõ rệt theo mùa, khác nhau giữa mùa mưa và mùa khô. Đáng chú ý, nghiên cứu đã phát hiện nhiều taxon có nguy cơ bị đe dọa: một số loài xuất hiện trong Danh sách Đỏ IUCN (2025) và Sách Đỏ Việt Nam (2024), điều này nhấn mạnh giá trị bảo tồn của hệ sông. Hơn nữa, phân tích tần suất gặp cho thấy hầu hết các loài có tần suất gặp ở mức thấp đến rất thấp, phản ánh tình trạng quần thể thưa thớt tự nhiên hoặc suy giảm do tác động nhân sinh. Những kết quả này cung cấp cơ sở để giám sát đa dạng sinh học và quản lí nguồn lợi thủy sản ở thượng lưu sông Tiền; đồng thời nhấn mạnh nhu cầu áp dụng các chiến lược bảo tồn tích hợp, tính đến biến động mùa vụ và bảo vệ các loài dễ tổn thương. Do đó, cần tiếp tục giám sát dài hạn để phát hiện xu hướng thay đổi và làm cơ sở cho quản lí thích ứng trước các biến đổi môi trường đang diễn ra.

***Từ khóa*: bảo tồn; Cypriniformes; phân bố; quần xã cá; Siluriformes**