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# Fish Diversity, Ecological Functional Guilds and IUCN Conservation Status in the Lower Mekong River, Northeastern Thailand

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## ABSTRACT

This study aimed to quantify spatial and seasonal variation in fish diversity, classify fish into ecological functional guilds, and assess conservation status using the IUCN Red List in the Mekong River across three provinces in northeastern Thailand: Loei, Nakhon Phanom, and Ubon Ratchathani. Fish sampling was conducted during three seasonal periods. A total of 84 fish species belonging to 61 genera and 21 families were recorded. The highest diversity was the family Cyprinidae, with 45 species, followed by the families Bagridae and Siluridae, each represented by six species. The assessment of species diversity and evenness indicated that the fish community exhibited a moderate level of diversity with a relatively even distribution of species. Classification of fish based on ecological functional guilds showed that most species belonged to group G3, which inhabits and spawns in the main river channel, accounting for 29 species. The conservation status assessment based on the International Union for Conservation of Nature (IUCN) Red List revealed that most species were categorized as Least Concern (LC), with 65 species, followed by Vulnerable (VU), with six species. One species was classified as Endangered (EN), namely Probarbus jullieni. The findings of this study provide important baseline information for fisheries management and biodiversity conservation in the Mekong River ecosystem of Thailand.

**Keywords:** Mekong River, Fish diversity, Ecological Functional Guilds, Conservation status

## INTRODUCTION

The Mekong River is a major global river system and an important freshwater ecosystem that supports both biodiversity and the livelihoods of millions of people in Southeast Asia. Originating on the Tibetan Plateau, the river flows through six countries, including China, Myanmar, Lao PDR, Thailand, Cambodia, and Vietnam, before eventually discharging into the South China Sea. In total, the Mekong River extends for approximately 4,880 km and drains a basin of about 795,000 km² (Mekong River Commission, 2009).

The lower Mekong basin has diverse topography and habitats, such as the mekong mainstream, tributaries, floodplains, wetlands, and deep pools. These habitats provide important ecological conditions that sustain many freshwater organisms. (Valbo-Jørgensen *et al*., 2009, Hortle and Bamrungrach, 2015). The high diversity of ecosystems has led to the Mekong River basin being classified as a globally important biodiversity area within the Indo-Burma biodiversity hotspot (Critical Ecosystem Partnership Fund, 2020). Changes in ecosystems, water levels, and flooded areas in each season affect the structure of habitats and the life cycles of aquatic animals, especially fish. Many fish species undertake seasonal migrations to access feeding grounds, spawning habitats, and nursery areas at different times of the year. (Mekong River Commission, 2009, Valbo-Jorgensen *et al*., 2009)

The Mekong River supports a highly diverse fish species; approximately 1,100 species have been recorded throughout the basin, with at least 850 species occurring in the Lower Mekong Basin (Rainboth *et al*., 2012, Hortle, 2009). In 2016, about 540 fish species were reported from the Mekong River (Nagao Natural Environment Foundation, 2021). The Cyprinidae family represents the most diverse assemblage in the Mekong Basin, accounting for over 40 percent of all recorded fish species in the basin (Mekong River Commission, 2021). Moreover, more than 693 species have been assessed and documented in the IUCN Red List of Threatened Species; the *Platytropius siamensis* has been declared extinct (Mekong River Commission, 2019).

The Mekong River flows along the border between Thailand and Lao PDR for about 917 km. It passes through eight provinces: Chiang Rai, Loei,

Nong Khai, Bueng Kan, Nakhon Phanom, Mukdahan, Amnat Charoen, and Ubon Ratchathani (National Water Resources Office, 2023). Northeastern is part of the Lower Mekong Basin and is an important place for fish resources and diversity. For instance, a survey of fish diversity in the provinces of Ubon Ratchathani, Amnat Charoen, Mukdahan, and Nakhon Phanom found 164 species from 97 genera and 32 families (Rotmongkoldee *et al*., 2012). A study in the Mekong River in Nakhon Phanom Province found 82 fish species from 56 genera, 19 families, and 11 orders, with Cypriniformes being the most common group (Nuntawan *et al*., 2019). At present, infrastructure development such as hydropower dam construction, overfishing, and climate change may have long-term impacts on the ecosystem and fish diversity of the Mekong River. Therefore, assessing fish diversity and conservation status in the Mekong River is important for monitoring changes in fisheries resources and supporting the sustainable management of aquatic resources.

However, previous studies have primarily focused on species inventories without integrating ecological functional guilds and updated conservation status. Therefore, this study aims (1) to quantify spatial and seasonal variation in fish diversity, (2) to classify fish into ecological functional guilds, and (3) to assess conservation status using the IUCN Red List.

## MATERIALS AND METHODS

### *Study Area*

Fish sampling was carried out in the Lower Mekong River at three sites in Northeastern Thailand: Ban Huai Hiem, Hat Khamphi Subdistrict, Pak Chom District, Loei Province (18.211687/102.073306); Ban That Phanom Nuea, That Phanom Subdistrict, That Phanom District, Nakhon Phanom Province (16.044130/104.729622); and Hat Chom Dao, Ban Natal, Natal Subdistrict, Natal District, Ubon Ratchathani Province (15.907450/105.341432). A stratified random sampling design was used to cover three hydrological periods to capture seasonal variation: peak flood season (September–October; S1), receding flood season (November–December; S2), and low-water season (January–February; S3). At each site and in each season, three replicates were conducted to ensure good representation of fish assemblages.

### *Fish sampling*

Fish specimens were collected at three sampling stations using trawl nets. A trawl net with a mesh size of 2 × 2 cm, 40 m in length, and approximately 8 m in width, as well as a fine-mesh trawl net with a mesh size of 0.2 cm, 12 m in length, and 3 m in width, were towed along the riverbank. At each sampling station, trawling was conducted three times. Specimens were weighed using a digital balance with a precision of 0.1 g. Standard length (SL) and total length (TL) were measured to the nearest 0.1 cm. Fresh specimens were photographed using a digital camera and subsequently preserved in a 10% formalin solution for further analysis and taxonomic identification at the laboratory, Mahasarakham University.

The combined use of trawl nets with different mesh sizes was intended to reduce gear-specific bias and enhance overall sampling efficiency. Larger trawl nets primarily target large-bodied fishes, nektonic, and pelagic species, whereas smaller trawl nets were more effective for capturing small-bodied and juvenile fishes in littoral zone or floodplain. This complementary approach is widely recommended to improve the representativeness of fish assemblage data, as different gear types selectively sample distinct components of the community (Guest et al., 2003).

Nevertheless, several limitations remain. Both gear types may underrepresent benthic and structure-associated species, and gear selectivity can influence the observed species composition and relative abundance. In addition, catch efficiency may vary with environmental conditions, such as flow velocity, turbidity, and habitat complexity, as well as fish behavior, potentially introducing additional sampling bias.

Fish sampling conducted for this study was approved under the ethical guidelines for the use of animals in scientific research and biosafety by the Institutional Animal Care and Use Committee of Mahasarakham University (Approval No. IACUC-MSU-09/2024).

### *Water quality measurement*

Water quality was conducted at Mekong River fish sampling stations throughout three seasons, pH, electrical conductivity (EC), water temperature (T), and dissolved oxygen (DO), using the Eutech PCD 650 (OAKTON) automatic water quality meter.

### Data analysis

Fish species were identified using standard taxonomic references, including Saenjandaeng (2014), Metheethananwat (2012), and the Nagao Natural Environment Foundation (2021), as well as the online database FishBase (www.fishbase.org). The conservation status of each recorded species was verified based on the IUCN Red List of Threatened Species. Fish guilds were classified according to their migratory behavior and habitat use patterns following the Mekong River Commission (2021).

Ecological analyses were conducted to evaluate fish community structure and diversity. The diversity index (H′) (Shannon and Wiener, 1949), dominance index (D) (Simpson, 1949), species richness index (R) (Margalef, 1968), and evenness index (J′) (Pielou, 1966) were calculated for each sampling site and season.

### Statistical Analysis

Data were assessed for normal distribution using the Shapiro–Wilk test. Differences in fish yields by province and season were evaluated using one-way analysis of variance (ANOVA) when data were normal; otherwise, the non-parametric Kruskal–Wallis test was used when data violated normality. Statistical significance was set at $p < 0.05$. All analyses were performed using IBM SPSS Statistics version 29.

## RESULTS

A survey of fish diversity in the Mekong River was done over three seasons in three provinces in northeastern Thailand: Loei, Nakhon Phanom, and Ubon Ratchathani. A total of 1,690 fish specimens were collected, representing 84 species, 61 genera, and 21 families. The family Cyprinidae showed the highest species richness with 45 species, accounting for 54% of the total species recorded. This was followed by the families Bagridae and Siluridae, each represented by six species (7% of the total species) (Figure 1).

Species composition analysis indicated that *Barbonymus altus* was the most abundant species, comprising 20.5% of all individuals collected. Other dominant species included *Puntioplites proctozystron*, *Oreochromis niloticus*, *Sikukia gudgeri*, and *Parambassis siamensis*, accounting for 13%, 6.5%, 6.2%, 6.2%, and 5.2% of the total individuals, respectively. In contrast, several species were rarely encountered, including *Puntioplites waandersi*, *Rasbora myersi*, *Pristolepis fasciatus*, and *Wallago attu*, each representing only 0.1% of the total individuals recorded.

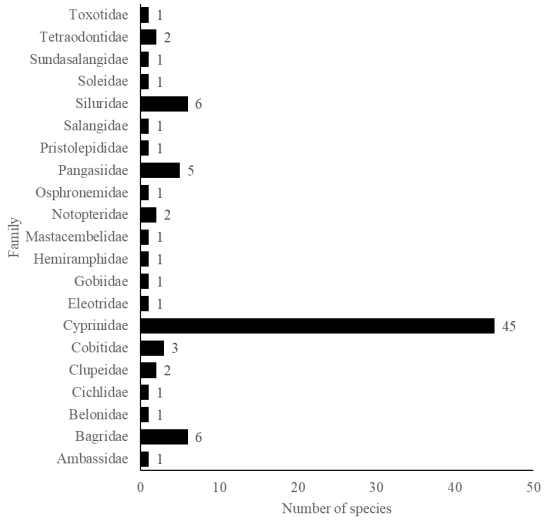


**Figure 1.** Distribution of fish species richness by family in the Lower Mekong River, northeastern Thailand.

When fish diversity was examined by sampling area, Ubon Ratchathani showed the highest species richness with 52 species, followed by Nakhon Phanom with 50 species and Loei with 37 species (Figure 2). In Loei Province, a total of 395 individuals were collected. The most abundant species was *Oreochromis niloticus*, representing 23.48% of the total individuals, followed by *Cyclocheilichthys enoplos* (15.58%) and *Parambassis siamensis* (14.65%). In Nakhon Phanom Province, 865 individuals were recorded. *Barbonymus altus* was the most abundant species, accounting for 25.78% of the total individuals, followed by *Puntioplites proctozystron* (21.38%) and *Mystacoleucus obtusirostris* (8.20%). In Ubon Ratchathani Province, 430 individuals were collected. The dominant species was *Barbonymus altus* (29.11%), followed by *Puntioplites proctozystron* (7.34%) and *Raiamas guttatus* (6.08%). Examination of species distribution among sampling areas indicated that 13 species occurred in all three provinces. These included *Barbonymus altus*, *Barbonymus gonionotus*, *Probarbus jullieni*, *Puntioplites proctozystron*, *Raiamas guttatus*, *Sikukia gudgeri*, *Henicorhynchus siamensis*, *Acantopsis rungthipae*, *Hemibagrus spilopterus*, *Xenentodon canciloides*, *Mastacembelus armatus*, *Parambassis siamensis*, and *Brachirus harmandi*. Fish abundance was compared among the three sampling areas using the Kruskal Wallis test. The

results indicated no significant difference in fish abundance among areas at the 0.05 significance level (H = 3.289, p = 0.193).

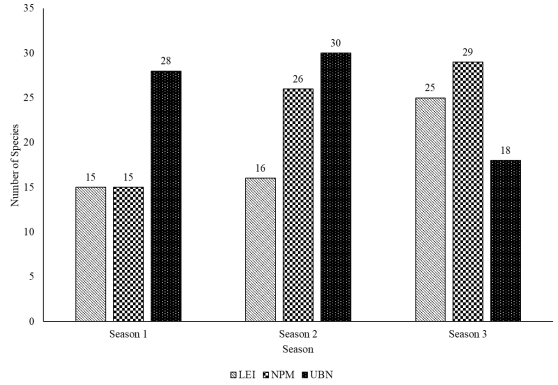


**Figure 2.** Variation in the number of fish species recorded in the Mekong River across three seasonal periods.

When seasonal variation was examined, the receding flood season (S2) showed the highest species richness with 50 species, followed by the low-water season (S3) with 49 species and the peak flood season (S1) with 43 species. During the peak flood season (S1), the most abundant species was *Barbonymus altus*, representing 34.70% of the total individuals, followed by *Cyclocheilichthys enoplos* (13.13%) and *Mystacoleucus obtusirostris* (12.94%). During the receding flood season (S2), *Barbonymus altus* remained the most abundant species, accounting for 21.78% of the total individuals. Other common species included *Oreochromis niloticus* (17.61%) and *Sikukia gudgeri* (13.63%). In the low water period (S3), *Puntioplites proctozystron* was the most abundant species (29.60%), followed by *Barbonymus altus* (8.28%) and *Cosmochilus harmandi* (6.28%). Fish abundance among seasons was compared using the Kruskal Wallis test. The results indicated no significant difference in fish abundance among seasons at the 0.05 significance level (H = 0.622, p = 0.733).

Ecological indices including the diversity index (H′), dominance index (D), species richness (R), and evenness index (J′) were also calculated for each province. Results were presented as mean ± standard error (SE). In Loei Province, H′, D, R and J′ were 2.11 ± 0.62, 0.21 ± 0.12, 3.62 ± 1.33, and 0.72 ± 0.13, respectively. In Nakhon Phanom Province, H′, D, R, and J′ were 1.96 ± 0.42, 0.24 ± 0.07, 3.97 ± 1.09, and 0.62 ± 0.06, respectively. In Ubon Ratchathani Province, H′, D, R, and J′ were 2.52 ± 0.15, 0.13 ± 0.04, 5.04 ± 1.01, and 0.78 ± 0.06, respectively (Figure 3).

When ecological indices were examined across seasons (mean±SE), the peak flood season (S1) showed an H′, D, R and J′ were 1.90 ± 0.47, 0.26 ± 0.08, 3.55 ± 1.32, and 0.65 ± 0.09, respectively. During the receding flood season (S2), H′ increased to 2.17 ± 0.49, whereas D, R and J′ were 0.21 ± 0.08, 4.52 ± 1.60, and 0.69 ± 0.09, respectively. And, during the low-water season (S3), H′ further increased to 2.54 ± 0.26, while D decreased to 0.12 ± 0.06, R was 4.57 ± 0.58, and J′ reached 0.81 ± 0.10, respectively (Figure 4).

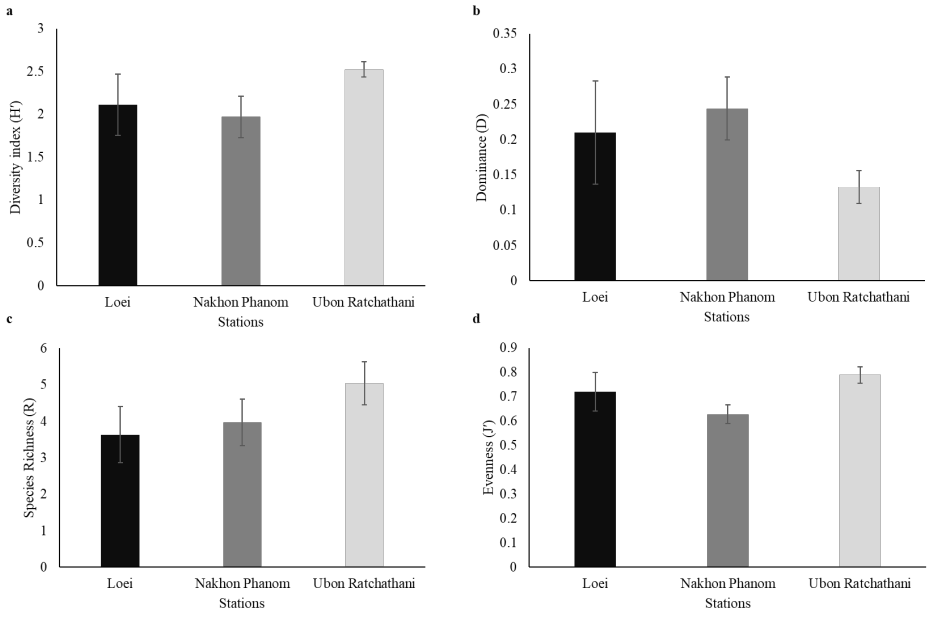


**Figure 3**. Fish community structure indices at three sampling sites in the Lower Mekong River, northeastern Thailand (mean±SE): (a) diversity index (H′), (b) dominance index (D), (c) species richness (R), and (d) evenness index (J′).

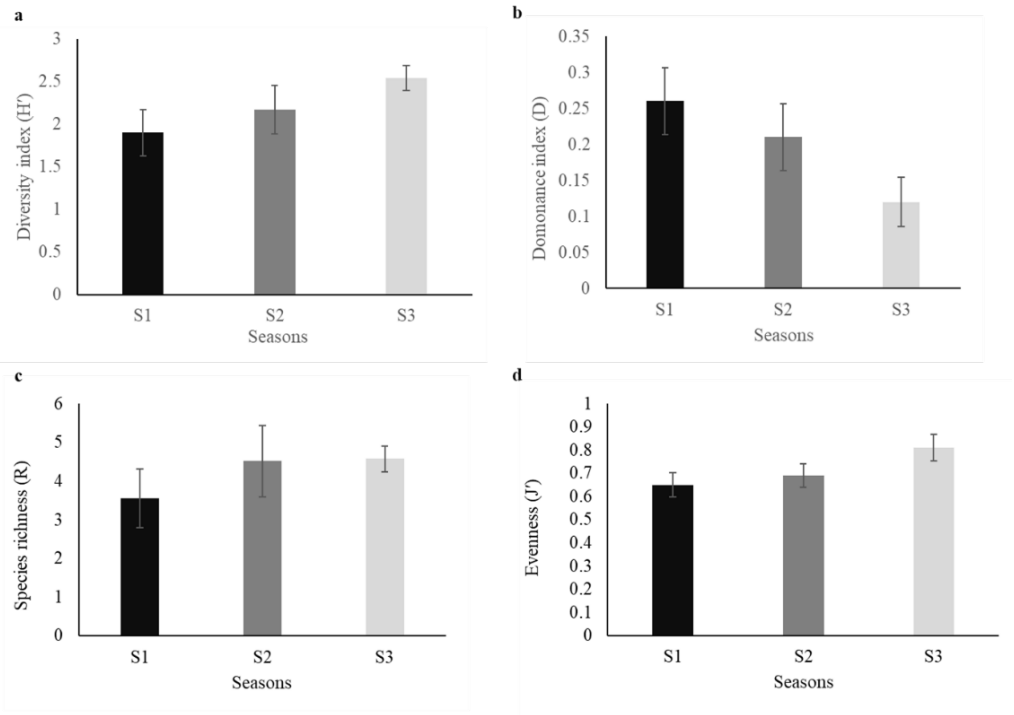


**Figure 4.** Fish community structure indices across three hydrological seasons in the Lower Mekong River, northeastern Thailand (mean±SE), including (a) diversity index (H′), (b) dominance index (D), (c) species richness (R), and (d) evenness index (J′). S1 = peak flood season (September–October), S2 = receding flood season (November–December), and S3 = low-water season (January–February).

Fish species were further classified into ecological functional guilds based on migration behavior and habitat use following the criteria of the Mekong River Commission. A total of six functional groups were identified. These comprised rhithron residents (G1) with nine species, main channel residents or long-distance white fishes (G2) with five species, main channel spawners or short distance white fishes (G3) with 29 species, floodplain spawners or grey fishes (G4) with 19 species, eurytopic or generalist fishes (G5) with 15 species, and floodplain residents or black fishes (G6) with two species. In addition, five species were classified as non-native or exotic species (G11). Most species were assigned to the main channel spawners group (G3). Representative species in this group included *Clupeichthys aesarnensis*, *Hypsibarbus malcolmi*, and *Phalacronotus micronemus*. The second most common group was floodplain spawners (G4), which included species such as *Barbonymus altus*, *Bagrichthys majusculus*, and *Toxotes mekongensis* (Table 1).

Fish species recorded in this study were also classified according to their conservation status based on the IUCN Red List of Threatened Species. The results indicated that one species was classified as Endangered (EN), six species as Vulnerable (VU), two species as Near Threatened (NT), 65 species as Least Concern (LC), five species as Data Deficient (DD), and one species as Not Evaluated (NE) (Figure 5).

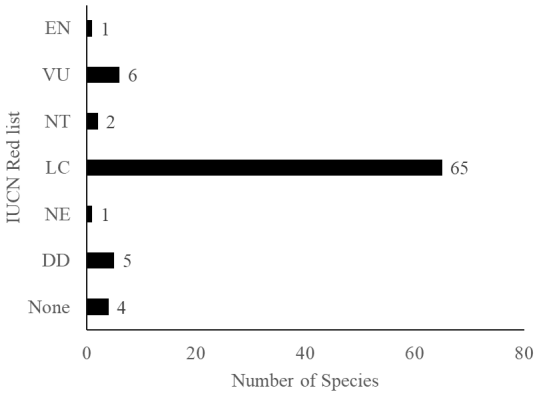


**Figure 5.** Conservation status of fish species recorded from the Lower Mekong River in northeastern Thailand (based on IUCN Red List categories).

**Table 1.** Checklist, conservation status (based on IUCN Red List), and ecological guilds of fish species recorded at each sampling station in the Mekong River, northeastern Thailand (Loei, Nakhon Phanom, and Ubon Ratchathani).

| Family / Scientific Name | Guild of MRC | IUCN Red list | LEI | NPM | UBN | N |
|---|---|---|---|---|---|---|
| **Family Notopteridae** | | | | | | |
| *Chitala ornata* (Gray, 1831) | G5 | LC | | + | | 7 |
| *Notopterus notopterus* (Pallas, 1769) | G5 | LC | + | + | | 13 |
| **Family Sundasalangidae** | | | | | | |
| *Sundasalanx mekongensis* (Britz & Kottelat, 1999) | G3 | LC | | | + | 1 |
| **Family Salangidae** | | | | | | |
| *Neosalanx brevirostris* (Pellegrin, 1923) | G11 | DD | + | | + | 10 |
| **Family Clupeidae** | | | | | | |
| *Clupeichthys aesarnensis* Wongratana, 1983 | G3 | LC | + | | + | 38 |
| *Tenualosa thibaudeaui* (Durand, 1940) | G3 | VU | | + | + | 15 |
| **Family Cyprinidae** | | | | | | |
| *Amblyrhynchichthys micracanthus* Ng & Kottelat, 2004 | G3 | LC | | + | | 1 |
| *A. truncatus* (Bleeker, 1850) | G3 | LC | | + | | 1 |
| *Barbichthys laevis* (Valenciennes, 1842) | G3 | LC | | | + | 7 |
| *Barbonymus altus* (Günther, 1868) | G4 | LC | + | + | + | 346 |
| *B. gonionotus* (Bleeker, 1849) | G5 | LC | + | + | + | 5 |
| *B. schwanefeldii* (Bleeker, 1854) | G4 | LC | + | | | 5 |
| *Cirrhinus molitorella* (Valenciennes, 1844) | G3 | NT | | | + | 1 |
| *Cosmochilus harmandi* Sauvage, 1878 | G2 | LC | + | + | | 51 |
| *Cyclocheilichthys armatus* (Valenciennes, 1842) | G4 | LC | + | | | 1 |
| *C. enoplos* (Bleeker, 1849) | G2 | LC | + | + | | 71 |
| *C. repasson* (Bleeker, 1853) | G4 | LC | + | + | | 11 |
| *Cyprinus carpio* (Linnaeus, 1758) | G11 | - | | + | + | 5 |
| *Discherodontus ashmeadi* (Fowler, 1937) | G1 | LC | + | | | 1 |
| *Epalzeorhynchos munensis* (Smith, 1934) | G1 | VU | | | + | 5 |
| *Esomus metallicus* (Ahl, 1923) | G6 | LC | | | + | 4 |
| *Hampala dispar* (Smith, 1934) | G5 | LC | + | | + | 4 |
| *H. macrolepidota* (Kuhl & Van Hasselt, 1823) | G5 | LC | | + | + | 6 |
| *Henicorhynchus entmema* (Fowler, 1934) | G5 | LC | + | | | 1 |
| *H. siamensis* (Sauvage, 1881) | G5 | LC | + | + | + | 6 |
| *Hypophthalmichthys molitrix* (Valenciennes, 1844) | G11 | - | | | + | 1 |
| *Hypsibarbus lagleri* (Rainboth, 1996) | G3 | VU | | + | + | 3 |
| *H. malcolmi* (Smith, 1945) | G3 | LC | | + | + | 34 |
| *H. vernayi* (Norman, 1925) | G3 | LC | + | + | | 27 |
| *H. wetmorei* (Smith, 1931) | G3 | LC | + | + | | 20 |
| *Labeo rohita* (Hamilton, 1822) | G11 | - | | | + | 1 |
| *Labiobarbus siamensis* (Sauvage, 1881) | G5 | LC | | | + | 12 |
| *Mystacoleucus obtusirostris* (Valenciennes, 1842) | G1 | LC | + | + | + | 105 |
| *Opsarius koratensis* (Smith, 1931) | G1 | LC | + | | + | 7 |
| *Osteochilus microcephalus* (Valenciennes, 1842) | G5 | LC | | | + | 1 |
| *Paralaubuca barroni* (Fowler, 1934) | G4 | LC | + | | | 1 |
| *P. riveroi* (Fowler, 1935) | G4 | LC | | | + | 16 |
| *Probarbus jullieni* (Sauvage, 1880) | G2 | EN | + | + | + | 5 |

**Table 1.** Checklist, conservation status (based on IUCN Red List), and ecological guilds of fish species recorded at each sampling station in the Mekong River, northeastern Thailand (Loei, Nakhon Phanom, and Ubon Ratchathani).

| Family / Scientific Name | Guild of MRC | IUCN Red list | LEI | NPM | UBN | N |
|---|---|---|---|---|---|---|
| *Puntioplites falcifer* Smith, 1929 | G3 | LC | | + | + | 21 |
| *P. proctozystron* (Bleeker, 1865) | G3 | LC | + | + | + | 219 |
| *P. waandersi* (Bleeker, 1859) | G3 | LC | | | + | 1 |
| *Raiamas guttatus* (Day, 1870) | G1 | LC | + | + | + | 55 |
| *Rasbora argyrotaenia* (Bleeker, 1849) | G4 | LC | + | | | 13 |
| *R. aurotaenia* Tirant, 1885 | G4 | LC | | | + | 4 |
| *R. borapetensis* Smith, 1934 | G4 | LC | + | | + | 8 |
| *R. myersi* Brittan, 1954 | G4 | LC | | | + | 1 |
| *Scaphognathops bandanensis* Boonyaratpalin & Srirungroj, 1971 | G3 | VU | | + | + | 19 |
| *Sikukia gudgeri* (Smith, 1934) | G4 | DD | + | + | + | 105 |
| *Systomus rubripinnis* (Valenciennes, 1842) | G3 | DD | | + | | 8 |
| *Thynnichthys thynnoides* (Bleeker, 1852) | G4 | LC | | | + | 2 |
| *Tor sinensis* Wu, 1977 | G1 | VU | | | + | 9 |
| **Family Cobitidae** | | | | | | |
| *Acantopsis rungthipae* Boyd, Nithirojpakdee & Page, 2017 | G3 | NE | + | + | + | 7 |
| *Aperioptus delphax* Siebert, 1991 | G3 | LC | | + | + | 4 |
| *Yasuhikotakia lecontei* (Fowler, 1937) | G1 | LC | | | + | 2 |
| **Family Bagridae** | | | | | | |
| *Bagrichthys majusculus* Ng, 2002 | G4 | DD | | + | | 3 |
| *Hemibagrus spilopterus* Ng & Rainboth, 1999 | G3 | LC | + | + | + | 12 |
| *Mystus bocourti* (Bleeker, 1864) | G4 | VU | | + | | 7 |
| *M. mysticetus* Roberts, 1992 | G4 | LC | | + | | 1 |
| *M. singaringan* (Bleeker, 1846) | G4 | LC | | + | | 3 |
| *Pseudomystus siamensis* (Regan, 1913) | G3 | LC | | + | | 1 |
| **Family Siluridae** | | | | | | |
| *Belodontichthys truncatus* Kottelat & Ng, 1999 | G3 | LC | | + | + | 8 |
| *Kryptopterus cheveyi* Durand, 1940 | G3 | LC | | + | + | 3 |
| *Phalacronotus apogon* (Bleeker, 1851) | G3 | LC | | + | + | 6 |
| *P. bleekeri* (Günther, 1864) | G3 | LC | | | + | 1 |
| *P. micronemus* (Bleeker, 1846) | G3 | LC | | + | | 15 |
| *Wallago attu* (Bloch & Schneider, 1801) | G3 | NT | | + | | 1 |
| **Family Pangasiidae** | | | | | | |
| *Helicophagus leptorhynchus* Ng & Kottelat, 2000 | G3 | DD | | + | | 2 |
| *Pangasius bocourti* Sauvage, 1880 | G2 | LC | | + | | 1 |
| *P. conchophilus* Roberts & Vidthayanon, 1991 | G2 | LC | | + | | 1 |
| *P. macronema* Bleeker, 1850 | G3 | LC | + | | + | 7 |
| *Pseudolais pleurotaenia* (Sauvage, 1878) | G3 | LC | | + | | 1 |
| **Family Hemiramphidae** | | | | | | |
| *Dermogenys siamensis* Fowler, 1934 | G4 | LC | + | | | 6 |

**Table 1.** Checklist, conservation status (based on IUCN Red List), and ecological guilds of fish species recorded at each sampling station in the Mekong River, northeastern Thailand (Loei, Nakhon Phanom, and Ubon Ratchathani).

| Family / Scientific Name | Guild of MRC | IUCN Red list | LEI | NPM | UBN | N |
|---|---|---|---|---|---|---|
| **Family Belonidae** | | | | | | |
| *Xenentodon canciloides* (Bleeker, 1854) | G5 | LC | + | + | + | 16 |
| **Family Mastacembelidae** | | | | | | |
| *Mastacembelus armatus* (Lacepède, 1800) | G5 | LC | + | + | + | 6 |
| **Family Ambassidae** | | | | | | |
| *Parambassis siamensis* (Fowler, 1937) | G5 | LC | + | + | + | 86 |
| **Family Tetraodontidae** | | | | | | |
| *Toxotes mekongensis* Kottelat & Tan, 2018 | G4 | LC | | + | + | 24 |
| **Family Pristolepididae** | | | | | | |
| *Pristolepis fasciatus* (Bleeker, 1851) | G4 | LC | | + | | 1 |
| **Family Cichlidae** | | | | | | |
| *Oreochromis niloticus* (Linnaeus, 1758) | G11 | - | + | + | | 110 |
| **Family Eleotridae** | | | | | | |
| *Oxyeleotris marmorata* (Bleeker, 1852) | G5 | LC | + | | | 1 |
| **Family Gobiidae** | | | | | | |
| *Papuligobius ocellatus* (Fowler, 1937) | G5 | LC | + | | + | 15 |
| **Family Osphronemidae** | | | | | | |
| *Trichopodus pectoralis* Regan, 1910 | G6 | LC | | + | | 1 |
| **Family Soleidae** | | | | | | |
| *Brachirus harmandi* (Sauvage, 1878) | G5 | LC | + | + | + | 16 |
| **Family Tetraodontidae** | | | | | | |
| *Pao suvattii* (Sontirat & Soonthornsatit, 1985) | G1 | LC | + | | | 7 |
| *Pao turgidus* (Kottelat, 2000) | G1 | LC | | | + | 1 |
| **Total** | | | | | | **1,690** |

Notes:

| | | | | | |
|---|---|---|---|---|---|
| G1 | Rhithron residents | G2 | Main-channel residents/ long-distance white fishes | G3 | Main-channel spawners/ short-distance white fishes |
| G4 | Floodplain spawners/ grey fishes | G5 | Eurytopic/ generalist fishes | G6 | Floodplain residents/ black fishes |
| G11 | Non-Native/ Exotic / Alien Species | EN | Endangered | VU | Vulnerable |
| NT | Near Threatened | LC | Least Concern | DD | Data Deficient |
| NE | Not Evaluated | - | None | N | Number of individuals |
| LEI | Loei | NPM | Nakhon Phanom | UBN | Ubon Ratchathani |

Most species recorded in the present study were classified as Least Concern (LC), comprising 65 species. Representative species in this category included *Cyclocheilichthys enoplos*, *Hypsibarbus malcolmi*, *Cosmochilus harmandi*, *Mystacoleucus obtusirostris*, *Raiamas guttatus*, *Acantopsis rungthipae*, and *Pseudolais pleurotaeni*. Only one species was classified as Endangered (EN), namely *Probarbus jullieni*, which was recorded in all three provinces. Six species were classified as Vulnerable (VU), including *Tenualosa thibaudeaui*, *Epalzeorhynchos munensis*, *Hypsibarbus lagleri*, *Scaphognathops bandanensis*, *Tor sinensis*, and *Mystus bocourti*. Two species were classified as Near Threatened (NT), namely *Cirrhinus molitorella* and *Wallago attu*. In addition, five alien species were

recorded in the study area, including *Cyprinus carpio*, *Hypophthalmichthys molitrix*, *Labeo rohita*, *Neosalanx brevirostris*, and *Oreochromis niloticus*. These species were found across the three surveyed provinces.

Water quality analysis across the Loei, Nakhon Phanom, and Ubon Ratchathani stations during all three seasons (S1–S3) revealed that pH levels remained consistently within the slightly alkaline range. The highest variability in pH was observed at the Ubon Ratchathani station, ranging from 6.76 (S1) to 8.68 (S3). Electrical conductivity (EC) showed a distinct upward trend at all stations during S3, with the maximum value recorded at the Loei station (167.37±0.25 µS/cm). Regarding dissolved oxygen (DO), the highest concentration found during S2 (10.96–12.73 mg/L), while the lowest concentration was recorded at the Ubon Ratchathani station during S1 (6.80±0.27 mg/L). Water temperature fluctuated according to seasonal factors, peaking at the Loei station during S2 (28.96±0.81 °C) and reaching its minimum at the Nakhon Phanom station during S3 (22.33±0.06 °C). Overall, these fluctuations significantly demonstrate the influence of both spatial (station location) and temporal (seasonal) factors on water quality.

## DISCUSSION

The study recorded a total of 84 fish species from 21 families in the Mekong River within northeastern Thailand. Species richness was highest in the family *Cyprinidae*, consistent with surveys conducted by the Mekong River Commission (2021), which reported cyprinids as the dominant group, representing 45% of all recorded species. A similar pattern was observed in the Songkhram River Basin, where cyprinids were the most abundant family among all species recorded (Buanuak *et al*., 2004).

Analysis of species composition indicated that *Barbonymus altus* and *Puntioplites proctozystron* were the most abundant species. These species inhabit main river channels and undertake short-distance migrations for spawning and feeding (Poulsen et al., 2002). They play a central role in shaping fish community structure in the Mekong River and constitute important resources for local fisheries (Baran et al., 2005). In contrast, rarely observed species, such as *Puntioplites waandersi*, *Rasbora myersi*, and *Wallago attu*, likely reflect the influence of environmental factors, including water level, seasonal variation, and habitat structure, on species distribution across different areas (Chan *et al*., 2020). Spatial analysis indicated that Ubon Ratchathani province exhibited the highest species richness, followed by Nakhon Phanom and Loei. These differences likely reflect variations in topography and habitat complexity. The lower reaches of the river typically encompass a mosaic of habitats, including rapids, sandbanks, and floodplain areas, which provide suitable conditions for a wide range of fish species (Poulsen *et al*., 2002). Kruskal–Wallis tests revealed no significant differences in fish abundance among the provinces, suggesting that the Mekong River ecosystem in the study area maintains good habitat connectivity, allowing broad dispersal of fish populations (Baran *et al*., 2006).

Seasonal analysis revealed that species richness was higher during the receding flood season (S2) and low-water season (S3) compared with the peak flood season (S1). This pattern reflects the hydrodynamic regime of the Mekong River, which varies with water levels. This seasonal fluctuation is consistent with the flood-pulse concept, which suggests that the predictable advance and retreat of water over the floodplain drive biological productivity and the movement of organisms (Junk et al., 1989). As floodwaters recede, floodplain areas gradually dry, prompting many fish species to move back into the main river channels, resulting in increased density and higher observed species richness (Poulsen et al., 2002). Conversely, during the flood season, fish disperse extensively into inundated floodplain areas, reducing detectability in the main channels (Baran, 2006). This phenomenon underscores the importance of lateral connectivity, where the unimpeded exchange of nutrients and organisms between the river channel and its floodplain is crucial for maintaining biodiversity (Ward and Stanford, 1995).

The diversity index (H′) ranged from 1.90 to 2.54, indicating that fish communities exhibited moderate species diversity. Evenness index (J′) ranged from 0.56 to 0.88, reflecting a moderate balance in species distribution across the study sites. During the low water period (S3), evenness was higher, indicating a more equitable distribution of individuals among species. Dominance index (D) ranged from 0.1 to 0.2 during the same period, demonstrating that no single species dominated the community (Magurran, 2004). The relatively high evenness during S3 may be attributed to the concentration of diverse taxa within the main-channel refugia, where stable low-flow conditions support a heterogeneous community structure before the next flood cycle begins.

Classification of ecological functional groups indicated that most species belonged to the main-channel spawners, or short-distance white fishes (G3). This pattern reflects the characteristics of the Mekong River as a large river system, where many fish undertake migrations for spawning and feeding (Mekong River Commission, 2019). From the perspective of fish migration ecology, these white fish species are highly sensitive to changes in hydrological cues and longitudinal connectivity (Winemiller and Jepsen, 1998). Species in this group play a key role in sustaining fisheries, as the life cycles of many species depend on movements between the main channel and adjacent floodplain areas (Mekong River Commission, 2023).

In terms of conservation, the Endangered species *Probarbus jullieni* was recorded in Loei, Nakhon Phanom, and Ubon Ratchathani provinces. This large migratory species undertakes long-distance movements along the main channel of the Mekong River and is of considerable economic importance. Spawning occurs during the dry season, from December to February (Poulsen *et al*., 2004). Populations have declined sharply across the Mekong Basin due to overfishing, dam construction, and habitat degradation (Chevalier *et al*., 2023; Sor *et al*., 2023). To support conservation efforts, the Department of Fisheries has implemented hatchery propagation and restocking programs in several areas along the Mekong River. However, these measures alone may be insufficient to ensure long-term population recovery without basin-scale management. Effective strategies should include the protection of key spawning grounds and migration corridors, the implementation of seasonal fishing closures, the regulation of fishing gear to reduce juvenile capture, and the restoration of riparian and floodplain habitats that function as nursery areas. In addition, community participation and co-management are essential for enhancing the effectiveness of conservation measures and promoting sustainable fisheries management (Coates, 2001).

Another notable finding was the presence of five alien fish species, including *Oreochromis niloticus* and *Cyprinus carpio*, which were introduced for aquaculture or fisheries purposes. These species are classified as noninvasive alien species (Sihiranwong, 2020). Nevertheless, the establishment of alien species in the Mekong River ecosystem may impact native fishes through competition for food and habitat and could potentially drive long-term changes in fish community structure (Strayer, 2010).

The results of this study demonstrate that spatial and temporal variation in water quality plays an important role in shaping species richness and fish assemblage structure within the Mekong River system. During the receding flood season (S2), higher dissolved oxygen (DO) levels and favorable temperatures are likely to enhance biological activity and promote a greater concentration of fish within the main channel, resulting in increased species richness.

This pattern is consistent with the flood pulse concept proposed by Wolfgang Junk, which suggests that, as water levels decline, fish move from floodplain habitats back into the main channel, accompanied by a transfer of resources (Junk *et al*., 1989). In contrast, the peak flood season (S1) is associated with lower DO levels in certain areas, which may limit oxygen availability. Under such conditions, some species may avoid or disperse from the main channel, leading to lower observed species richness despite the expansion of available habitat (Baran *et al*., 2001).

Elevated EC during the low water season (S3) may indicate higher dissolved ion concentrations, potentially favor tolerant species and subtly alter fish assemblages. Nevertheless, EC likely plays a secondary, site-specific role rather than acting as a primary driver of community structure. In contrast, relatively stable pH conditions suggest limited direct constraint on fish communities, although spatial variability in pH may still reflect underlying habitat heterogeneity (Nuon *et al*., 2025).

In this study, the widespread distribution of the Cyprinidae family, particularly *Barbonymus altus*, across all stations and seasons highlights the role of generalist species in tolerating low dissolved oxygen (DO) during peak flood season (Ngor *et al*., 2023). This pattern indicates adaptive capacity under seasonal hydrological stress. The findings further emphasize river connectivity and water quality dynamics as key drivers of fish diversity and community composition in the Mekong River ecosystem.

The use of trawl nets alone may not fully capture the complete fish species diversity in the Mekong River. Therefore, future studies should employ multiple sampling methods to obtain a more comprehensive understanding of fish community composition. The findings of this study provide essential baseline information for supporting sustainable fisheries management and the conservation of fish resources in the face of increasing pressures on the Mekong River ecosystem.

## CONCLUSIONS

This study shows that the Mekong River in northeastern Thailand continues to support a high diversity of freshwater fishes, with 84 species representing 61 genera and 21 families. The family Cyprinidae exhibited the highest species richness. Dominant species, such as *Barbonymus altus* and *Puntioplites proctozystron*, underscore both the ecological importance and fisheries value of the river in the region. Fish diversity varied across spatial and seasonal scales. The highest diversity was observed during the receding flood season (S2) and low-water season (S3), reflecting hydrological fluctuations and migratory patterns. Although most species are classified as least concern, the presence of the endangered species *Probarbus jullieni* and several non-native species indicates potential ecological risks. These findings highlight the importance of continuous monitoring of fish diversity and community structure to inform sustainable fisheries management and the conservation of freshwater biodiversity in the Mekong River.

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