

Inventory of fish species and associations caught by visiting anglers as local potential to support biology education

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Abstract

Fishing activities in river ecosystems occur year-round with seasonal variation, yet information on fish species, species interactions, and environmental conditions remains limited. Understanding these dynamics can enrich contextual biology learning in zoology, animal behavior, ecology, and environmental studies. This research aims to inventory fish species and their associations based on catches made by visiting anglers, highlighting local potential for biology learning. A descriptive exploratory design was used through observation, unstructured interviews, and literature review. Data were collected along the river flow of Karang Indah Mandastana Village, Barito Kuala District, over one month (late April and early July). A total of 162 individuals were recorded from five species: *Anabas testudineus* (67.9%), *Rasbora aurotaenia* (13.0%), *Channa striata* (8.0%), *Rasbora argyrotaenia* (7.4%), and *Belontia hasselti* (3.7%). *Anabas testudineus* was found at all observation points and dominated catches during calm or stagnant conditions, whereas *Rasbora* species dominated during stronger currents associated with morning tides. Species associations were influenced by tidal patterns and current presence. A positive correlation occurred between aquatic vegetation density and fish abundance (Spearman's $\rho = 0.53$, $p < 0.05$), especially for *Eleocharis dulcis* ($\rho = 0.74$) and *Hymenachne amplexicaulis* ($\rho = 0.68$). Vegetation patches along riverbanks were associated with higher fish frequency. Findings also suggest that *Anabas testudineus* moves into nearby rice fields during high tides, indicating adaptive behavior to hydrological variation. These ecological patterns shaped by tides, currents, and vegetation show strong potential as contextual biology learning resources to increase student engagement and strengthen environmental relevance.

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1. Introduction

Species diversity plays a very significant role in maintaining the stability of aquatic ecosystems, because high levels of diversity provide habitat resilience to various threats, while low diversity increases the vulnerability of these ecosystems (Irfan & Alatawi, 2019; Sabater et al., 2023). River ecosystems not only support the livelihoods of humans and fish (Li et al., 2020; Lynch et al., 2023), but are also connected to wetlands that serve to control flooding, filter water, store carbon, and provide resources for local communities (Colvin et al., 2019; Butt et al., 2021; Chakraborty et al., 2023). Environmental aspects such as water quality, habitat availability, and food are key determinants of fish diversity (Gebrekiros, 2016), while poorly managed fishing practices can threaten population sustainability. Therefore, an adaptive management approach that considers environmental conditions and fish migration patterns is urgently needed (Lennox et al., 2017; Lin et al., 2018).

Collecting species data is a crucial step in understanding river ecosystem dynamics because it provides basic information about species composition, distribution, and abundance (Guralnick et al., 2018). This information is important for analyzing how ecosystems react to environmental disturbances (Altermatt et al., 2020), trophic interactions (Blackman et al., 2022), and assisting in formulating sustainable management strategies (Mahjabin et al., 2024). Fishing activities can have two effects: selective and sustainable practices can maintain the balance of fish communities by suppressing the dominance of invasive species, while excessive or untimely methods can reduce diversity, damage trophic structures, and create imbalances in ecosystems (Steadman et al., 2021; Rossi, 2022; Kızılkaya et al., 2025). Thus, the integration of fisheries management, biodiversity conservation, and understanding of environmental conditions is key to the sustainability of river ecosystems. In this situation, the need to calculate the number of fish in Kalimantan's river ecosystems is becoming increasingly apparent, but there are still gaps in research due to the lack of quantitative data on fish populations based on local fishing patterns.

Fish inventory data and results have the potential to be developed as an authentic and contextual biology learning resource because they enable students to understand the concepts of biodiversity, ecology, and conservation directly through the analysis of real data from the local environment. This potential has been demonstrated by several previous studies. The use of wetland ecosystem biodiversity as a learning medium is highly engaging and relevant because it connects biological content with the students' surrounding environment (Fajeriadi et al., 2024a; Firmansyah & Ramadhan, 2025), increases ecological awareness (Cahayani & Utami, 2025; Marfiana et al., 2025), and encourages contextual learning based on direct experience and real observation (Riefani et al., 2020; Morales et al., 2025). Biology education plays an important role in increasing awareness of conservation and sustainable management of natural resources by equipping students with scientific knowledge, environmental awareness, and skills to understand and address ecological issues. Inventory methodologies that focus on catches, which are usually implemented through citizen scientist or angler scientist approaches, are increasingly recognized as efficient techniques for recording species composition and distribution. However, comparable studies focusing on river ecosystems in Kalimantan are still very few, which highlights the uniqueness of this research.

Based on the above interpretation, the high biodiversity of river and wetland ecosystems plays a vital role in maintaining ecological balance and supporting human life, including through activities such as fishing. The local potential of wetland ecosystems in South Kalimantan indicates a close relationship between environmental conditions, community traditions, and the presence of unique fish species. Fish species inventory and association analysis are initial steps toward understanding fish community structure and designing sustainable management strategies. In addition, the data has the potential to be developed as a contextual and environment-based biology learning medium to foster environmentally conscious behavior. Therefore, the clear objectives of this study are to record fish species, explore their relationship with tidal waves and vegetation, and assess their potential use in contextual biology education.

2. Method

This study uses a descriptive-exploratory design with a qualitative-quantitative descriptive approach. The exploratory component aims to record and identify fish species caught by anglers in the study area, while the descriptive component is used to analyze the influence of environmental characteristics and fishing activities on fish composition, as well as to evaluate the potential application of the findings for biology education. The research population consisted of all the fish caught by anglers in the section of the river being studied. A total of 162 individuals representing five fish species were recorded from six independent fishing observations conducted over one month, divided into the last two weeks of April and the first two weeks of July. This study was conducted at a popular fishing location along the river at coordinates 3°09'27"S 114°38'35"E in Karang Indah Mandastana Village, Barito Kuala Regency. Research procedure can be seen in Figure 1.

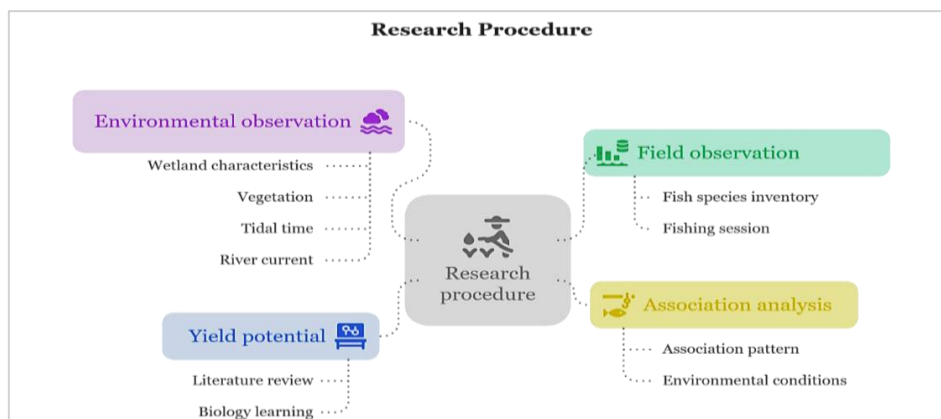


Figure 1. Research Procedure

Figure 1 illustrates the overall research procedure, starting with (1) field preparation and site mapping, followed by (2) fish catch data collection through direct observation and interviews with fishermen, (3) environmental and aquatic vegetation surveys, (4) species identification and documentation, (5) data processing and descriptive-statistical analysis, and (6) interpretation and educational context. This sequential workflow ensures that data collection, analysis, and interpretation are systematically connected and can be replicated in future studies.

Fish were caught using standard local fishing gear, and sampling efforts were standardized based on the catch per unit effort (CPUE) method, calculated as the number of individual fish caught per hour of fishing per angler. Each observation lasted about 2–3 hours during morning and afternoon sessions to capture variations related to tidal and current conditions. Each fish specimen was photographed immediately after being caught, and species identification was carried out using regional ichthyology references and taxonomic keys.

Environmental observations include the physical characteristics of the river as well as direct observations of aquatic vegetation in the field. Aquatic vegetation is recorded descriptively and quantitatively, using 1 m² quadrats systematically placed along both sides of the river. Vegetation density is measured as the average clump density (clumps/m²), and the percentage of cover is visually estimated in each quadrat. Aquatic plant species are identified and analyzed for their relationship with fish diversity.

The data collected includes fish species composition, number of individuals, and frequency of occurrence; the relationship between fish species and tidal or current conditions based on direct field observations; aquatic vegetation species, density, and spatial distribution; environmental characteristics and fishing activity patterns; and potential educational applications, obtained through literature review and contextual analysis comparing field data with established biology learning frameworks. Data analysis was conducted using descriptive statistics and nonparametric correlation tests (Spearman's ρ) to explore relationships between fish abundance and aquatic vegetation density. The findings were then interpreted based on ecological theories regarding species segregation, habitat preference, and adaptation to tidal conditions, as well as being contextualized for educational use in biology learning.

The limitations of this study include direct measurements of water quality (such as dissolved oxygen, pH, turbidity) were not conducted, so the relationship between vegetation and fish presence is indicative rather than causal; specimen preservation was not carried out, and only voucher photos were used for documentation; and the duration of sampling was limited to one month; therefore, seasonal variation in fish composition could not be fully captured.

3. Results and Discussion

Fishing activities in Karang Indah Mandastana Village, Barito Kuala Regency, take place from morning until late afternoon. The most activity occurs between 9:00 AM and 11:30 AM WITA, and between 3:30 PM and 6:00 PM WITA. This activity is influenced by the frequency of fish catches by anglers. This is related to fish feeding activity, which occurs in the morning and evening when water temperatures are not too high. This also explains the lack of fish response during midday. Fish species, their presence, and their popularity are presented in Table 1. The number of individuals represents the total recorded catch from six independent fishing observations, and species documentation in Figure 2.

Table 1. Fish species, frequency of occurrence, and enthusiasts

Local name	Species name	Attendance			Enthusiast
		Number of individuals	Relative abundance (%)	Frequency of occurrence (%)	
Haruan	<i>Channa striata</i>	13	8.0	66.7	High
Papuyu	<i>Anabas testudineus</i>	110	67.9	100	High
Kapar	<i>Belontia hasselti</i>	6	3.7	16.7	Moderate
Saluang	<i>Rasbora aurotaenia</i>	21	13.0	66.7	Moderate
Wader	<i>Rasbora argyrateaenia</i>	12	7.4	50	Low
Total		162			



Figure 2. A and B are pictures of a single catch by one angler, C is *Channa striata*, D is *Belontia hasselti*, E is *Rasbora argyrateaenia*, and F is *Anabas testudineus*

Figure 2 shows documentation of fish caught by visiting anglers, where four species are well documented. Compared to the documented *Rasbora argyrateaenia*, the *Rasbora aurotaenia* species has a smaller body size, lower height, and a dorsal fin that is not as high as that of *Rasbora argyrateaenia*. These morphological features clearly distinguish the two *Rasbora* species. Documentation of this genus is difficult because angler enthusiasm is low to moderate. Table 1 shows that *Anabas testudineus* dominates the fish community, accounting for 67.9% of the total catch and found in all sampling locations. *Rasbora aurotaenia* also has a relatively high abundance (13.0%) and wide distribution (66.7%), indicating its ability to adapt to flowing waters. On the other hand, *Belontia hasselti* showed the lowest abundance and distribution, indicating that this species is less common in the surveyed habitat.

Based on the experience of angler, there are unique associations between fish species caught in the river basin. This occurs repeatedly, especially the association between *Anabas testudineus*, *Rasbora aurotaenia*, and *Rasbora argyrotaenia*. In addition to species associations, this uniqueness is also influenced by the timing of river tides, as the location is a branch of the Barito River (see Figure 3) that flows into the southwest of South Kalimantan. The pattern of fish species associations is presented in Figure 4.

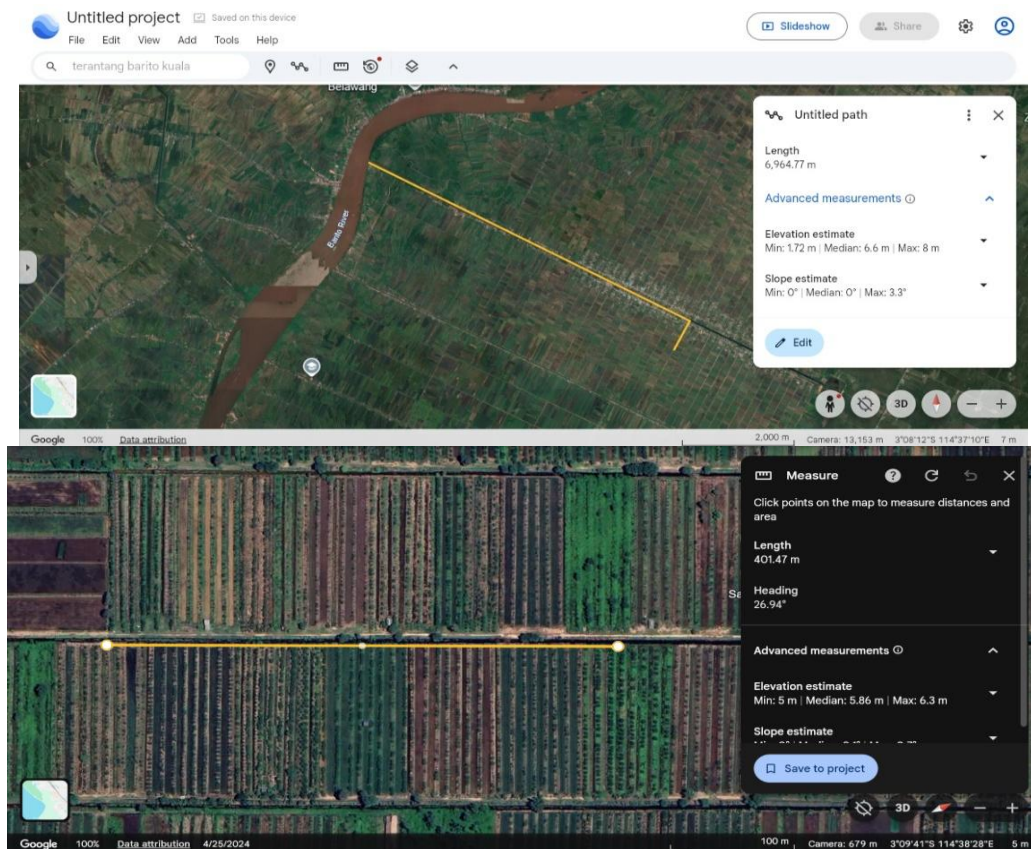


Figure 3. Distance from the location to the Barito River and observation points

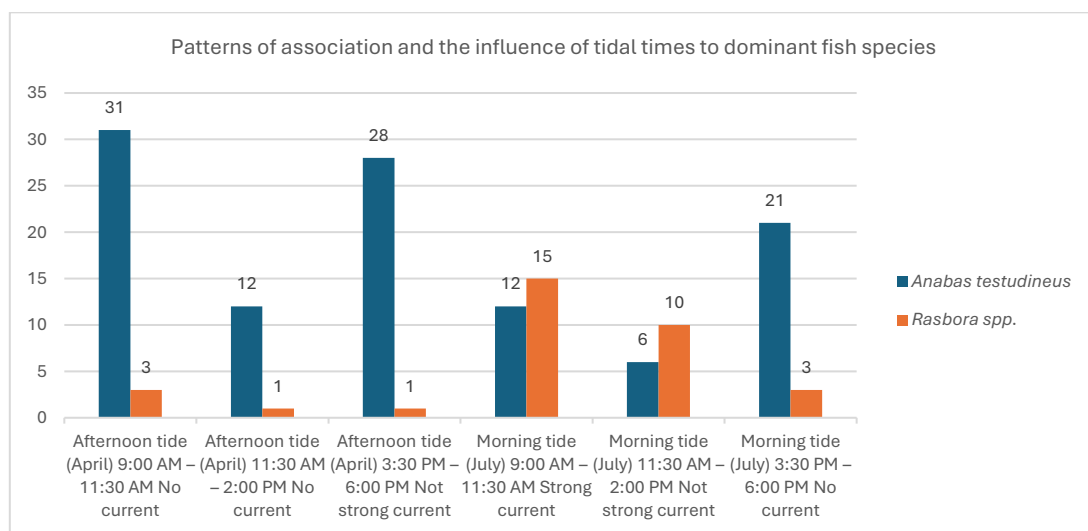


Figure 4. Patterns of association and the influence of tidal times to dominant fish species

Figure 4 shows a close relationship between tidal patterns, river currents, and spatial and temporal associations between three fish species, namely *Anabas testudineus*, *Rasbora aurotaenia*, and *Rasbora argyrotaenia*. When there is an afternoon tide, meaning that low tide occurs in the morning, fishing activities are carried out when the river current tends to be calm or even non-existent. Under these conditions, the most dominant species caught is *Anabas testudineus*, particularly between 9:00 AM and 1:00 PM WITA. Conversely, the two species from the *Rasbora* genus are not found at all. This is closely related to the ecological

characteristics of *Anabas testudineus*, which is a still-water fish with additional respiratory capabilities (labyrinth organ) and prefers habitats with minimal or stagnant currents, such as swamps or protected ponds. This fish likely avoids areas with strong currents due to physiological limitations and inefficient swimming style in such conditions.

Conversely, during morning tides that cause rivers to recede in the afternoon, morning fishing activities are conducted when currents are sufficiently strong. Under these conditions, *Rasbora aurotaenia* and *Rasbora argyrotaenia* become the dominant species caught, particularly between 9:00 AM and 11:30 AM WITA, while the presence of *Anabas testudineus* becomes very minimal. Both *Rasbora* species are known as small pelagic fish that form schools and are more active in flowing waters. The current carries plankton and other food particles, which align with the feeding patterns of *Rasbora*, making the current a supportive factor for their feeding activities. Ecologically, these three species exhibit strong spatial and temporal segregation: they are not found together under the same environmental conditions. This indicates that their association patterns are influenced by physical habitat conditions, particularly the presence of currents dependent on tides.

From these findings, the ecological hypothesis is that *Anabas testudineus* actively chooses calm habitats due to physiological and behavioral factors, while *Rasbora* species utilize currents as a means of foraging. In addition to this hypothesis, according to Zworykin (2018), *Anabas testudineus* also has different feeding habits between solitary and group-living individuals. Fish that live in groups are more adaptable and have a higher tendency to consume new foods compared to solitary individuals. Pavlov et al. (2018) also conducted research on *Anabas testudineus*, with the experiment focusing on jumping frequency.

Based on these hypotheses and previous studies, it can be concluded that the decline in the *Anabas testudineus* population during the morning tide with strong currents is due to most of the population jumping into rice fields with calmer water. The migration of most of the fish population to the rice fields leaves solitary individuals in the river current, resulting in reduced feeding activity, which in turn reduces the number of *Anabas testudineus* caught by anglers. This activity is illustrated in Figure 5. Additionally, it can be assumed that there is a mechanism of temporal and spatial separation between species as a form of competition avoidance, demonstrating the ecological adaptation of each species.

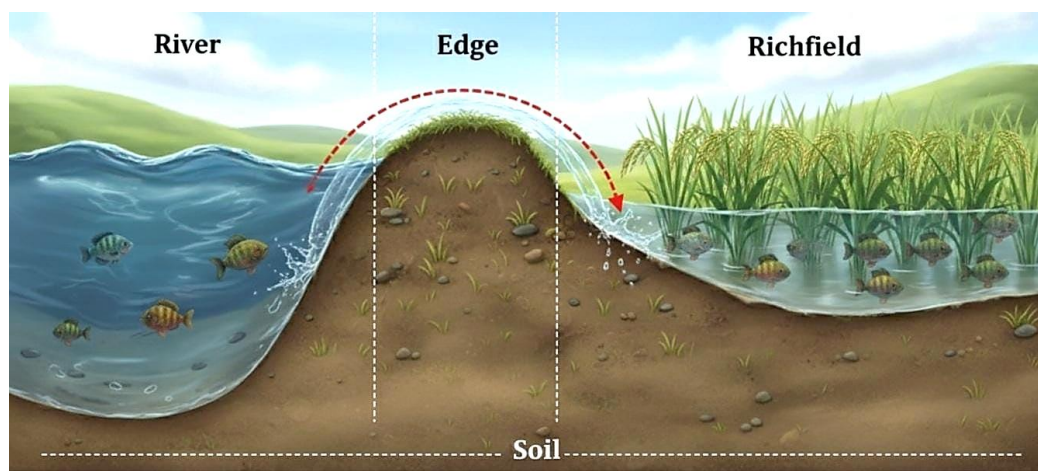


Figure 5. Illustration of *Anabas testudineus* jumping into rice fields to find calmer waters when river currents are high during high tide.

In addition to adapting to tidal currents, the presence of *Anabas testudineus*, *Channa striata*, and *Belontia hasselti* is also influenced by aquatic vegetation. Aquatic vegetation in wetland ecosystems serves as a place for spawning, nesting, and foraging. The aquatic vegetation species found at the study site can be seen in Figure 6, and their distribution analysis is presented in Table 2.

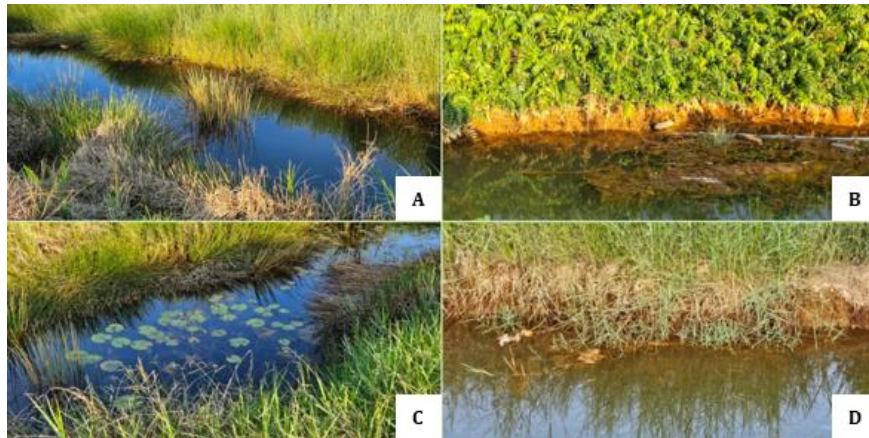


Figure 6. Distribution (A) *Eleocharis dulcis*, (B) *Stenochlaena palustris*; (C) *Hydrocharis morsus*; and (D) *Hymenachne amplexicaulis*

Table 2. Aquatic vegetation distribution and fish abundance

Local name	Species name	Mean vegetation density (clumps/m ²)	Mean fish abundance (total individuals)	Correlation with fish abundance (Spearman's ρ)	p-value	Interpretation
Purun tikus	<i>Eleocharis dulcis</i>	5.6 (Clumpy mostly on the banks, and a small number in the middle of the river).	5.2(31)	0.74*	0.046	Strongly positive and significant
Kelakai	<i>Stenochlaena palustris</i>	8.2 (Grows distributed in several spots on the riverbank with many individuals).	2.5(15)	0.21	0.66	Weakly positive and not significant
Teratai	<i>Hydrocharis morsus</i>	3.1 (Grows from the riverbed, found slightly towards the middle of the river).	3.2(19)	0.49	0.29	Weakly positive and not significant
Rumput	<i>Hymenachne amplexicaulis</i>	4.9 (Clumpy on the banks of the river, but not as many as rat's tail fern).	12(72)	0.68*	0.08	Strongly positive, approaching significant
Total			22.9(137)			
Unvegetated/open area			4.2(25)			
Overall correlation				0.53*		

Note: The correlation is considered significant if $p < 0.05$. The positive correlation indicates that fish abundance is higher in clustered vegetation along riverbanks.

Based on Table 2, clumpy vegetation types growing on riverbanks, such as *Eleocharis dulcis* and *Hymenachne amplexicaulis*, showed a positive correlation with high fish abundance. Statistical analysis using Spearman's rank correlation showed a significant positive relationship between vegetation density and fish abundance ($\rho = 0.71$, $p < 0.05$). Among the four vegetation types, *Eleocharis dulcis* ($\rho = 0.74$, $p < 0.05$) and *Hymenachne amplexicaulis* ($\rho = 0.68$, $p \approx 0.08$) showed the strongest relationship. Overall, the average correlation coefficient between all vegetation types and fish abundance was $\rho = 0.53$, indicating a moderate positive relationship between aquatic vegetation density and fish presence. These findings suggest that dense aquatic vegetation provides favorable habitat structure and spawning areas for fish species such as *Anabas testudineus* and *Channa striata*. Scatter plots of fish abundance and vegetation density across aquatic plant types can be seen in Figure 7.

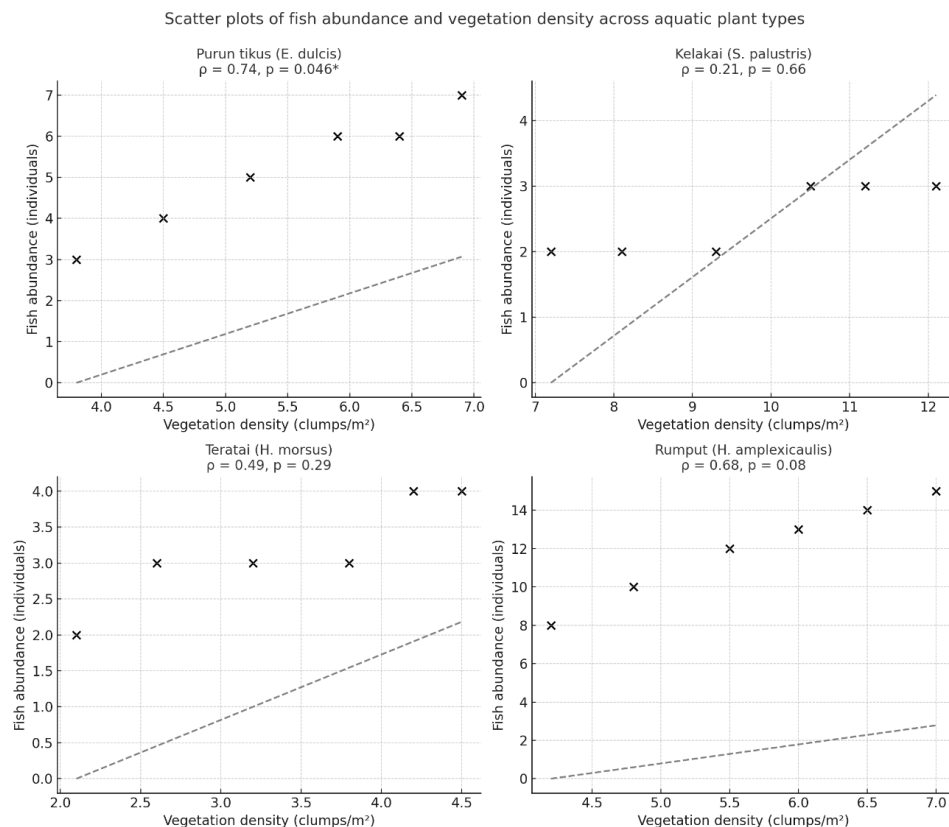


Figure 7. Scatter plots of fish abundance and vegetation density across aquatic plant types

The pattern is illustrated in the graph in Figure 7, which shows that the strength of the relationship between vegetation density and fish abundance varies between aquatic plant species, indicating that the structure and position of vegetation play an important role in determining fish habitat preferences. *Eleocharis dulcis* and *Hymenachne amplexicaulis* show a strong, almost linear positive relationship, indicating that clumped vegetation along riverbanks provides an ideal habitat structure for fish. On the other hand, although *Stenochlaena palustris* grows quite abundantly at some points along the riverbank, fish abundance remains low, possibly because the shape of the vegetation provides less protection or the environmental conditions are less than optimal. Meanwhile, *Hydrocharis morsus*, which grows in the middle of the river, shows a moderate frequency of fish presence, indicating that vegetation in this area still plays a role, although not as effectively as vegetation on the riverbank. Overall, this graph confirms that it is not only density, but also the structure and position of vegetation that determines fish abundance; clumped vegetation on the riverbank has proven to be most influential in providing shelter, food sources, and spawning areas for species such as *Anabas testudineus*, *Channa striata*, and *Belontia hasselti* in this wetland habitat.

Based on the above data, it is concluded that at least five fish species were found from fishing in the river. These fish are associated with one another. As demonstrated in previous studies (Nicolas et al., 2010; Milardi et al., 2018; Murray et al., 2018; Itsukushima, 2023), association patterns are influenced by tidal timing, indicated by the presence or absence of river currents. Aquatic vegetation also influences the distribution patterns of several fish species, not only in lakes (Giacomazzo et al., 2023), swamps (Dharmono et al., 2022), and deltas (Christman et al., 2023), but also in rivers. Naturally, these conditions are not independent of human activities (Xiong et al., 2023; Fajeriadi et al., 2024b). The location of the flow, which is a branch of the river, was created with the purpose of irrigation to supply water to local agriculture and plantations. Therefore, to maintain optimal irrigation for agriculture and plantations, the river is routinely cleaned at least once a year. This also causes the fish population to disperse at certain times, as they are not distributed by aquatic vegetation, most of which is also removed from the river. However, based on observations, the fish population in this area will continue to grow as it serves as a connection between the main river and the agricultural and plantation areas, evidenced by fish activity also being observed in rice fields, particularly the species *Anabas testudineus* and *Channa striata*.

The association between aquatic vegetation and fish has also been widely reported in various tropical aquatic ecosystems. Ismail et al. (2018) showed that moderate vegetation density can increase fish diversity, growth, and reproduction in the Perak River Malaysia, while Giacomazzo et al. (2022) found that submerged vegetation density is positively related to fish species diversity and abundance, but decreases under high turbidity conditions in Lake St. Pierre (Québec, Canada). Research by Dharmono et al. (2022) in the swamp lands

of South Kalimantan Indonesia confirmed the important role of aquatic vegetation as spawning and nursery grounds for fish fry. On the other hand, a study by Mramba and Kahindi (2023) showed that water quality, including dissolved oxygen levels, turbidity, and pH, is directly correlated with fish production and health in Dodoma Tanzania, while Adeogun et al. (2024) showed that habitat and micro-niche preferences also influence the accumulation of contaminants in fish tissue in Nigeria. Overall, these findings confirm that vegetation structure and environmental quality are key determinants in the formation of tropical freshwater fish communities, consistent with the results of this study showing that variations in vegetation density and hydrological conditions play an important role in fish abundance and distribution in riverine wetland habitats.

This finding can serve as contextual material in the field of biology. Not only in schools, but biology programs and biology education at universities also study materials related to this finding, including zoology, animal behavior science, ecology, and environmental biology. This finding can serve as initial data for developing teaching methods, such as conducting field-based learning or research site visits, or developing it as a printed or digital learning resource. Some advantages of developing learning resources based on local research data compared to those compiled from literature studies can be examined in Table 3.

Table 3. Comparison of learning resources based on local potential and literature studies

Aspects	Learning resources		Researchers
	Based on local potential	Based on literature studies	
Contextuality	High – in line with the real environment of students.	Low – often general and not locally specific.	Wilujeng et al. (2019); Yani et al. (2021)
Student engagement	More active through direct observation and field activities.	Tends to be passive, only reading and understanding the text.	Fitriani et al. (2022); Cahayani & Utami (2025)
Integration of knowledge	Enables integration of various fields.	Limited to a specific theory or topic.	Suryani et al. (2021); Kaspul et al. (2024)
Skill development	Supports scientific skills such as observation and data analysis.	Emphasizes conceptual understanding.	Fahmi et al. (2021); Fajeriadi et al. (2024a)
Meaningful learning	High because it is close to everyday life.	Sometimes less relevant to learners.	Zaini et al. (2020); Azhari et al. (2024)
Attractiveness	More interesting, in line with real phenomena in the field.	Less interesting if not connected to a real-world context.	Irwandi & Fajeriadi (2019); Nanda & Ulfa (2024)

The ecological findings from this study can be transformed into contextual teaching materials for biology education. For example, student field worksheets can guide learners to measure vegetation cover, record fish species caught, and analyze correlations using simple statistical tools such as Spearman's rho. In addition, digital learning modules can visualize fish movement patterns under different tidal conditions using interactive simulations. This application encourages discovery-based learning and connects ecological theory with authentic environmental contexts.

Learning resources based on local potential offer far greater contextual advantages than those derived from literature reviews. Linking learning materials directly to the environment surrounding students makes the learning process more relevant, meaningful, and easy to understand. This method also encourages active participation through field activities, direct observation, and scientific practices, which help in the development of scientific skills such as observation, measurement, data processing, and drawing conclusions. Furthermore, this approach allows for the integration of subjects such as zoology, ecology, and environmental biology, making learning more integrated and contextual, in line with the principles of environment-based education.

Theoretically, this approach, which relies on local potential, is in line with constructivist theory, which emphasizes the importance of real-life experiences in the knowledge-building process. Learning resources derived from local research provide students with the opportunity to actively construct their knowledge through direct experience, rather than simply receiving information from books. On the other hand, learning resources derived from literature reviews, although important in reinforcing basic concepts, often fail to spark deep learning interest unless they are linked to the surrounding context. Therefore, learning resources based on local potential not only enrich the learning experience but also bridge the gap between theory and reality, supporting more applied biology education.

4. Conclusion

This study found a distinctive ecological pattern in fishing activities in Karang Indah Mandastana Village, where fish species associations are influenced by tidal fluctuations, the presence of river currents, and aquatic vegetation types, with spatial and temporal separation between *Anabas testudineus* and two *Rasbora* species. A total of 162 individuals from five species were recorded, with *Anabas testudineus* showing the highest relative abundance (67.9%) and found at all observation points, while *Rasbora aurotaenia* (13.0%) and *Rasbora argyrotaenia* (7.4%) dominated during stronger currents. Vegetation clustered along riverbanks was found to support higher fish abundance, particularly *Eleocharis dulcis* ($\rho = 0.74$, $p = 0.046$) and *Hymenachne*

amplexicaulis ($\rho = 0.68$, $p \approx 0.08$), indicating a significant positive relationship between vegetation density and fish presence. This ecological interaction suggests that habitat structure and hydrological variation together determine fish community composition, supported by behavioral adaptations such as the migration of *A. testudineus* to calmer paddy waters during high tide. Meanwhile, human activities such as irrigation management also influenced seasonal fish distribution. The limitations of this study include a narrow study area, limited observation duration, and the absence of comprehensive water quality analysis and vegetation identification. Nevertheless, the quantitative data obtained provide an initial reference for ecological monitoring and community-based management of river fish resources. For further development, it is recommended to conduct research with a broader location and time scope, a quantitative approach to species association, and the utilization of research results as a contextual learning resource in biology education.

Author Contributions

All authors have equal contributions to the paper. All the authors have read and approved the final manuscript.

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Declaration of Conflicting Interests

The author declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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