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Fish Diversity in the Middle Part of Klawing River, Purbalingga Regency, Central Java Province

Keanekaragaman Ikan di Bagian Tengah Sungai Klawing, Kabupaten Purbalingga, Jawa Tengah

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ABSTRAK

Penelitian tentang keanekaragaman spesies ikan di bagian tengah Sungai Klawing, Kabupaten Purbalingga, Propinsi Jawa Tengah, bertujuan untuk menganalisis keaneka ragaman spesies ikan di bagian tengah Sungai Klawing. Metode survey diterapkan untuk pengambilan data primer selama bulan April-Juni 2022. Pengambilan sampel ikan secara langsung dilakukan di 3 stasiun di bagian tengah Sungai Klawing. Pemilihan stasiun pengambilan sampel disesuaikan dengan aktivitas budidaya ikan, pemukiman warga dan kemudahan akses. Stasiun 1 terletak di Desa Onje Kecamatan Mrebet, stasiun 2 terletak di Desa Slinga, dan Stasiun 3 terletak di Desa Lamongan. Kecamatan Kaligondang. Hasil penelitian menunjukkan bahwa di bagian tengah Sungai Klawing secara total tertangkap sebanyak 707 ekor, terdiri dari 23 spesies, dan 12 famili. Famili Cyprinidae mendominasi seluruh sampel. Indeks keaneka ragaman tertinggi pada stasiun 2 yaitu 1,94 dan stasiun 3 yaitu 1,99. Keaneka ragaman terendah di stasiun 1 dengan nilai yaitu 1,609. Indeks dominansi tertinggi stasiun 1 (0,26) dan terendah di stasiun 2 (0,18), serta di stasiun 3 (0,198). Indeks keseragaman tertinggi di stasiun 1 (0,73), dan stasiun 2 (0,76). Indeks keseragaman terendah pada stasiun 3 (0,68).

Kata Kunci: *Keanekaragaman, dominansi, keseragaman, Sungai Klawing, Kabupaten Purbalingga.*

ABSTRACT

Research on the diversity of fish species in the middle part of the Klawing River, Purbalingga Regency, Central Java Province, dealt with exploring the diversity of fish species in the middle part of the Klawing River. A survey method was applied to collect primary data from April-June 2022. Direct fish sampling was carried out at 3 stations in the middle part of The Kawing River. The stations were chosen based on fish farming activities, domestic areas and accessibility. Stations 1, 2, and 3 were located in Onje Village of Mrebet District, in Slinga and in Lamongan Villages of Kaligondang District, respectively. The results showed that a total of 707 individuals were sampled, consisting of 23 species and 12 Familia. Cyprinids dominated the total samples. Diversity indexes were 1.94 and 1.99 in stations 2 and 3, respectively. The diversity index in station 1 was 1.61. Dominance indexes were 0.26, 0.18, and 0.198 in stations 1, 2, and 3, respectively. Evenness indexes comprised 0.73 and 0.76 in stations 1 and 2, respectively. However, the evenness index in station 3 was 0.68.

Keywords: diversity, dominance, evenness, indexes, Klawing River, Purbalingga Regency.

Introduction

Klawing River is part of Serayu watershed (DAS), located in Purbalingga Regency, Central Java Province, running along 55.5 km (Pramono *et al.*, 2018). Klawing River crosses the districts of Bobotsari, Mrebet, Bojongsari, Purbalingga, Kaligondang, and Kemangkon in Purbalingga Regency. Large tributaries include the rivers of Pelus, Berem, Ponggawa, Peguling, Lebak, Kajar, Rumbling, Lemberang, Gintung, Paingen, Soso, Laban, and Tungtung. As an ecosystem, river ecosystem becomes a habitat for aquatic organisms strongly influenced by the surrounding environment (Sari *et al.* 2020).

Rivers were furthermore source of water for the community, being for various purposes and daily activities, such as household, agriculture, industry, mineral mining, and other uses (Suryaningsih *et al.* 2012), and tourism (Emmanuel and Modupe, 2010; Hossain *et al.*, 2012; Zuliyanti and Cahyaningrum, 2022). Water pollution frequently occurs due to anthropogenic impacts such as industrial waste, urbanization, global warming, and agricultural intensification (Altaf *et al.* 2015). Community activities in the middle part of the Klawing River included sand mining, plants, agriculture, and fisheries. A dam, called Slinga dam, in Slinga Village, Kaligondang District, Purbalingga Regency, was constructed on Klawing River and used for irrigation and tourism. Dam construction affected the diversity of fish species (Limbu *et al.*, 2020). Kartamihardja (2019) stated that the existence of a dam changed the water ecosystem, from previously flowing into stagnant water and subsequently affecting aquatic biota structure, including fish community. However, the use of unfriendly environmentally fishing gear (Britton *et al.* 2022), habitat degradation (Arantes *et al.* 2018), and diluted oxygen, current velocity, and pH (Adhikari *et al.* 2021) would affect fish diversity.

Several studies on the diversity of fish species in the Klawing River were carried out and collected 7 Familia, 13 genera, and 13 species. One of them was an introduced species, namely gourami (*Oshpronemus gouramy*), and an invasive species, namely broomstick fish (*Hypostomus plecostomus*), and the rest were native fish species of the Klawing River, Purbalingga Regency (Pramono *et al.* 2018).

Gunara and Rukayah (2019) discovered 23 species in the Klawing River. Meanwhile, Suryaningsih et al (2012) found 18 species. Fish diversity was one of the aquatic resources, and it was required to know the economic value to increase community income around the riverbanks (Mardani and Yusurum Jagau, 2013). Aquatic resources should be managed sustainably (Chessman, 2013). Shrestha (2017), parallelly stated that endangered fish should be conserved. Information on fish species diversity in Klawing River remained restricted. There was necessary research on fish species diversity in the Klawing River as additional data. Therefore, the purpose of this study was to provide information on fish species diversity in the middle part of the Klawing River. Moreover, all data would be required to maintain and support the sustainability of fish resources in the Klawing River.

Materials and Methods

Research Sites

This research was conducted during April-June 2022 in the middle part of Klawing River, Purbalingga Regency, Central Java Province. Samples were collected from 3 stations, i.e., station 1 was located in Onje Village of Mrebet District; station 2 was located in Slinga Village of Kaligondang District; and station 3 was in Lamongan Village of Kaligondang District. Distribution of the 3 stations along Klawing River was plotted in a map as seen in Figure 1. Maps of the 3 Sampling Stations (i.e Onje, Slinga, and Lamongan Villages) in the Middle Part of Klawing River, Purbalingga Regency, Central Java Province.Figure 1.

Each sampling site/station, as described in Table 1, showed some land characteristics and water qualities. These stations were chosen based on fish farming activities, domestic areas, and accessibility. Domestic areas featured areas where people inhabited. Accessibility included a footpath to facilitate collecting fish from fisherman boats.

Data Collection

A research method operated a survey method in collecting fish samples (Notoadmodjo, 2002). Fish were sampled twice a month, during the day and the night, in given stations by pole and line fishing, trapping, and gill nets of mesh sizes of ¾" inner wall and 2" outer wall, with the assistance of local fishermen. Fish from each station were separately stored alive in an ice box, then transported to the laboratory for further analysis. Laboratory analysis consisted of weighing (mg), measuring total and standard lengths (mm), identifying species level, dissecting, and weighing gonads, livers, and visceral.

Fish Identification

Fish identification was based on morphological characteristics and was subsequently compared with identification books of Kottelat *et al.* (1993), fishbase.org, fish inventory research hitherto in Klawing River, e.g., by Suryaningsih *et al*. (2012), and Suryaningsih *et al*. (2018).

Water Quality

In parallel with fish sampling, water qualities were measured, i.e., dissolved oxygen (DO-meter), depth and transparency (Secchi disk), pH (pH-meter), water temperature (thermometer), and current velocity (floating plastic bottle). These water quality parameters were checked *in situ*.

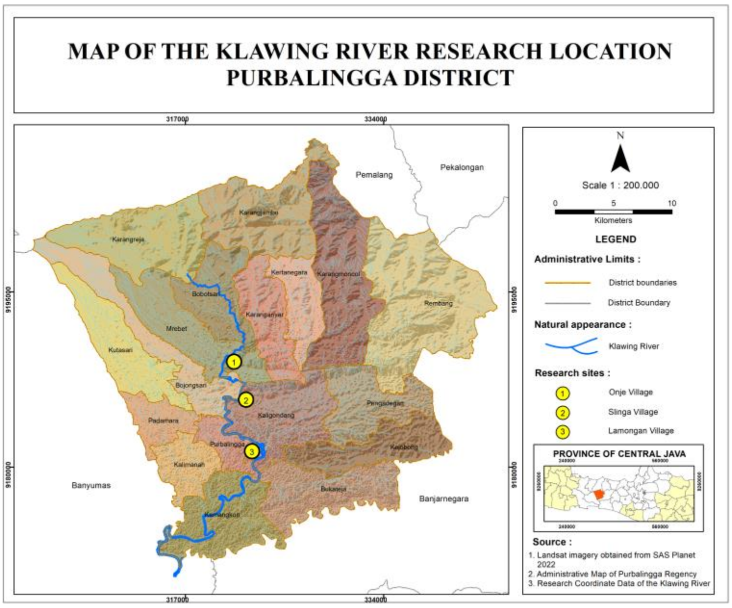

Figure 1. Maps of the 3 Sampling Stations (i.e Onje, Slinga, and Lamongan Villages) in the Middle Part of Klawing River, Purbalingga Regency, Central Java Province.

Data Analysis

Diversity Index

The Shannon-Wiener diversity index was used to determine the diversity of a species of a taxon in a formula as follows:

$$H = -\Sigma p\ i * \ln(p\ i)$$

where: Σ: a greek symbol of "sum"

ln: natural log;

p i: the proportion of the entire community made up of species i

The higher the value of H, the higher the diversity of species in a particular community. The lower the value of H, the lower the diversity. A value of H = 0 indicates a community that only has one species (Zach, 2021)

Table 1. Description of Sampling Stations in the Middle Part of Klawing River, Purbalingga Regency, Central Java Province.

Sampling Stations	Coordinates	Characteristics	Water Quality
Onje	7°20'9'' S, 109°22'16'' E	Small fast-growing mimosoid, coconut, bamboo, and bushes trees populated river periphery; Some fish ponds irrigated from Klawing River; Waters used for daily activity, such washing, bath; Substrate: sand and small gravel.	DO: 7.6-7.9 mg/L Transparency: 30-42 cm Depth: 1.43-1.8 m pH: 7.81-7.90 Temperature: 27-28 °C Current velocity: 8-12 m/s
Slinga	7°21' 35'' S, 109°23'6'' E	Small fast-growing mimosoid, coconut, bamboo, and bushes trees populated river periphery; Some fish ponds irrigated from Klawing River; Waters used for daily activity, such washing, bath; River tour, rafting, fishing games; Dam and sand mining; Substrate: sand and small gravel.	DO: 8.2-8.4 mg/L Transparency: 28-40 cm Depth: 2.2-3.11 m pH: 7.9-8.39 Temperature: 28-30 °C Current velocity: 3-8 m/s
Lamongan	7°24'23' S, 109°24'7'' E	Small fast-growing mimosoid, coconut, bamboo, and bushes trees populated river periphery; Some fish ponds irrigated from Klawing River; Waters used for daily activity, such washing, bath, and sand mining; Substrate: sandy and muddy.	DO: 8.3-8.5 mg/L Transparency: 30-40 cm Depth: 2.8-3.2 m pH: 7.94-8.22 Temperature: 29-30 °C Current velocity: 5-7 m/s

Evenness Index

Shannon Equitability Index was to measure the evenness of species in a community. The term "evenness" referred to how similar the abundances of different species were in the community.

Denoted as EH, this index was calculated as:

EH = H / ln(S)

where:
H: The Shannon Diversity Index
S: The total number of unique species
EH value ranges from 0 to 1 where 1 indicates complete evenness (Zach, 2021).

Dominance Index

This index was determined as Simpson's dominance index (Magurran, 1988; Thukral *et al.* 2019),

$$D = \sum_i p_i^2$$

where: p_i = species proportion, $p_i = x_i / N$; N = number total of fish

Results and Discussion

Fish identification during sampling in this study, in the middle part of the Klawing River, 707 individuals were collected, consisting of 23 species belonging to 12 Familia. The fish covered *Oxyeleotris marmorata*, *Anguila bicolor*, *Aplocheilus panchax*, *Hemibagrus nemurus*, *Colossoma macropomum*, *Oreochromis niloticus*, *Amphilophus trimaculatus*, *A. labiatus*, *Parachromis managuensis*, *Pangio kuhlii*, *Barbodes binotatus*, *Osteochilus vittatus*, *Systomus rubripinnis*, *Rasbora argyrotaenia*, *Barbonymus balleroides B. gonionotus*, *Labiobarbus leptocheilus*, *Hampala macrolepidota*, *Hypostomus plecostomus*, *Mastacembelus armatus*, *Nemacheilus pfeifferae*, *Trichopodus trichopterus*, and *Osphronemus gourami* (see Table 2). The biggest number of individuals was lifted from station 3 (Lamongan Village), i.e., 287 individuals. From station 1, only 191 individuals were sampled. This was due to the width and depth of the river. Table 2 presented *Oreochromis niloticus*, *Barbonymus balleroides*, and *Hypostomus plecostomus* that were abundantly caught, i.e, 145, 203, and 119 individuals, respectively. Nevertheless, *Anguila bicolor*, *Amphilophus trimaculatus*, *Trichopodus trichopterus*, and *Osphronemus gouramy* were rarely sampled, 1 individual in each station. Based on Familia, Eleotrid represented 0.58%, Anguillid 0.14%, Aplocheilid 0.28%, Bagrid 1.27%, Characid 0.28%, Cichlid 21.67%, Cobitid 0.42%, Locariid 16.86%, Mastacembelid 0.14%, Nemacheilid 7.93%, Oshpronemid 0.14%. The most abundant family was Cyprinid 50.28% (Figure 2).

The high number of individuals in *O. niloticus*, *B. balleroides*, and *H. plecostomus*, should be considered. These species represented Invasive Alien Species (IAS) that developed in the middle of Klawing River. As Ricciardi (2013) described, in general, the more species introduced to an area, the more that become established. Such species have the potential to spread over long distances. Kour et al (2014), additionally, revealed that *O. niloticus* with its wide environmental tolerance, high reproductive rate, rapid population growth and ease of cultivation, rendered it highly invasive, with considerable potential for becoming a pest in aquatic environments where it was introduced. The risks of *O. niloticus* introduction should therefore be rigorously evaluated and weighed against the potential socio-economic benefits. The fish diversity index at station 3 (Lamongan Village) was the highest (1.991), followed then with station 2 (Slinga Village) being 1.940 and station 1 (1.609), as presented in Table 3. According to Zach (2021), the three stations were categorized as medium based on the results of the Shannon-Wiener diversity indexes. These indicated that the

Table 2. Number of Individual Representing Species and Familia Caught in the Middle Part of Klawing River, Purbalingga Regency, Central Java Province, according to Sampling Stations.

Familia	**Species**	**Number of Individual – Stations**			
		Onje	**Slinga**	**Lamongan**	**Total (ind.)**
Eleotridae	*Oxyeleotris marmorata*	0	0	4	4
Anguillidae	*Anguila bicolor*	0	0	1	1
Aplocheilidae	*Aplocheilus panchax*	0	0	2	2
Bagridae	*Hemibagrus nemurus*	2	6	1	9
Characidae	*Colossoma macropomum*	2	0	0	2
Cichlidae	*Oreochromis niloticus*	18	32	95	145
	Amphilophus trimaculatus	0	1	0	1
	Parachromis managuensis	0	0	4	4
	Amphilophus labiatus	0	0	3	3
Cobitidae	*Pangio kuhlii*	0	0	3	3
Cyprinidae	*Barbodes binotatus*	0	1	1	2
	Osteochilus vittatus	16	32	15	63
	Systomus rubripinnis	15	3	9	27
	Rasbora argyrotaenia	0	4	3	7
	Barbonymus balleroides	80	55	68	203
	Labiobarbus leptocheilus	9	4	32	45
	Hampala macrolepidota	0	3	0	3
	Barbonymus gonionotus	0	4	1	5
Loricariidae	*Hypostomus plecostomus*	48	62	9	119
Mastacembelidae	*Mastacembelus armatus*	0	0	1	1
Nemacheilidae	*Nemacheilus pfeifferae*	0	22	34	56
Oshpronemidae	*Trichopodus trichopterus*	1	0	0	1
	Osphronemus gourami	0	0	1	1
Total	**23**	**191**	**229**	**287**	**707**

ecosystem in the middle part of the Klawing River did not experience any stress. Special attention should be paid to station 3, where the highest index was found. This was presumably due to the confluence of river flows, resulting in more available sources of food and nutrients. This condition is the beneficial offers of the middle part of Klawing River as a comfortable habitat for potential IAS, for example, *Oreochromis niloticus*, *Hypostomus plecostomus*, *Amphilophus trimaculatus*, *Amphilophus labiatus*, *Parachromis managuensis*, and *Colossoma macropomum*. The presence of IAS posed a serious threat to the diversity of native and endemic fish species (Sentosa and Hedianto, 2019). According to Kottelat *et al.* (1993), a wider area would present a greater variety of habitats than a smaller one, meaning that the longer and wider the river size, the more fish would inhabit. In a previous study, Suryaningsih *et al.* (2018) stated that the diversity index in the upstream Klawing Purbalingga River was 1.051, the middle part was 1.691 and the downstream part was 1.97. They reported moreover that Cyprinid dominated at each research station, principally *Barbonymus balleroides*.

Cyprinid was known as fast and free-swimming fish and usually preferred areas with rocky and flowing waters (Maharudin *et al.*, 2021), adaptable to swim against the current (Dwirastina and Atminarso, 2021). This condition was conformable with the middle part of Klawing River. Muhammad *et al.* (2020) reported that high diversity of fish species in the Tembesi River, Bathin VIII

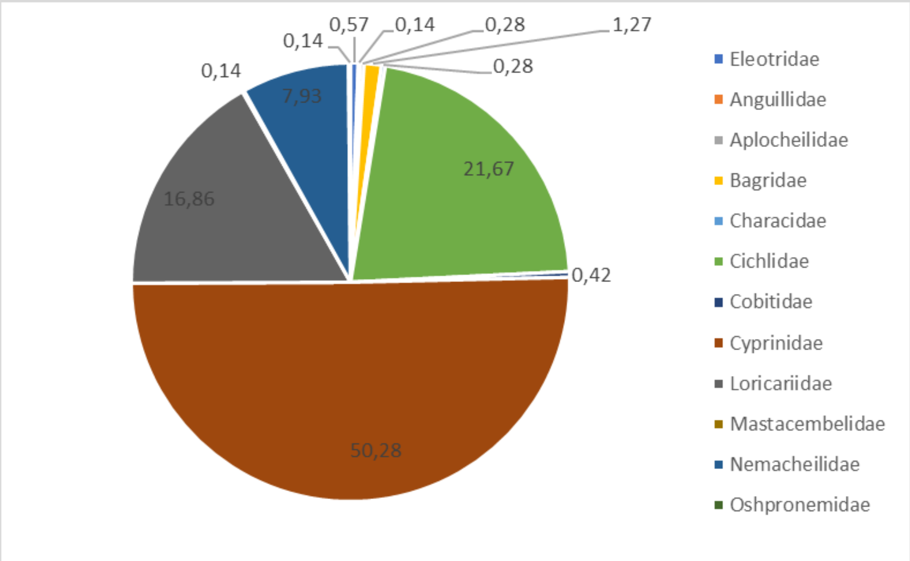

Figure 2. Percentage of familia sampled in the middle part of the Klawing River, Purbalingga Regency, Central Java Province

District, Sarolangun Regency, Jambi Province, was detected in shallow water with aquatic plants.

Odum (1996) conveyed that the evenness index (E) comprised of three qualifications, i.e, E≤0.4 = low population, 0.4<C≤0.6 = medium population, and E≤0.6 = high population. The highest E was found in station 2 (Slinga Village) being 0.756; in station 1 (Onje Village) 0.732, and in station 3 (Lamongan Village) was 0.676. Based on Odum (1996), stations 1 and 2 could be included as having high population evenness. Nonetheless, E in station 3 was moderate. Stations 1 and 2 were characterized with similar substrates (Table 1), i.e., small and large rocks for the substrates. According to Krebs (1989), the smaller the E, the smaller the E of a population. The greater the E, the greater the E of a population.

The dominance index (D) obtained for stations 1, 2, and 3, in the middle part of the Klawing River, were 0.263, 0.181, and 0.198, respectively (Table 3). There was not any dominated in the middle of the Klawing River since D closed to 0 (zero). The existence of the Slinga dam (around to station 2) possibly caused ecosystem and habitat changes. This would certainly impact biota inhabiting two ecosystems (upstream and downstream segments). D normally determined the dominant genus in a community with a criterion D closed 0 (zero). If D relatively closed to 1, a species could dominate the others (Odum, 1996). Bahiyah *et al.* (2013) research on Cyprinid, in Serayu River, revealed that *Barbonymus balleroides* was dominant species. This species represented positive rheo-taxis or fast-flowing fish, being able to live in a

Table 3. Dominance, Evenness, and Diversity Indexes of Fish Caught in the Middle Part of Klawing River, Purbalingga Regency, Central Java Province, according to Sampling Stations.

Indexes	Sampling Stations		
	Onje	**Slinga**	**Lamongan**
Dominance	0,263	0,181	0,198
Evenness	0,732	0,756	0,676
Diversity	1,609	1,940	1,991

temperature range of 25-30^{0}C. The middle part of Klawing River ecosystem was relatively steady. However, the D index related to nutrients and feed.

Water temperature in the middle part of Klawing River, reflected normal range aquatic biota life, since they ranged from 27-30^{o}C. According to water quality standards, from government rules (Peraturan Pemerintah Nomor 82 Tahun 2001, 2001), water temperature criteria for biotic life were 22-28^{o}C. Water temperature, supporting feeding and growth of fish, ranged 21-30^{0}C (Buckel *et al.*, 1995). Water temperature patterns were influenced by anthropogenic factors, e.g., human activities such as heat waste, factory cooling water, and deforestation, causing loss of protection of water bodies (Barus, 2004).

Dissolved oxygen DO in the current study area oscillated between 7.6 to 8.5 mg/L, being remained suitable for aquatic biota growth. DO was an important parameter for all organisms, including fish. The transparency of the middle part of Klawing River is undulated by around 28-40 cm. The difference in transparency made different characteristics of each station and could be influenced by the amount of mud sediment, other particles, and domestic or factory wastes. The current velocity in the Klawing River, Purbalingga Regency, ranges from 3-22 m/s. Current velocity, ranging around 3-12 m/s, tended to be fast to moderate. The difference in current velocity is due to the more intensity of rain. River structure and other factors, such as seasons, correspondingly determined current velocity. The pH, in the middle part of the Klawing River, remained comfortable, ranging from 7.81-8.22, and were in accordance with the finding of Suryaningsih *et al.* (2018) being 6.9-8. This pH was principally a determinant for water quality, since helping chemical processes of water (Andria and Rahmaningsih, 2018).

Depth in the middle part of the Klawing River, varied from 1.43 to 3.2 m. The lowest depth was in station 1, and the deepest was in station 3. The depth of the water affected the number of organisms, light penetration (transparency), and the distribution of plankton. Water depth represented a necessary factor in activities for organisms requiring low to a sufficient depth, changes in water quality, e.g., changes in physical and chemical parameters. Changes in these parameters could be caused by disposal activities, domestic and industrial waste and agriculture, into a body of water (Koniyo *et al.*, 2017).

Conclusion

Based on the results of the study, it could be concluded that the fish caught were 707 individuals, consisting of 23 species, 12 Familia. The diversity index ranges from 1.609-1.991, being categorized as moderate. The ecosystem in the study area did not experience significant pressure. The evenness indexes were between 0.676 and 0.756. The highest dominance index varied from 0.181 to 0.363. Cyprinid dominated in the middle part of the Klawing River. Information about the diversity of fish species was very indispensable as a basic material in order to maintain the diversity of native fish species of the Klawing River, for its sustainability.

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References

Adhikari, A., Limbu, J. H., Pathak, S. 2021. Fish diversity and water quality parameters of Mechi River, Jhapa, province no. 1, Nepal. *Borneo Journal of Resource Science and Technology*, 11(1): 24–34. https://doi.org/10.33736/bjrst.2954.2021

Altaf, M., Javid, A., Khan, A. M., Hussain, A., Umair, M., Ali, Z. 2015. The Status of Fish Diversity of River Chenab, Pakistan. *J. Anim. Plant Sci*, 25(3): 564–569.

Andria, A. F., Rahmaningsih, S. 2018. Kajian Teknis Faktor Abiotik pada Embung Bekas Galian Tanah Liat PT. Semen Indonesia Tbk. untuk Pemanfaatan Budidaya Ikan dengan Teknologi KJA. *Jurnal Ilmiah Perikanan Dan Kelautan*, 10(2): 95–105. https://doi.org/10.20473/jipk.v10i2.9825.

Arantes, C. C., Winemiller, K. O., Petrere, M., Castello, L., Hess, L. L., Freitas, C. E. C. 2018. Relationships between forest cover and fish diversity in the Amazon River floodplain. *Journal of Applied Ecology*, 55(1): 386–395. https://doi.org/10.1111/1365-2664.12967.

Bahiyah, D. D., Solihin, R., Affandi. 2013. Variasi genetik ikan brek (*Barbonymus balleroides* Val. 1842) sebagai dampak fragmentasi habitat di Sungai Serayu. *Jurnal Iktiologi Indonesia*. 13(2): 175-186.

Barus, T. A. 2004. Pengantar Limnologi. Studi Tentang Ekosistem Air Daratan. USU Press.165 hal.

Britton, J. R., Cucherousset, J., Dominguez Almela, V. 2022. Novel trophic subsidies from recreational angling transform the trophic ecology of freshwater fishes. *Journal of Applied Ecology*, 59(9): 2373–2385. https://doi.org/10.1111/1365-2664.14237.

Buckel, J. A., Steinberg, N. D., Conover, D. O. 1995. Effects of temperature, salinity, and fish size on growth and consumption of juvenile bluefish. *Journal of Fish Biology*, 47(4): 696–706. https://doi.org/10.1111/j.1095-8649.1995.tb01935.x.

Chessman, B. C. 2013. Do protected areas benefit freshwater species? A broad-scale assessment for fish in Australia's Murray-Darling Basin. *Journal of Applied Ecology*, 50(4): 969–976. https://doi.org/10.1111/1365-2664.12104.

Dwirastina, M., and Atminarso, D. 2021. Evaluation of the conditions of mamberamo river water with biomass and phytoplankton community approach. *Jurnal Ilmiah Perikanan Dan Kelautan*, 13(1): 38–47. https://doi.org/10.20473/jipk.v13i1.17565.

Emmanuel, L. O., and Modupe, O. O. 2010. Fish Diversity in Three Tributaries of River Ore, South West, Nigeria. *World Journal of Fish and Marine Sciences*, 2(6): 524–531.

Gunara, A. H., dan Rukayah, S. 2019. Manajemen Sungai Klawing Untuk Kelestarian Ikan Spesies Asli. *Florea: Jurnal Biologi dan Pembelajarannya*, 6(2): 88-96.

Hossain, M. S., Gopal Das, N., Sarker, S., Rahaman, M. Z. 2012. Fish diversity and habitat relationship with environmental variables at Meghna River estuary, Bangladesh. *Egyptian Journal of Aquatic Research*, 38(3): 213–226. https://doi.org/10.1016/j.ejar.2012.12.006.

Kartamihardja, E. S. 2019. Degradasi Keaneka ragaman Ikan Asli di Sungai Citarum Jawa Barat. *Warta Iktiologi*, 3(2): 1–8.

Koniyo, Y., Lamadi, A. 2017. Analisis Kualitas Perairan pada Daerah Pengangkapan Ikan Nike (*Awaous melanocephalus*). *Nikè:*

Jurnal Ilmiah Perikanan dan Kelautan. 5(1): 1-7.

Kottelat, M., Whitten, A. J., Kartikasari, S. N., Wirjoatmojo, S. 1992. Freshwater Fishes of Western Indonesia and Sulawesi: Ikan Air Tawar Indonesia Bagian Barat dan Sulawesi. Univ of New South Wales. 260p.

Kour, R., Bhatia, S., and Sharma, K. K. 2014. Nile Tilapia (*Oreochromis niloticus*) as a successful biological invader in Jammu (J&K) and its impacts on native ecosystem. *International Journal of Interdisciplinary and Multidisciplinary Studies (IJIMS)*, 1(10): 1-5.

Krebs, C. J. 1989. Ecology The Experiment Analysis of Distribution and Abundance. Harper and Row Publisher. New York. Magurran AE. 1988. Ecological Diversity and Its Measurement. New Jersey: Pricenton University Press.

Limbu, J. H., Bhurtel, B., Adhikari, A., Punam, Gc., Maharjan, M., Sunuwar, S. 2020. Fish Community Structure and Environmental Correlates in Nepal's Andhi Khola, Province No. 4, Syangja. *Borneo Journal of Resource Science and Technology*, 10(2): 85–92. https://doi.org/10.33736/bjrst.2510.2020.

Magurran, A. E. 1988. Ecological Diversity and Its Measurement. Princeton University Press.

Maharudin, Irianti, R., Zuhroh Z., S., Aulia Rahma, N., Puteri, N. A., Fajeriati, A. N. 2021. Keanekaragaman Jenis Ikan Familia Cyprinidae di Sungai Nagara Kecamatan Daha utara Kabupaten Hulu Sungai Selatan. Prosiding Seminar Nasional Lingkungan Lahan Basah. Lembaga Penelitian Dan Pengabdian Kepada Masyarakat, Universitas Lambung Mangkurat. 6(2): 6.

Mardani, A. M., and Yusurum Jagau, J. H. 2013. Inventarisasi Jenis Ikan Yang Tertangkap Di Beberapa Perairan Danau Ardan Di Wilayah Kecamatan Kamipang Kabupaten Katingan Kalimantan Tengah. *Enviro Scienteae*, 9: 85–99.

Muhammad, Syafrialdi, Hertati, R. 2020. Kenanekargaman Jenis-Jenis Ikan di Sungai Tembesi Kecamatan Bathin VIII Kabupaten Sarolangun Provinsi Jambi. *Semah: Journal Pengelolaan Sumberdaya Perairan*. 4(1): 1-12.

Notoadmodjo, S. 2002. Metodologi Penelitian Kesehatan. Rineka Cipta.

Odum, E. P. 1996 . Dasar-Dasar Ekologi. Edisi ketiga. Yogyakarta: Gadjah Mada University Press.

Omayio, D., and Mzungu, E. 2019. Modification of Shannon-Wiener Diversity Index towards Quantitative Estimation of Environmental Wellness and Biodiversity Levels under a Non-comparative Scenario. *Journal of Environment and Earth Science*. 9(9): 46-57.

Peraturan Pemerintah Nomor 82 Tahun 2001 tentang pengelolaan kualitas air dan pengendalian pencemaran air.

Pramono, T. B., Arfiati, D., Widodo, M. S., Yanuhar, U. 2018. Iktiofauna Di Hilir Sungai Klawing Kabupaten Purbalingga, Jawa Tengah. *Samakia*. 9(2): 65-69.

Ricciardi, A. 2013. Invasive Species. In book: Encyclopedia of Sustainability Science and Technology. Editors: R.A.Meyers. Publisher: Springer. DOI: 10.1007/978-1-4614-5755-8_10

Sari, T., Hertati, R., Syafrialdi. 2020. Studi Keanekaragaman Jenis-Jenis Ikan Di Sungai Batang Pelepat Kabupaten Bungo Propinsi Jambi. *Semah: Journal Pengelolaan Sumberdaya Perairan*, 4(1): 1–12. http://ojs.umb-bungo.ac.id/index.php/SEMAHJPSP.

Sentosa, A. A., Hedianto, D. A. 2019. Sebaran Ikan Louhan yang Menjadi Invasif di Danau Matano, Sulawesi Selatan. *LIMNOTEK Perairan Darat Tropis di Indonesia*, 26(1): 1–9.

Shrestha, J. N. 2017. Fish diversity of Triyuga River, Udayapur District, Nepal. *Our Nature*, 14(1): 124–134. https://doi.org/10.3126/on.v14i1.16452.

Sundari, N. 2014. Hubungan Perilaku Masyarakat dalam Memanfaatkan Air Sungai untuk Kebutuhan Mandi, Cuci, dan Kakus (MCK) di Desa Kuta Bate Kecamatan Beutong Kabupaten Nagan Raya. *Jurnal Geografi Nusantara*, 4(4): 1–62.

Suryaningsih, S., Sagi, M., Nitimulyo, K. H., Hadisusanto, S. 2012. Spawning aspects of javanese barb *Puntius orphoides* (Valenciennes, 1842) in Klawing River, Purbalingga, Central Java. *Jurnal Iktiologi Indonesia*.12(1): 35-48.

Suryaningsih, S., Sukmaningrum, S., Simanjuntak, S. B. I., Kusbiyanto. 2018. Diversity and longitudinal distribution of freshwater fish in Klawing River, Central Java, Indonesia. *Biodiversitas*. 19(1): 85-92.

Syafrialdi, M., Hertati, R. 2020. Keanekaragaman Jenis-Jenis Ikan di Sungai Tembesi Kecamatan Bathin VIII Kabupaten Sorolangun Provinsi Jambi. *Semah: Journal Pengelolaan Sumberdaya Perairan*, 4(1): 1–12. http://ojs.umb-bungo.ac.id/index.php/SEMAHJPSP.

Thukral, A. K., Renu Bhardwaj, R., Kumar, V., Anket Sharma, A. 2019. New indices regarding the dominance and diversity of communities, derived from sample variance and standard deviation. *Heliyon*, 5(12): 1-17.

Zach. 2021. Shannon Diversity Index: Definition & Example. https://www.statology.org/shannon-diversity-index/

Zuliyanti, A. R., and Cahyaningrum, W. 2022. Analisis Pemanfaatan Air Sungai Bagi Rumah Tangga di Bantaran Sungai Melawi Desa Sungai Ana Kabupaten Sintang. *Geo Khatulistiwa: Jurnal Pendidikan Geografi Dan Pariwisata*, 2(1): 35–51.