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Original Research Paper

Diversity of Fish Species as Bioindicators of Water Quality in The Cikapundung River, Bandung City

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Abstract: Human activity along the river impacts the aquatic environment from biotic and abiotic factors. One indicator that can reflectthe quality of the waters is fish diversity. Several studies have used fish diversity as a biological indicator to determine the quality of waters, such as lake and river waters. The purpose of this study was to determine the diversity of fish and also to determine the quality of water in the Cikapundung River, Bandung City. The method used in this study was a survey and exploration method, which involved collecting samples at five stations using umbrella traps, cast nets, and fishing gear in the morning and evening. The fish obtained were identifiedusing the Fish Identification Guidebook, and the number of each type was calculated. The biotic data obtained were processed using the Shannon-Weinerdiversity index (H'), Evenness index (E), Margalef Abundance index (Dmg), and Simpson Dominance index (C). In contrast, the abiotic data were sent to the water quality testing institution (LPKL). The study's results identified seven species from 5 families: Cyprinus sp., Ancistrus sp., Xiphophorus sp.,Barbodes sp. According to the Shannon-Weiner index, the diversity of fish species in the Cikapundung River in Bandung City is relatively moderate, with a value (H') of 1.55. The results of water quality measurements of the Cikapundung River from LPKL based on the class II water quality standards of PP RI Number 22 of 2021 show that the condition of the river is in the moderately polluted category.

Keywords: Bioindicators, Cikapundung River, diversity, fish, water quality.

Introduction

The Cikapundung River is the main water channel in the city center. This river serves as a raw water source for the PDAM of Bandung City, which has water pumping facilities in Dago Pakar, Dago Singa, and Badak Singa, as well as a source of hydroelectric power. Additionally, the Cikapundung River passes through several tourist destinations, such as Maribaya, Curug Dago, and the zoo (Halimatusadiah, 2014). Given its function, the Cikapundung River's existence needs attention. As in other major cities in Indonesia, the Cikapundung River in Bandung City also requires special attention regarding water quality.

Quality and environmental sustainability. Human activities, such as disposing of domestic and industrial waste directly into the river flow and other activities taking place in the riverbank area, can deteriorate water quality (Djiko et al., 2022). According to the information from the Directorate General of Pollution and Environmental Damage Control (Ditjen PPKL) in the Ministry of Environment and Forestry (KLHK) indicates that around 59% of rivers in Indonesia experienced severe pollution in 2020 (Mada et al., 2023). Therefore, sustainable efforts are needed to monitor and control river water pollution in accordance with

Government Regulation No. 22 of 2021 to ensure the quality and quantity of river water are maintained (Government of the Republic of Indonesia, 2021).

Stated that fish are biotic components that are highly vulnerable to changing environmental conditions; human activities, directly or indirectly, affect these environmental changes (Febrian et al., 2022). Polluted waters increase the concentration of heavy metals in the water, which eventually accumulate. Therefore, the environmental condition around the river area can be categorized into two factors: physical and chemical, both of which greatly influence the living conditions of fish in the aquatic ecosystem (Salim et al., 2017).

Several fish species are often used as biological indicators in assessing water quality conditions because fish can respond to environmental changes. Using bioindicators, we can anticipate natural conditions in an area or get an idea of the level of contamination (Khatri & Tyagi, 2015). Therefore, it is necessary to conduct research focused on the "Diversity of Fish Species as Bioindicators of Water Quality In The Cikapundung River, Bandung City". This research can promote the development of sustainable monitoring techniques through periodic assessments by analyzing water quality based on physical, chemical, and biological parameters.

Materials and Methods

Research time and location

The research was conducted from April 15 to June 24, 2023, at the Cikapundung River in Bandung City, West Java. Sampling was carried out at five predetermined stations with three repetitions.

Data collection methods

Data were collected directly through field surveys and interviews with local fishermen around the Cikapundung River. The collected data were divided into two aspects: (a) the types of fish found in the Cikapundung River and (b) environmental parameters (temperature, depth, current, clarity, TDS, pH, DO, COD, BOD5).

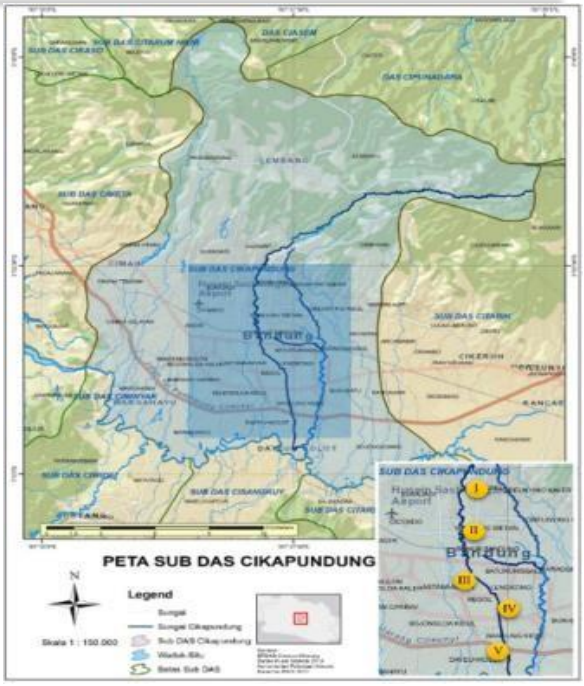

Figure 1. Map of research location points

Data analysis

This study's data analysis was descriptive, covering the level of species diversity, dominance, evenness, abundance, the correlation between environmental factors and diversity level, and the level of river water pollution.

Results and Discussion

Fish Species Diversity

Ninety-six fish were obtained, consisting of 5 families and seven species. At station I, nine fish from 4 species were obtained. At station II, five fish from 4 species were obtained. At station III, 11 fish from 4 species were obtained. At station IV, seven fish from 5 species were obtained. At station V, 64 fish from 7 species were obtained. The details of the total individual fish obtained can be seen in (Table 1).

Fish biodiversity can reflect the stability and complexity of an aquatic ecosystem. To measure the condition of a particular ecosystem by calculating the species diversity level, a diversity index can be used. A diversity index is a metric used in the process of measuring the level of life diversity related to the number of species present in a community.

Table 1. Total Fish Species Collected

Species	TDS	Temp.	Current	depth	pH	DO	COD	BOD5
Barbodes binotatus	**.718**	.444	**.811**	-.462	.410	-.237	**.667**	.205
Rasbora argyrotaenia	.354	.408	.559	-.707	.707	.000	.354	-.354
Xiphophorus hellerii	.289	.667	.000	.000	**.866**	**-.444**	.000	-.289
Cyprinus carpio	.154	.148	.162	**-.821**	.462	.289	-.154	**-.718**
Oreochromis niloticus	-.224	.000	.354	-.671	.447	.344	.224	-.447
Clarias gariepinus	**.718**	**.740**	.162	-.359	.821	-.395	-.051	-.410
Ancistrus cirrhosis	.410	.444	.081	-.616	.667	-.026	-.205	-.667

Table 2. Index value analysis

Index	Stations				
	I	II	III	IV	V
Shanon Wiener(H')	1.21	1.01	1.37	1.55	1.29
Dominansi (C)	0.33	0.24	0.26	0.22	0.38
Evenness (E)	0.62	0.52	0.71	0.80	0.66
Abundance (Dmg)	1.37	1.86	1.25	2.06	1.44

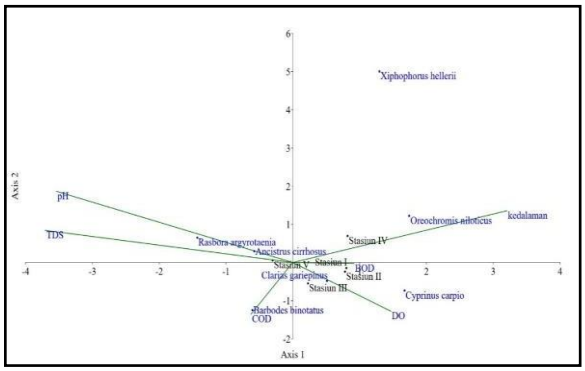

Figure 2. CCA graph of species with environmental parameters

CCA calculation is a correlation method between two variables in research. In the CCA analysis process, the variables consist of two types, namely dependent and independent (Hertika et al., 2020). Suheriyanto et al. (2019) also mentioned that CCA analysis can be used to measure the relationship between abiotic and biotic factors. In this study, the independent variables include depth, TDS, pH, DO, COD, and BOD, while the dependent variables include the fish species obtained. The level of correlation between species and environmental parameters can be seen in (Table 3).

Table 3. Diversity values and environmental parameters correlation

Famili	Species Name	Station					Total
		1	2	3	4	5	
Cyprinidae	1.*Cyprinus carpio*	4	2	3	2	5	16
	2.*Rasbora argyrotaenia*	-	-	-	-	5	5
	3.*Barbodes binotatus*	-	1	3	-	10	14
Poeciliidae	1.*Xiphophorus hellerii*	-	-	-	1	1	2
Cichilidae	1.*Oreochromis niloticus*	1	1	-	1	2	5
Clariidae	1.*Clarias gariepinus*	1	-	2	1	4	8
Loricariidae	1. *Ancistrus cirrhosus*	3	1	3	2	37	46
Total		**9**	**5**	**11**	**7**	**64**	**96**

Water quality index at five research stations

The environmental conditions are also considered an important factor involved in the diversity level of species inhabiting a particular habitat. The measurements of environmental parameters of the Cikapundung River at the research station can be seen in (Table 4).

Table 4. Environmental parameter index measurements

Parameter	Station				
	I	II	III	IV	V
Temp.(℃)	23-24	23-24	24	24	24

Depth (cm)	77-82	79-86	84-93	82-98	67-73
Current (m/s)	0.18-0.25	0.26-0.29	0.25-0.28	0.23-0.25	0.23-0.29
Transparency (cm)	41-44	44-45	45-48	43-50	41-49
pH	7,72-8,18	7,74-7,89	7,73-9,6	7,82-9,36	7,86-9,51
DO (mg/L)	5	4.3	3.6	3.6	4.1
BOD5 (mg/L)	6,34	12,24	11,57	11,35	8,37
COD (mg/L)	18,39	68,03	41,88	34,11	44,07
TDS (ppm)	72-109	87-115	98-154	117-145	121-151

Discussion Fish diversity

This study identified seven types of fish: *Cyprinus carpio*, *Barbodes binotatus*, *Rasbora argyrotaenia*, *Xiphophorus hellerii*, *Oreochromis niloticus*, *Clarias gariepinus*, and *Ancistrus cirrhosus*. The results of the diversity index calculation obtained at each research station can be ranked from highest to lowest diversity as follows: station IV, station III, station V, station I, and station II (Table 2). Husamah and Rahardjanto (2019) state that for the Shannon-Wiener diversity index, if (1<H'<3) the diversity is moderate, if (H'>3) the diversity is high, and if (H'<1) the diversity is low. Odum (1996) mentioned that if the dominance value (D>0.5) is high, there is a species that dominates, but if the dominance value approaches 0, there is no dominant species in the ecosystem. The measurement and calculation of the water quality index of the Cikapundung River in Bandung City, based on Indonesian Government Regulation No. 22 of 2021, indicate that the river is moderately polluted. However, several fish species still can be found, meaning the river environment still supports the life of organisms, mainly fish. This occurs because fish have a relatively high environmental tolerance.

The species most frequently obtained from the five research stations consist of three species: *Barbodes binotatus* with 14 individuals, *Cyprinus carpio* with 16 individuals, and *Ancistrus cirrhosus* with 46 individuals. *Barbodes binotatus* has a high environmental tolerance and is classified as a schooling fish (Eakins, 2023). This is one of the factors contributing to the large number of *Barbodes binotatus* found. Another species found in large numbers is *Cyprinus carpio* or common carp. This fish is an omnivore that easily finds food in the Cikapundung River due to the accumulation of organic waste on the surface and at the bottom of the water. Additionally, *Cyprinus carpio* inhabits warm waters with slow flows, such as rivers and lakes with good vegetation (Kerbs, 2007). Its high tolerance to environmental changes makes *Cyprinus carpio* found at every research station.

Ancistrus cirrhosus, locally known as "sapu - sapu" fish, was the most abundant species found among all the obtained species. It is called "sapu- sapu" due to its mouth shape, which resembles a sucker (inferior), feeding on layers attached to the surfaces of objects or vegetation. The primary food source for this fish is algae that grow on hard surfaces and food residues that settle at the river bottom (Qoyyimah et al., 2017). This fish belongs to the family Loricariidae, characterized by its hard outer skin and sucker-shaped mouth, making *Ancistrus cirrhosis* less prone to predators. Additionally, it is highly tolerant of extreme environmental changes (Puspitasari et al., 2021). The abundance index obtained at each station, ranked from highest to lowest, is as follows: station IV, station II, station V, station I, and station III. The abundance calculations for station I are 1.37 (low), station II 1.86 (low), station III 1.25 (low), station IV 2.06 (low), and station V 1.44 (low). The relationship between abundance and diversity indicates that a high diversity index value will also reflect a high abundance index value (Lestari et al., 2021).

The calculation of CCA (canonical correlation analysis) is a method for correlating two variables in research. In the CCA analysis process, the variables are dependent and independent (Hertika et al., 2020). Suheriyanto et al., (2019) also mentioned that CCA analysis can measure the relationship between abiotic and biotic factors. This study's independent variables include depth, TDS, pH, DO, COD, and BOD, while the dependent variables include the fish species obtained. The results of the calculations (Figure 1) show that the pH and TDS parameters correlate with *Rasbora argyrotaenia* and *Ancistrus cirrhosus*. The BOD and COD parameters are associated with *Cyprinus carpio* and *Clarias gariepinus*. The COD parameter is related to the fish species *Barbodes binotatus*,

and the depth parameter is related to *Oreochromis niloticus*. Each research station has characteristics that influence the presence of fish species. Stations I, II, and III have similar characteristics suitable for *Clarias gariepinus* and *Cyprinus carpio*. The characteristics of station IV are suitable for *Oreochromis niloticus*. The characteristics of station V are suitable for *Barbodes binotatus*, *Rasbora argyrotaenia*, *Oreochromis niloticus*, *Cyprinus carpio*, *Clarias gariepinus*, *Xiphophorus hellerii*, and *Ancistrus cirrhosus*.

The correlation calculation between current velocity, TDS, and COD has a high correlation value with the species *Barbodes binotatus*. This indicates a strong correlation between current velocity, TDS, and COD with the species *Barbodes binotatus*. The positive correlation value suggests that the higher the TDS, current velocity, and COD parameters, the more *Barbodes binotatus* are found. *Barbodes binotatus* has a tropical climate habitat, inhabiting the middle to deeper areas of flowing waters (Pratama et al., 2018). The pH and DO parameters have a high correlation value with the species *Xiphophorus hellerii*. The positive correlation between *Xiphophorus hellerii* and the pH parameter indicates that the higher the pH, the more *Xiphophorus hellerii* are found. This is related to the high environmental tolerance of *Xiphophorus hellerii*, which prefers waters with a pH level of 7-8 (Mari, 2021).

Cyprinus carpio has a high correlation value with water depth and BOD. The negative correlation indicates that the shallower the water depth and the lower the BOD level, the higher the likelihood of finding *Cyprinus carpio*. One characteristic of *Cyprinus carpio* is its ability to survive and tolerate various conditions (Page, 2011). According to Luo et al., (2019), *Cyprinus carpio* can feed on insects at the water surface but generally inhabits deeper water areas. *Cyprinus carpio* also prefers large bodies of water with slow currents and muddy bottom sediments (Eakins, 2023).

The results of the correlation analysis show that TDS and temperature parameters have a high correlation with the species. The positive correlation value indicates an increase in independent and dependent variables. The higher the TDS and temperature parameters, the more likely *Clarias gariepinus* will be found. Fapohunda et al. (2022) state that *Clarias gariepinus* tolerates extreme environmental conditions, where water parameters have only a minor impact.

Water quality index at five research stations

Measurements of acidity levels in the Cikapundung River show that the pH ranges from 7.7 to 9.3 (Table 4). According to Kamalia and Sudarti (2022), changes in water pH values can be caused by industrial waste directly entering waterways such as rivers. This is evidenced by the high pH value at station III, caused by domestic waste directly discharged into the river. Moreover, because station III has the fastest water flow among other station locations, the pH at this location changes very quickly. However, the pH values along the research location still meet the Indonesian Government Regulation No. 22 criteria of 2021. All fish species collected at the research stations, ranging from *Cyprinus carpio* to *Ancistrus cirrhosis*, can adapt to conditions with pH in the neutral to alkaline range (Tambunan, 2018).

Dissolved oxygen (DO) levels obtained from measurements at each research station indicate that river water conditions have a four mg/L DO level. This result can be interpreted based on the river water quality standards in Indonesian Government Regulation No. 22 of 2021. The highest result obtained from field measurements is 5 mg/L. The lowest DO levels were found at stations III and IV, with values of 3.6 mg/L (Table 4). This is due to the influence of pollution loads from both industrial and domestic waste around stations III and IV.

The highest water flow velocity can be found at stations II and III, ranging from 0.25 to 0.28 m/s (Table 4). Meanwhile, the lowest flow was recorded at station I, ranging from 0.18 to 0.25 m/s. According to Nugroho and Rolia (2022), rivers can be classified based on their flow velocity: fast flow (0.5-1 m/s), medium flow (0.25-0.5 m/s), and slow flow (0.1-0.25 m/s). The flow velocity along the research locations falls within the slow to medium flow range. Aprilliyani and Rahayuningsih (2020) state that fish species diversity is usually moderate in environments with medium or slow flow, depending on the variation and number of fish present. Conversely, waters with high flow tend to have low fish biodiversity, as only certain

species can adapt to fast-flowing waters. The measurements during this research indicate that fish diversity is relatively moderate, with only seven species identified and one species dominating.

Based on the measurement results using a Secchi disk, the brightness range obtained was 41-50 cm. According to Sandi and Hariyanto (2019), water clarity at all stations falls into the murky category. Water quality can be grouped into three condition categories based on its clarity levels. These categories are waters with high transparency (>500 cm), waters with medium clarity (100-500 cm), and waters with low clarity (25-100 cm). The determination of clarity levels depends on the amount of dissolved solids, particles, and color in the water (Sandi & Hariyanto, 2019). The flow of water carrying silt and sand can also cause a decrease in water clarity, which in turn affects water quality (Manullang & Khairul, 2020). During the research, the substrate at each research station was dominated by silt, Sand and stones. All fish species obtained during the research were able to adapt to these substrate conditions. According to Indonesian Government Regulation No. 22 of 2021, the water quality during the research falls into the moderately polluted category.

Conclusion

The fish species found consist of 5 families and seven species, including *Cyprinus carpio*, *Barbodes binotatus*, *Rasbora argyrotaenia*, *Xiphophorus hellerii*, *Oreochromis niloticus*, *Clarias gariepinus*, and *Ancistrus cirrhosus*. The diversity index (H') ranges from 1.01 to 1.55, which falls into the moderate category. The dominance index ranges from 0.22 to 0.38, indicating no species dominance. The evenness index for all stations ranges from 0.52 to 0.8, also categorized as moderate, and the abundance index ranges from 1.37 to 2.06, which is categorized as low.

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