Fisheries Journal, 16 (2), 784-793 (2026)
http://doi.org/10.29303/jp.v16i2.2173

BIOECOLOGICAL EXPLORATION AND DISTRIBUTION MAPPING OF CYPRINIDAE FISH IN THE BATANG ASAI RIVER, SAROLANGUN, JAMBI PROVINCE

Eksplorasi Bioekologi dan Pemetaan Distribusi Ikan Cyprinidae di Sungai Batang Asai Sarolangun Provinsi Jambi

Yoppie Wulanda[1*], Rizky Janatul Magwa[2], Ester Restiana Endang Gelis[2], Septy Heltria[2], Lauura Hermala Yunita[1], Farhan Ramdhani[2], Febrina Rolin[2], Yusyam Leni[2], Muhammad Hafidz Ibnu Khaldun[2], Ainun Rohmawati Bareta[2]

[1]Fishery Product Technology Study Program, University of Jambi
[2]Fisheries Resource Utilization Study Program, University of Jambi

Jl. Jambi - Muara Bulian No.KM. 15, Mendalo Darat, Kec. Jambi Luar Kota, Kabupaten Muaro Jambi

*Corresponding Author: yoppiewulanda@unja.ac.id

(Received April 13th 2026; Accepted May 30th 2026)

ABSTRACT

The Batang Asai River in Sarolangun Regency, Jambi, is one of the major rivers with a length of approximately 104 km. Currently, its water quality is declining due to anthropogenic activities such as land clearing, settlements, and mining. This condition threatens the sustainability of fish populations, particularly those from the Cyprinidae family, which are important food fish and sensitive to environmental degradation. However, scientific information regarding the bioecology and spatial distribution of Cyprinidae in this area remains very limited. Therefore, this study is necessary to provide baseline data to support adaptive conservation strategies and fisheries management. The objectives of this research are to identify Cyprinidae species, analyze bioecological aspects (morphometrics, diversity, reproduction, and habitat characteristics), map spatial distribution based on GIS, and determine conservation status according to the IUCN Red List. The study was conducted in August 2025 at three observation stations. The methods used include field surveys, bioecological analysis, and GIS-based spatial mapping. The results showed that 19 species of Cyprinidae were identified with a total of 482 individuals. The fish diversity index value of 2.07 indicates a moderate diversity category, with an evenness value of 0.70 and a dominance value of 0.17. The sex ratio of males to females was 1.9:1, dominated by fish at gonadal maturity stage (GMS) I with 263 individuals. In general, the water quality of the Batang Asai River still supports fish life, and no species were classified as threatened according to the IUCN Red List.

Keywords: Batang Asai River, Cyprinidae, Distribution Mapping, IUCN

ABSTRAK

Sungai Batang Asai di Kabupaten Sarolangun, Jambi, merupakan salah satu sungai besar yang panjangnya mencapai 104 km. Saat ini, kualitas perairannya menurun akibat aktivitas antropogenik seperti pembukaan lahan, pemukiman, dan penambangan. Kondisi ini mengancam keberlanjutan populasi ikan, khususnya dari famili *Cyprinidae* yang merupakan kelompok ikan konsumsi penting dan sensitif terhadap degradasi lingkungan. Namun, informasi ilmiah mengenai bioekologi dan distribusi spasial *Cyprinidae* di wilayah ini sangat terbatas. Oleh karena itu, riset ini diperlukan untuk menyediakan data dasar guna mendukung strategi konservasi dan pengelolaan perikanan secara adaptif. Tujuan penelitian ini mengidentifikasi spesies *Cyprinidae*, menganalisis aspek bioekologi (morfometrik, keanekaragaman, reproduksi, dan karakteristik habitat), memetakan distribusi spasial berbasis GIS, serta menentukan status konservasi berdasarkan daftar IUCN Penelitian dilakukan pada bulan Agustus 2025 di tiga stasiun pengamatan. Metode yang digunakan mencakup survei lapangan, analisis bioekologi, serta pemetaan spasial berbasis GIS. Hasil penelitian menemukan 19 spesies *Cyprinidae* dengan total 482 individu. Nilai indeks keanekaragaman ikan sebesar 2,07 menunjukkan kategori keanekaragaman sedang, dengan keseragaman 0,70 dan dominansi 0,17. Rasio kelamin jantan dan betina adalah 1,9:1, didominasi oleh ikan dengan tingkat kematangan gonad (TKG) I sebanyak 263 individu. Secara umum, kualitas perairan Sungai Batang Asai masih mendukung kehidupan ikan, dan tidak ditemukan spesies yang tergolong dalam kategori terancam punah menurut IUCN.

Kata Kunci: *Cyprinidae*, IUCN, Pemetaan Distribusi, Sungai Batang Asai

INTRODUCTION

The Batang Asai River in Sarolangun Regency is part of the Batanghari River Basin (DAS). Land clearing for exploitation and exploration in the Batanghari River Basin is highly dangerous because it has the potential to cause a prolonged ecological disaster. One example is illegal gold mining activities in Bungo Regency, Jambi Province, which negatively impact aquatic biota. Currently, illegal gold mining activities (PETI) in the Batanghari River continue to increase.

According to the Indonesian Conservation Community (KKI Warsi Jambi), the area of damage from illegal gold mining in Jambi Province has reached 45,896 hectares, with the largest area being in Sarolangun Regency, followed by Merangin, Bungo, and Tebo, an increase of 3,535 hectares (8%) from 42,361 hectares in 2021 (Muhammad et al., 2020). The Batang Asai River has high biodiversity potential, particularly in freshwater fish. Based on fishermen's catches, one of the dominant fish families is the Cyprinidae. This group has high ecological and economic value, both as a local food source and as an indicator of aquatic ecosystem quality.

Currently, the Batang Asai River aquatic ecosystem is under pressure due to anthropogenic activities such as household waste, gold mining, and unsustainable fishing, which have directly impacted the habitat and population of Cyprinid fish. The decline in aquatic environmental quality can disrupt ecosystem balance and threaten the sustainability of endemic species, especially fish with high economic value. Inland waters (rivers, lakes, swamps) play a crucial role in maintaining the sustainability of aquatic biota within the ecosystem (Wulanda et al., 2025). However, currently, research on bioecological aspects is limited, and there is no data mapping the distribution of Cyprinid fish in the Batang Asai River in Sarolangun Regency. Therefore, this study is urgently needed as a basis for scientifically based fish resource management, particularly information on the bioecological aspects and geographic distribution of fish species. The objectives of this study are to identify Cyprinid species, analyze bioecological aspects (morphometrics, diversity, reproduction, and habitat characteristics),

map their spatial distribution using GIS, and determine their conservation status based on the IUCN list.

RESEARCH METHODS

This exploration was conducted in the Batang Asai River in Sarolangun Regency in August 2025 at three stations representing different ecosystem conditions: upstream (minimal anthropogenic activity), midstream (moderate to high activity), and downstream (near settlements/estuary). The methods used included field surveys, bioecological analysis, and GIS-based spatial mapping.

Fish sampling was conducted three times at each station using various active and passive fishing gears: hooks, nets, cast nets, and traps of various sizes. Nocturnal fish (active at night) were captured using baited nets. Captured fish were photographed and then identified. Identification results were compared with several fish identification books (Kottelat et al., 1993; Sukmono et al., 2017). The identified fish were tabulated to determine the number, composition, and species. The Shannon-Wiener index (diversity), Simpson index (dominance), and Pielou index (evenness) were analyzed. Fish reproduction analysis in the form of determining sex and gonad maturity level (TKG) using macroscopic methods (Effendi, 1979). The conservation status of fish will be analyzed using the IUCN redlist (www.iucnredlist.org) and fishbase (www.fishbase.se). Habitat parameter measurements were carried out at 07.00-09.00 WIB. Habitat characteristics measured include; coordinates, riparian vegetation, water morphometry, DO, pH, temperature, and brightness (Effendi, 1979; Sukmono & Utomo, 2023). The tools used to measure habitat characteristics are: Garmin GPS, DSLR Camera, Fish Finder Lucky FF918C, Water Quality Meter AZ86031, and Secchi Disk.

RESULT

Fish Biodiversity

Based on survey data on fish that have been analyzed morphometrically and meristically, 19 species were identified, with a total of 482 individuals (Table 1). The following data shows the types and number of Cyprinidae fish species in the Batang Asai River:

Table 1. Number of Cyprinidae Fish by Genus in the Batang Asai River

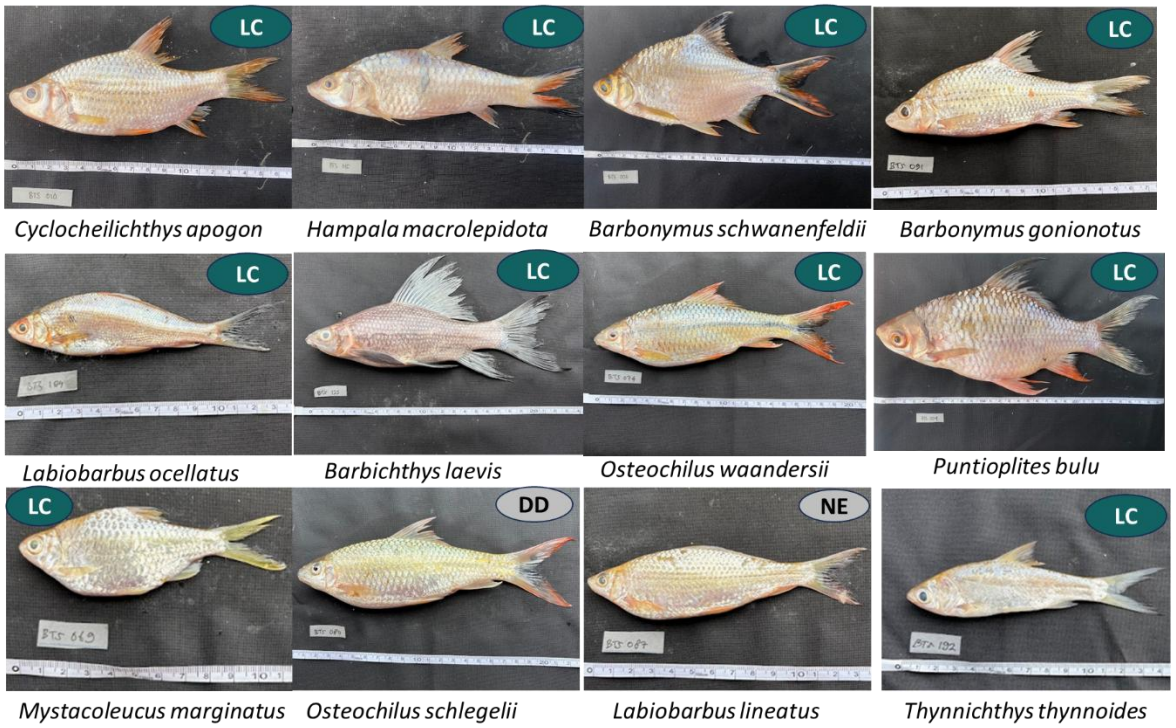
No	Genus	Species	Individual (fish)
1	Barbichthys	1	22
2	Barbonymus	2	117
3	Cyclocheilichthys	2	123
4	Hampala	2	3
5	Labeo	1	4
6	Labiobarbus	3	46
7	Mystacoleucus	1	5
8	Osteochilus	3	75
9	Puntioplites	2	12
10	Striuntius	1	1
11	Thynnichthys	1	74
	Total	19	482

Nineteen fish species were found in this study (Table 2), namely *Barbichtys laevis, Barbonymus gonionotus, Barbonymus schwanenfeldii, Cyclocheilichthys apogon, Cyclocheilichthys enoplos, Hampala ampalong, Hampala macrolepidota, Labeo chrysophekadion, Labiobarbus leptocheilus, Labiobarbus lineatus, Labiobarbus ocellatus, Mystacoleucus marginatus, Osteochilus kappenii, Osteochilus schlegelii, Osteochilus*

waandersii, Puntioplites bulu, Puntioplites waandersii, Striuntius lineatus, Thynnichthys thynnoides.

Table 2. Composition of Cyprinidae Fish by Species in the Batang Asai River

No	Species	Total	Composition (%)
1	*Barbichtys laevis*	22	4.56
2	*Barbonymus gonionotus*	3	0.62
3	*Barbonymus schwanenfeldii*	114	23.65
4	*Cyclocheilichthys apogon*	120	24.90
5	*Cyclocheilichthys enoplos*	3	0.62
6	*Hampala ampalong*	1	0.21
7	*Hampala macrolepidota*	2	0.41
8	*Labeo chrysophekadion*	4	0.83
9	*Labiobarbus leptocheilus*	3	0.62
10	*Labiobarbus lineatus*	10	2.07
11	*Labiobarbus ocellatus*	33	6.85
12	*Mystacoleucus marginatus*	5	1.04
13	Osteochilus kappenii	66	13.69
14	*Osteochilus schlegelii*	5	1.04
15	*Osteochilus waandersii*	4	0.83
16	*Puntioplites bulu*	1	0.21
17	*Puntioplites waandersii*	11	2.28
18	*Striuntius lineatus*	1	0.21
19	*Thynnichthys thynnoides*	74	15.35



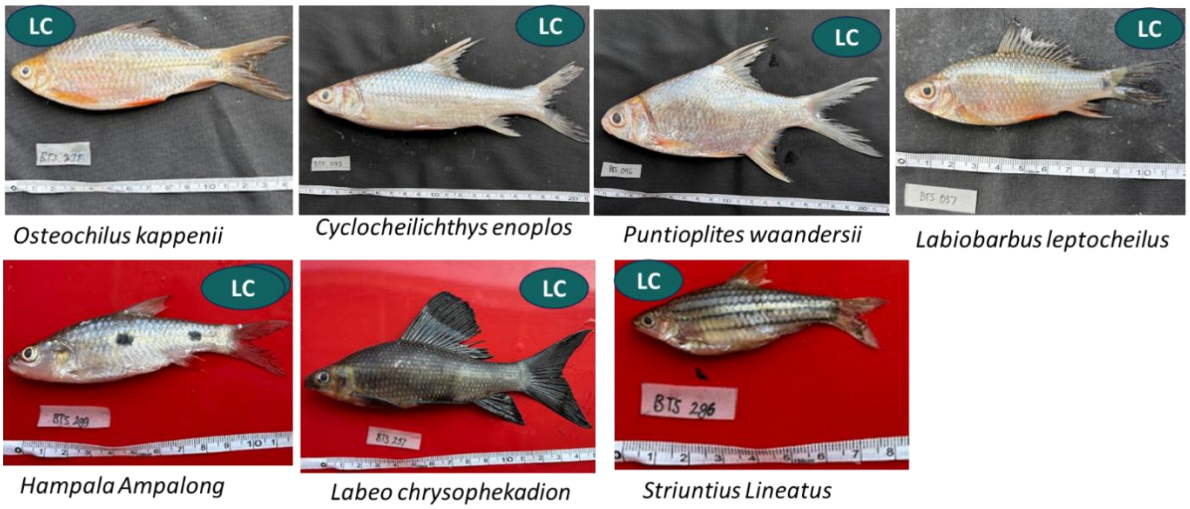


Figure 1. Cyprinidae Fish Species in the Batang Asai River

The results of the ecological index analysis (Table 3) show a diversity value (H') of 2.07, a uniformity index (E') of 0.70, and a dominance index (C) of 0.17.

Table 3. Ecological Index of Fish in the Batang Asai River

Index	Value	Criteria
Diversity	2.07	Moderate
Uniformity	0.70	Prevalent
Dominance	0.17	Low

Fish Reproduction

The results of the reproductive analysis of Cyprinidae fish in the Batang Asai River yielded 66 female fish and 197 male fish, as follows:

Table 4. Fish Composition Based on Sex and Gonad Maturity

Fish Sex	TKG			
	I	II	III	IV
Female	66	36	28	35
Male	197	83	23	14

Habitat Characteristics

In this study, the parameters measured included temperature, clarity, pH, dissolved oxygen (DO) levels, and water depth (Table 5). These data describe the environmental conditions of the waters that serve as fish habitats in the study area.

Table 5. Water Quality of the Batang Asai River

Water Quality Parameters	Unit	Value Range
Temperature	°C	25.9 – 26.1
Brightness	cm	4 – 5
pH	-	6.43 – 7.01
Dissolved Oxygen (DO)	% saturation	67.3 – 91.7
Depth	m	5.8 – 7.0

Fish Distribution Mapping

The fish catch at the research station contained varying numbers of species, as shown in the following distribution map of Cyprinidae fish in the Batang Asai River:

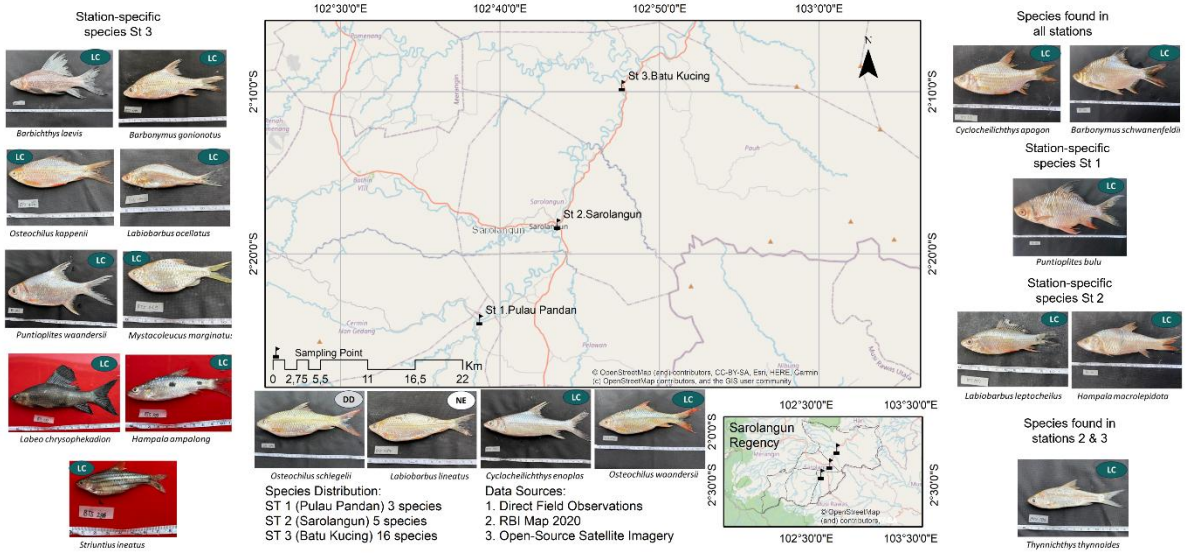


Figure 2. Distribution Map of Cyprinidae Fish in the Batang Asai River

Based on the IUCN status analysis of Cyprinidae fish in the Batang Asai River (Table 6), most fish are still considered Least Concern. One species is classified as Not Evaluated and Data Deficient.

Table 6. Fish Distribution Based on IUCN Status

No	Types of Fish	IUCN
1	*Barbichthys laevis*	*Least Concern*
2	*Barbonymus gonionotus*	*Least Concern*
3	*Barbonymus schwanenfeldii*	*Least Concern*
4	*Cyclocheilichthys apogon*	*Least Concern*
5	*Cyclocheilichthys enoplos*	*Least Concern*
6	*Hampala ampalong*	*Least Concern*
7	*Hampala macrolepidota*	*Least Concern*
8	*Labeo chrysophekadion*	*Least Concern*
9	*Labiobarbus leptocheilus*	*Least Concern*
10	*Labiobarbus lineatus*	Not evaluated
11	*Labiobarbus ocellatus*	*Least Concern*
12	*Mystacoleucus marginatus*	*Least Concern*
13	*Osteochilus kappenii*	*Least Concern*
14	*Osteochilus schlegelii*	Data Deficient
15	*Osteochilus waandersii*	*Least Concern*
16	*Puntioplites bulu*	*Least Concern*
17	*Puntioplites waandersi*	*Least Concern*
18	*Striuntius lineatus*	*Least Concern*
19	*Thynnichthys thynnoides*	*Least Concern*

DISCUSSION

Fish Biodiversity

Based on the results of a study of Cyprinidae fish in the Batang Asai River, with a sample size of 482 fish, 11 genera and 19 species were identified. The most abundant genera caught were Labiobarbus (3 genera) and Osteochilus (3 genera), but these numbers were not significantly different from the other genera, which showed relatively even distribution. The highest number of species was found in *Barbonymus schwanenfeldii* (114 individuals) and *Cyclocheilichthys apogon* (120 individuals). This indicates that *Barbonymus schwanenfeldii* and *Cyclocheilichthys apogon* have better adaptation to the environmental conditions of the Batang Asai River than other species. This can be seen from the discovery of *Barbonymus schwanenfeldii* in large rivers such as the Padang River in South Sumatra, the Ogan River in Ogan Ilir, the Keureuto River, the Bunin River, and the Sikundur River in Aceh Province (Mutiara, 2017; Harmilia et al., 2024; Akmal et al., 2025). *Cyclocheilichthys apogon* was also found in large rivers, namely the Musi Banyuasin River and the Kelingi River in Lubuklinggau City (Sofian et al., 2024; Samitri & Rozi, 2017).

The results of the diversity index analysis of Cyprinidae fish in the Batang Asai River are in the moderate category ($1 \geq H' \leq 3$), indicating that the fish community is quite diverse, with a relatively large number of species and a moderate distribution of individuals within each species. The same diversity index category was also found in a study of Cyprinidae fish in the Ariung River, Kapuas Hulu Regency (Septian et al., 2020).

One factor contributing to the low fish diversity in the Batang Asai River is anthropogenic activity, namely illegal gold mining (PETI). Apriliyani (2020) stated that the level of substrate pollution, availability of food sources, interspecific competition, environmental disturbances, and general water conditions can affect the level of fish diversity in an aquatic ecosystem. As a result, species with low tolerance to environmental changes tend to experience population declines, while those with high tolerance are able to survive and even increase in number. Furthermore, interviews with local fishermen revealed that the current decrease in fish diversity in the Batang Asai River compared to several years ago is due to fishing activities using electric nets. A similar trend also occurred in the Peraya Besar River in Kaur Regency. Corneles & Darwin (2025) stated that some fishermen currently use electric nets, which impacts the growth and development of fish in the river, potentially leading to fish declines and even mortality.

A uniformity (E') value of 0.70 indicates a high level, meaning the distribution of individuals between species is relatively even. No species has a significantly higher number of individuals than other species, so competitive pressure within the community can be said to be stable. Furthermore, the dominance (C) value of 0.17 is considered low, which reinforces the idea that no particular species truly dominates the community. This condition indicates that the fish community structure in these waters remains stable despite anthropogenic activities that threaten the survival of fish species. Fish will grow, reproduce, and dominate if they can adapt to their environment. However, if in the long term, fish cannot adapt to their environment, their presence will decline rapidly and they will disappear or become extinct (Andani et al., 2017).

Fish Reproduction

Analysis of the sex ratio of 317 males and 165 females showed that males (66%) were significantly more dominant than females (34%), with a male-to-female ratio of 1.9:1. This indicates that the male-to-female ratio of Cyprinidae fish in the Batang Asai River is not ideal. According to Kelkusa et al. (2025), the percentage of males and females that does not follow a 1:1 ratio indicates an imbalance in the aquatic population. This imbalance in the sex ratio of fish in the Batang Asai River can be caused by anthropogenic activities such as illegal fishing (PETI). PETI activities cause increased turbidity, sedimentation, and heavy metal pollution

such as mercury (Hg), which impacts substrate quality and water productivity. These conditions disrupt the aquatic food chain, particularly the availability of benthos, periphyton, and plankton, which are the primary food sources for fish in the Cyprinidae family. Furthermore, Rahmawati (2015) stated that the distribution of male and female fish caught each month is strongly influenced by external factors, including food availability and human activities such as fishing season.

Data on the structure of gonad maturity levels (GMT) by sex (Table 4) shows differences in developmental patterns between male and female fish. For female fish, the largest number of individuals was at GMT I (66 individuals) (40%), while 35 individuals had reached GMT IV, or were ready to spawn. For male fish, the largest number of individuals was also at GMT I (197 individuals) (62%), with only 14 individuals (4%) at GMT IV. Based on observations of GMT, most male and female Cyprinidae in the Batang Asai River were still in the immature stage. This is suspected to be due to the sampling time not coinciding with the peak spawning season. The study was conducted in August, the transition period to the rainy season, whereas Cyprinidae generally spawn in the early to mid-rainy season. According to the Meteorology, Climatology, and Geophysics Agency (BMKG), Indonesia is predicted to enter the rainy season from September to November 2025. This is when water discharge and nutrient availability in the waters increase. Most tropical freshwater fish, particularly members of the Cyprinidae family, spawn seasonally, with peak spawning occurring during the rainy season (Putri et al., 2021).

Habitat Characteristics

Water quality measurements at the observation site indicate a water temperature of 25.9–26.1°C with a relatively low transparency of 4–5 cm. The pH value recorded was between 6.43–7.01, indicating near-neutral water conditions. The pH range obtained is ideal for fish growth, as it aligns with the Quality Standards document for Government Regulation No. 22 of 2021, with a pH of 6–9, which is considered good for freshwater fish cultivation. Dissolved oxygen (DO) levels varied between 67.3–91.7%. The water depth at the observation site ranged from 5.8–7 m. In general, these water quality parameters are still within the range that can support fish life. Station 3, located in Batu Kucing Village, has a relatively natural river condition with natural brown water and riparian vegetation still present along the banks that function to maintain the stability of the riverbanks. In contrast, Station 2, located in Sarolangun City, shows the river color tends to be cloudy due to high human activity in the area, while riparian vegetation in some parts has been reduced due to settlements and urban activities. Meanwhile, Station 1 on Pandan Island shows the river condition is very cloudy and even muddy due to illegal gold mining activities (PETI), with riparian vegetation that is heavily disturbed and most of the riverbank area has been exposed due to mining activities.

Fish Distribution Mapping and IUCN Status

In the fish distribution mapping of 19 fish species, station three (ST1) had 3 species, station two (ST2) had 5 species, and the most species were found at station one (ST3) with 16 species. Based on the distribution of each station (Figure 2), the key species were *Barbonymus schwanenfeldii* and *Cyclocheilichthys apogon*, which were found at every research station. Station one (ST1) had the highest number of identified species, encompassing almost all species found in the survey. Station two (ST2) had less species representation, but several important species, such as *Hampala macrolepidota* and *Labiobarbus leptocheilus*, were found only at this station. Meanwhile, station three (ST3) was recorded as inhabited by several economically valuable species, such as *Barbonymus schwanenfeldii*, *Cyclocheilichthys apogon*, and *Puntioplites bulu*. This indicates that the distribution of fish in these waters is uneven across stations, with some species having specific habitat preferences.

Analysis of the IUCN status using the IUCN Redlist (www.iucnredlist.org) and Fishbase (www.fishbase.se) revealed that most species are classified as Least Concern (LC) (Table 6), meaning they are not yet threatened with extinction. One species, *Osteochilus schlegelii*, is listed as Data Deficient (DD), meaning information on its population status is still very limited. Wulanda et al. (2025) stated that fish with Data Deficient status have limited data on their wild populations, making them vulnerable to the risk of undetected population decline.

Furthermore, one species, *Labiobarbus lineatus*, is listed as Not Evaluated (NE), indicating that there has been no official assessment of its sustainability. The conservation status of *Labiobarbus lineatus* is Not Evaluated (NE), meaning the species has not been further evaluated according to the IUCN classification due to limited data and information required to accurately determine its conservation status (IUCN, 2025). This finding demonstrates the importance of further monitoring efforts, particularly for species with limited or unassessed data, to provide a clearer picture of fish population dynamics and support sustainable fisheries management strategies in these waters.

CONCLUSION

In general, the water quality of the Batang Asai River still supports fish life, as evidenced by the moderate diversity index and the absence of dominant species. However, most of the fish found during the study were still in an immature gonad state.

ACKNOWLEDGEMENT

Thank you to all the research team of lecturers in the Fisheries Department, Faculty of Animal Husbandry, University of Jambi. Thank you to the Institute for Research and Community Service, University of Jambi, this research is research funded by the University of Jambi through the 2025 Research and Community Service Grant Program.

REFERENCES

Akmal, Y., Yunus, M., Plumeriastuti, H., & ... (2025). *Growth patterns, condition factors and morphological variations in Barbonymus schwanefeldii from Indonesia. Biosystems Ecology*. Retrieved from http://ecology.dp.ua/index.php/ECO/article/view/1378

Andani, A., Herawati, T., Zahidah, & Hamdani, H. (2017). *Identifikasi dan inventarisasi ikan yang dapat beradaptasi di Waduk Jatigede pada tahap inundasi awal. Jurnal Perikanan dan Kelautan*, 8(2), 28–35.

Anggraini, J., Agustriani, F., & Isnaini, I. (2019). *Komposisi spesies dan struktur komunitas ikan di kawasan ekosistem mangrove Muara Sungai Musi Kabupaten Banyasin Sumatera Selatan. Jurnal Penelitian Sains*, 21(1), 21–27.

Aprilliyani, E. P. (2020). *Keanekaragaman spesies ikan sebagai bioindikator kualitas perairan di Sungai Kaligarang Kota Semarang* (Skripsi). Jurusan Biologi, Fakultas Matematika dan Ilmu Pengetahuan Alam, Universitas Negeri Semarang.

Badan Meteorologi Klimatologi dan Geofisika. (2025). *Prediksi musim hujan 2025/2026 di Indonesia.* Retrieved from https://www.bmkg.go.id/iklim/prediksi-musim/prediksi-musim-hujan-2025-2026-di-indonesia

Corneles, V. A., & Darwin, C. (2025). *Keanekaragaman jenis-jenis ikan di Sungai Perairan Luas Kabupaten Kaur. Jurnal Intelek Insan Cendikia.* Retrieved from https://jicnusantara.com/index.php/jiic/article/view/2642

Effendie, M. I. (1979). *Metode biologi perikanan.* Bogor: Yayasan Dewi Sri.

Harmilia, E. D., Khotimah, K., & Ma'ruf, I. (2024). *Fish fauna in the Ogan River, South Pemulutan District, Ogan Ilir. Journal of Global Sustainable Agriculture*, 66–77.

IUCN. (2025). *The IUCN Red List of Threatened Species (Version 2025-1).* Retrieved from https://www.iucnredlist.org/

Kelkusa, K., Mudjirahayu, M., Handayani, T., Simatauw, F. F., & Saleh, F. I. (2025). *Aspek pertumbuhan ikan julung-julung (Hemiramphus lutkei Valenciennes, 1847) yang dipasarkan di Kabupaten Manokwari. Jurnal Sumberdaya Akuatik Indopasifik*, 9(1), 67–80.

Kottelat, M., Whitten, A. J., Kartikasari, S. N., & Wirjoatmodjo, S. (1993). *The freshwater fishes of Western Indonesia and Sulawesi.* Singapore: Periplus Edition & EMDI Project.

Muhammad, M., Syafrialdi, S., & Hertati, R. (2020). *Keanekaragaman jenis-jenis ikan di Sungai Tembesi Kecamatan Bathin VIII Kabupaten Sarolangun Provinsi Jambi. SEMAH: Jurnal Pengelolaan Sumberdaya Perairan*, 4(1).

Mutiara, D. (2017). *Keanekaragaman spesies ikan di Sungai Padang Kecamatan Sirah Pulau Padang Kabupaten Ogan Komering Ilir Provinsi Sumatera Selatan. Sainmatika: Jurnal Ilmiah Matematika dan Ilmu Pengetahuan Alam*, 14(2), 107–111.

Putri, N. M. S. A., Pertami, N. D., & Kartika, G. R. A. (2021). *Aspek reproduksi ikan nyalian (Barbodes binotatus Valenciennes, 1842) di Danau Tamblingan. Jurnal Sumberdaya Akuatik Indopasifik*, 5(3), 303–314.

Rahmawati, A. S. (2015). *Biologi reproduksi wader pari (Rasbora lateristriata) di Rawa Jombar Kabupaten Klaten* (Skripsi). Fakultas Pertanian, Universitas Gadjah Mada, Yogyakarta.

Riki, P., Pangerang, U. K., Purnama, M. F., & Fekri, L. (2023). *Kelimpahan dan keanekaragaman ikan di Muara Sungai Konaweha Kabupaten Konawe Provinsi Sulawesi Tenggara. Jurnal Manajemen Sumber Daya Perairan.*

Samitra, D., & Rozi, F. Z. (2017). *Identifikasi jenis-jenis ikan di Sungai Kelangi Kota Lubuklinggau. Semnas Bioeti Ke-4 & Kongres PTTI Ke-12.*

Septian, S. T., Prayogo, H., & Dirhamsyah, M. (2020). *Keanekaragaman jenis ikan famili Cyprinidae di Sungai Ariung Kecamatan Putussibau Utara Kabupaten Kapuas Hulu. Jurnal Hutan Lestari*, 8(2), 407–415.

Sofian, S., Humairani, H., & Saputra, A. (2024). *Keanekaragaman jenis ikan di perairan pasang surut Sungai Musi Kecamatan Muara Telang Kabupaten Banyuasin. Jurnal Ilmu-Ilmu Perikanan dan Budidaya Perairan*, 19(1), 55–65.

Sukmono, T., & Margaretha, M. (2017). *Ikan air tawar di ekosistem Bukit Tigapuluh.* Jambi: Yayasan Konservasi Ekosistem Hutan Sumatra dan Frankfurt Zoological Society.

Sukmono, T., & Utomo, P. E. P. (2023). *Kajian ekologis pembersihan kanal dan kolam kuno di KCBN Muaro Jambi.* Jambi.

Wulanda, Y., Sukmono, T., Yunita, L. H., Magwa, R. J., Putra, T. S., & Utomo, P. E. P. (2025). *Ichthyofauna biodiversity in Lake Kelari within the Muaro Jambi National Cultural Heritage Area as a basis for establishing a Lubuk Larangan. Journal of Fish Health*, 5(2), 153–166.