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Growth Pattern and Morphometric Characteristics of Keting *Mystus gulio* (Hamilton, 1822) in Downstream of Gembong and Rejoso River, Pasuruan, Indonesia

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Abstract: Keting fish is a type of fish from freshwater which is usually used as a consumption fish or ornamental fish. There is a type of kein, namely from the species *Mystus gulio* (Hamilton, 1922). *Mystus gulio* ecosystem is disturbed due to land-use change activities in the river which causes the disturbance of the habitat of *Mystus gulio*. The purpose of this study is to analyze the long-weight relationship, growth pattern, and condition factors of *Mystus gulio* in downstream Gembong and Rejoso River. The method used in this study is to sample *Mystus gulio* from 3 stations on each river based on land use criteria. The research was carried out for 3 months, namely August, September and October 2023. The results of this study show that Mystus gulio caught in these two rivers all have a negative allometric growth pattern (b<3). The average value of the condition factor in these two rivers is 1 which indicates that the condition of *Mystus gulio* is good. The average growth of *Mystus gulio* caught in Gembong is relatively larger than Rejoso. The waters quality results of Gembong and Rejoso are still in optimal condition, except for Total Suspended Solid and Lead (Pb).

Keywords: Condition factor; Growth patterns; Mystus gulio; Negative allometric

Introduction

Indonesia is a country whose geographical condition is an archipelago with a variety of rich habitats. One of them is the habitat of fish which has a high diversity, especially fish from fresh waters. Fish in fresh water are known to have more than 1,258 types of fish found in Indonesian waters (Haryono & Sauri, 2020). One type of fish found in Indonesian waters is the Bagridae type, namely *Mystus gulio*. *Mystus gulio* is often referred to as a fish that has a long mustache. This fish is a euryhaline type which is often found in fresh waters or those with low salinity (Sandipan Gupta, 2014). *Mystus gulio* belongs to the Bagridae family in the Siluriformes order. *Mystus gulio* are fish that are small in size (Nguyen et al., 2023). *Mystus gulio* has an elongated body shape and its head is pointed, has antennae, is brownish gray in color and has spines on its dorsal fin (Ulfah et al., 2014). *Mystus gulio* is found in Southeast Asia and South Asia including Bangladesh, India, Myanmar, Pakistan, Sri Lanka, Indonesia, Malaysia, Singapore, Thailand and Vietnam (Hossain et al., 2015). The habitat of *Mystus*

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gulio likes shallow to deep waters. Apart from that, waters have a mixed substrate of sand, gravel, rocks or moss (Novika et al., 2021).

The downstream Gembong River empties into the Madura Strait. Communities around the river body use the Gembong River for their daily activities. The downstream reaches of the Gembong River to the estuary are used as a shipping route. As a result of shipping activities, this causes pollution from waste (Subekti, 2012). The river in Pasuruan whose downstream area receives waste input from community activities around the river is the Rejoso River. According to research from Staddal. (2019), a lot of waste from the agricultural sector enters river bodies. It was reported that around 44% of the upstream area of the Rejoso watershed experienced changes in land use and land cover. This is coupled with the area of horticulture plants planted in the Rejoso River watershed area which has increased by 20.58%. This is in accordance with the statement from (Amilia et al., 2016), which states that in Indonesia, pesticide residues contained in horticultural products have been reported to have residues that exceed the maximum limit of 2 ppm. One of the biota that receives a direct impact from pollution entering river bodies is *Mystus gulio* (Ulfah et al., 2014).

Fish growth is a change that occurs normally in a supportive environment within a certain period of time. In general, growth is defined as a change in dimensions which include length, weight, volume and size over each unit of time (Yonvitner & Ernawati, 2018). The relationship between length and weight of a fish can be used as a standard to see the development of a fish. Apart from that, it is a guide to look at obesity, health, gonad development, condition factors and so on (Arief et al., 2013). Morphometrics is defined as a technique for describing body shape. This method is widely used in taxonomy to see components that can be measured, for example measuring the length or distance between physical characteristics or anatomical landmarks of fish such as the size of body parts and fins and also the ratio of body lengths. In the last 50 years, this method has succeeded in differentiating between species in fish throughout the world. A growth aspect that is also important to know is condition factors. The condition factor shows the good condition of the fish in terms of physical capacity for survival and reproduction (Tamsil et al., 2019). This research aims to analyze the long-weight relationship, growth pattern, and condition factors of Mystus gulio in downstream Gembong and Rejoso River

Method

This research was carried out from August to October 2023, located downstream of the Gembong River and Rejoso River, Pasuruan, East Java Province. Fish collection locations in six locations (Figure 1). The sampling was conducted using a gill nets and traps. Fish were caught by anglers at each station during the morning to afternoon. The number of fish caught in this study was a total of 107 Gembong and 114 rejoso. The tools used during the observations were digital scales with an accuracy of 0.01g, calipers, writing instruments and a camera.

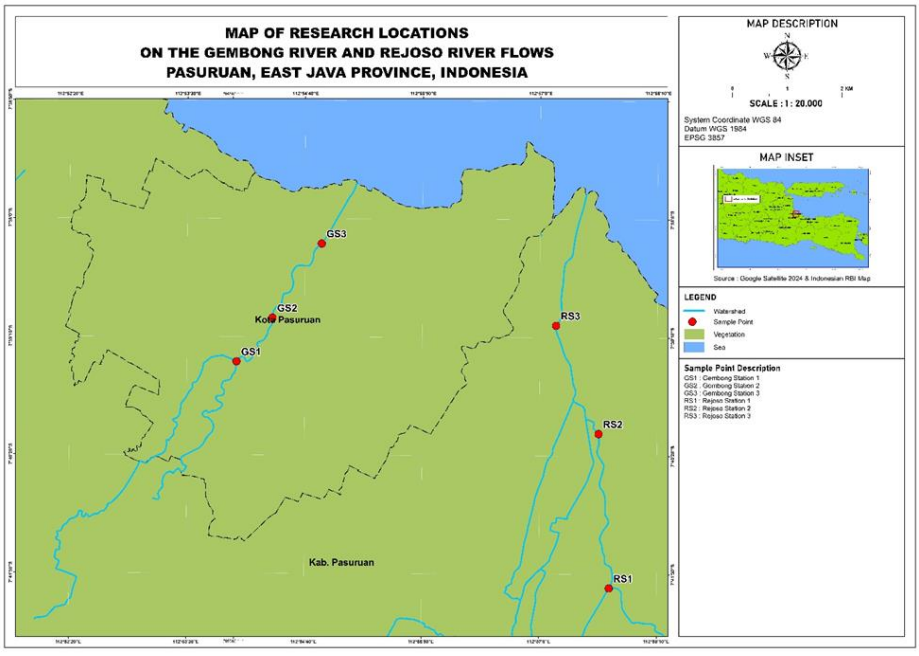

Figure 1. Map of Research Location

The parameters observed include morphometric characteristics, length-weight relationships and condition factors. The results of measurements and observations use primary data which is presented in the form of tables and graphs. To obtain the morphometrics of the *Mystus gulio* obtained during the research, they were analyzed by looking at the range of numbers per morphometric characteristic. Measurements of morphometric characteristics and observations of *Mystus gulio* were carried out at the Hydrobiology Laboratory, Faculty of Fisheries and Marine Sciences, Brawijaya University, Malang. The body parts of the fish measured are in Figure 2.

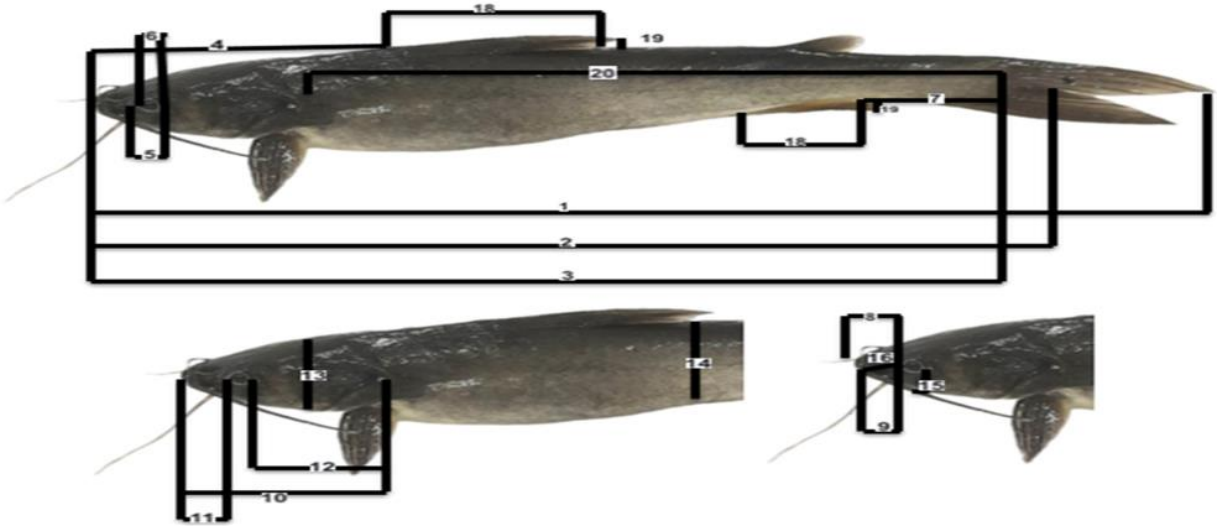

Figure 1. Measured Part of Mystus gulio (research documentation) Information: 1) Total Length (TL), 2) Forked Length (FL), 3) Standard Length (SL), 4) Pre Dorsal Length (PreDL), 5) Orbital Length (OrbL), 6) Eye Length (EyeL), 7) Caudal Penducle Length (CpedL), 8) Upper jaw leght, 9) Lower jaw leght, 10) Head Length (HdL), 11) Snouth Length(SntL), 12) Post Orbital Length, 13) Head height, 14) Height, 15) Check height, 16) Under eye height, 17) Thick height & body, 18) Leght of base of dorsal & anal fins, 19) Hight dorsal & anal fins, 20) Linea Lateralis (LL)

Morphometric characteristic data measured consist of 20 morphometric characteristics, calculated by standardizing the standard length. According (Herawati et al., 2021), Subsequently, the relationship between the length and weight of the fish is analyzed using Formula 1.

$$W = a \, . \, L \, b \quad (1)$$

Explanation: W= Weight (gram), L= Total Length (cm), a= intercept, b= slope.

Because the results of the growth pattern of Mystus gulio in the two rivers are allometric negative, the formula used to calculate the condition factor is different from isometric, namely according to Herawati et al. (2021), the formula for the condition factor (K) of allometric fish is as follows Formula 2.

$$K = \frac{W}{a.L^b} \quad (1)$$

Explanation: K = Conditional Factor; W = Fish Weigth (g); L = Total Lenght (cm); a = intercept ; b = slope

Water quality analysis in this research liked TSS used gravimetry method and COD was carried out in the Hydrobiology Laboratory, Faculty of Fisheries and Marine Sciences, Brawijaya University, except for the Lead (Pb) used Atomic Absorption Sepctroscopy (AAS) it was carried out in the Chemistry Laboratory, Faculty of Mathematics and Natural Sciences, Brawijaya University, Malang.

Result and Discussion

Fish growth is a change that typically occurs normally in an environment that supports it over a specific period of time. In general, growth is defined as a change in dimensions, encompassing length, weight, volume, and size over each unit of time (Yonvitner *et al*., 2018). In this study, the total number of fish (n) collected in Gembong was 107 fish samples, while in Rejoso, there were a total of 114 fish samples. The measurement results from both rivers during the sampling revealed that the total length of *Mystus gulio* in Gembong ranged from 9.7 cm to 15.3 cm, with an average of 12.5 cm. Meanwhile, in Rejoso, it ranged from 10 cm to 14.8 cm, with an average of 12.4 cm. This information is presented in Table 1. The results of the length

measurement of Mystus gulio caught in these two rivers are included in the general range category. As in the results of research conducted by Paujiah et al. (2023), it is stated that the Mystus gulio that is caught is generally 7-11 cm in size and the maximum length of Mystus gulio is 19-21 cm.

In this study, fish were obtained that have specific characteristics of the Mystus gulio species, namely a small adipose fin, has elongated barbels and an elongated body and a slightly depressed head. This is in accordance with the statement from Hossain et al. (2015), the body of Mystus gulio is elongated and compressed. The head was depressed. There are four pairs of barbels as well as small adipose fins and branched caudal fins.

Table 1. Morphometric Proportion of *Mystus gulio* to Total Length in the Downstream Gembong and Rejoso

Morphometric Code	Keting Gembong River's				Keting Rejoso River's			
	Min (cm)	Max (cm)	Average (cm)	Average (%)	Min (cm)	Max (cm)	Average (cm)	Average (%)
Total Length	9.7	15.3	12.5	100	10	14.8	12.4	100
Forked Lenght	7.9	11.2	9.55	76	7.8	10.8	9.3	75
Standard Length	8.1	9.3	9.3	74	8.1	9.2	8.65	70
Pre Dorsal Length	2.8	3.8	3.3	26	2.6	3.4	3	24
Orbital Length	0.3	0.4	0.35	3	0.3	0.6	0.45	4
Eye Length	0.1	0.1	0.1	1	0.2	0.3	0.25	2
Caudal Penducle	1.3	1.8	1.55	12	1.3	1.5	1.4	11
Upper Jaw Length	0.65	0.9	0.775	6	0.45	0.55	0.5	4
Lower Jaw Lenght	0.7	0.9	0.8	6	0.6	0.7	0.65	5
Head Length	2.02	2.7	2.36	119	1.65	1.95	1.8	15
Snought Lengh	1	1.1	1.05	8	0.9	1	0.95	8
Post Orbital Lenght	1.2	1.4	1.3	10	1.1	1.2	1.15	9
Head Height	1.1	1.7	1.4	11	1.5	2.1	1.8	15
Height	1.85	2.2	2.025	16	1.9	2.2	2.05	17
Check Height	0.6	0.8	0.75	6	0.4	0.8	0.6	5
Under Eye Height	0.35	0.5	042	3	0.3	0.5	0.4	3
Thick Height and Body	1.3 / 2	1.7 / 2.21	1.5 / 2.15	12 / 17	1.4 / 1.9	1.7 / 2.1	1.55 / 2	12 / 16
Leght of Base of Dorsal and Anal Fins	1.32 / 1.45	1.47 / 1.67	1.39 / 1.56	11 / 12	1.1 / 1.2	1.3 /1.3	1.2 / 1.25	10 / 10
Height Dorsal and Anal Fins	2 / 1.3	2.18 / 1.4	2.9 / 1.35	17 / 11	1.3 / 1.76	2 / 2.2	1.65 / 1.1	13 / 9
Linea Lateralis	8.3	10.4	9.35	75	7.6	10.2	8.9	72

In this study, the proportion of each morphometric character of the fish is calculated in relation to the total length of the fish. Table 1 indicates that there are four differences in morphometric characteristics between *Mystus gulio* in Gembong and Rejoso River. These differences are observed in the morphometric characteristics of Standard Length, Head Length, Head Height, and Anal Fin Height The differences between these characters are as follows: The morphometric character Standard Length (SL) of *Mystus gulio* in Gembong has a percentage ratio of 74%, while in Rejoso, it is 70%. This implies that the Standard Length (SL) of *Mystus gulio* in Gembong is longer compared to that in Rejoso. The morphometric character Head Length (HL) of *Mystus gulio* in Gembong has a percentage ratio of 19%, while in Rejoso, it is 15%. This indicates that the Head Length (HL) of *Mystus gulio* in Gembong is longer compared to that in Rejoso. The morphometric character Head Height of *Mystus gulio* in Gembong has a percentage ratio of 11%, while in Rejoso, it is 15%. This means that the Head Height of *Mystus gulio* in Rejoso is higher compared to that in Gembong. The morphometric character Anal Fin Height of *Mystus gulio* in Gembong has a percentage ratio of 17%, while in Rejoso, it is 13%. This indicates that the Anal Fin Height of *Mystus gulio* in Gembong is higher compared to that in Rejoso.

The differences in environmental conditions in the two rivers are closely related to the growth of the fish. Water quality also influences the food conditions in that environment. The input of pollutants into the river body also affects the condition and growth pattern of organisms (Yunita et al., 2020). Growth and Condition Factors of *Mystus gulio* in The Downstream Gembong River. *Mystus gulio* caught in the Gembong River have varying total lengths, namely between 9.7 cm to 15.3 cm and weigh between 33-57 grams. The results of the length-weight relationship calculation yield the regression equation W = 1.419L^2.3272 (Figure 3).

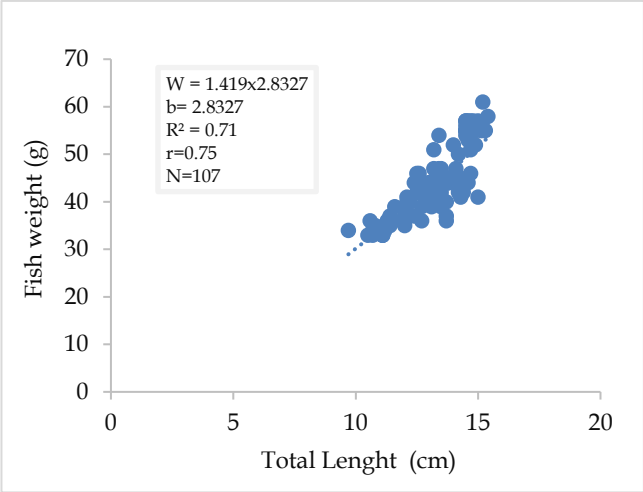

Figure 3. Growth of Mystus gulio in Gembong

The calculated slope (b) value is 2.83 (less than 3), indicating that the growth of *Mystus gulio* is negatively allometric. This implies that the length grows faster than the weight. The regression equation yields an R^2 value of 0.71, indicating that 71% of the weight increase in *Mystus gulio* is influenced by the length increase, while 29% is influenced by other factors. The correlation coefficient (r) is obtained as 0.75, signifying a strong correlation between the length and weight of *Mystus gulio*.

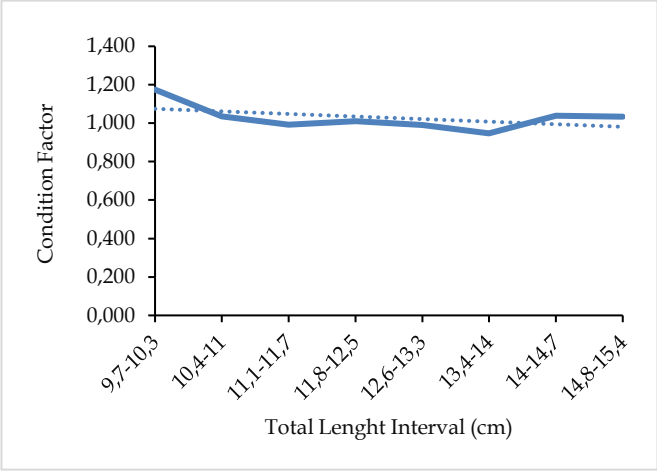

Figure 4. Condition Factor of Mystus gulio in Gembong

The condition factor (K) of *Mystus gulio* ranges from 0.97 to 1.03, with an average value of 1 (Figure 4). *Mystus gulio* with the highest condition factor are those with sizes between 9.7-10.3. The lowest condition factor is observed in the size range of 13.4-14.

The result of the length-weight relationship calculation yields the regression equation W = 0.8226L^2.5132 (Figure 5).

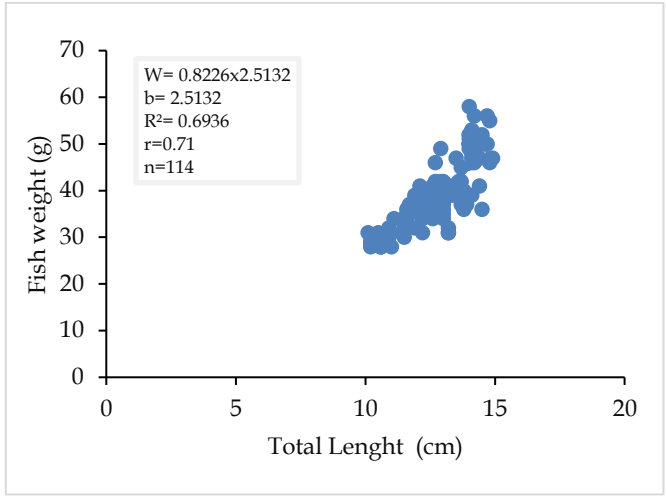

Figure 5. Growth of Mystus gulio in Rejoso

The calculated slope (b) value is 2.51 (less than 3), indicating that the growth of *Mystus gulio* is negatively allometric. This implies that the length grows faster than the weight. In the given equation, the regression coefficient (R2) is obtained as 0.6991, meaning that 69.31% of the increase in the weight of *Mystus gulio* is influenced by the increase in its length, while 30.69% is influenced by other factors. The correlation coefficient (r) is found to be 0.71, indicating a strong correlation between the length and weight of *Mystus gulio*.

The condition factor (K) of *Mystus gulio* ranges from 0.923 to 1.086, with an average value of 1 (Figure 6). *Mystus gulio* with the highest condition factor are those with sizes between 10-10.5, while *Mystus gulio* with the lowest condition factor are observed in the size range of 13-13.5.

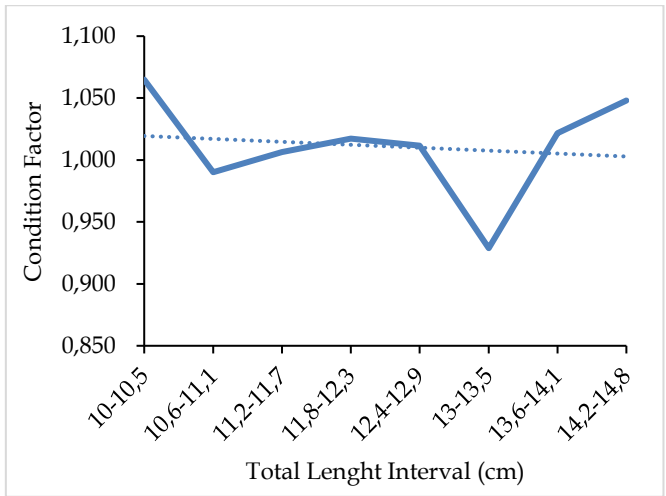

Figure 6. Condition Factor of Mystus gulio in Rejoso

The *Mystus gulio* living downstream of the Gembong River and downstream of the Rejoso River experience a faster increase in length compared to their weight. This indicates that *Mystus gulio* in Rejoso and

Gembong exhibit a negative allometric growth pattern. Essentially, allometric growth has a temporary nature, for example, due to growth associated with gonad maturity, while isometric growth occurs continuously and is proportional (Efendi et al., 2015). The total length and weight of the *Mystus gulio* found in this study show slight differences when compared to the reports from several previous researchers. In this study, Mystus gulio in Gembong and Rejoso exhibit a negative allometric value ($b < 3$). However, in a study conducted by Ridho et al. (2019), the length-weight relationship in Mystus gulio is positively allometric ($b > 3$). The values in the length-weight relationship can be observed through physiological conditions such as body shape and growth rate. Additionally, factors such as food availability, the quality of the consumed food, and feeding habits also influence the length-weight relationship of the fish.

The K value is highly correlated with the length-weight relationship of the fish. Similarly, the b value is crucial for assessing the overall condition of the fish species indicating whether it is in good condition or not. The codition factor of *Mystus gulio* shows a positive correlation, with K values ranging from 0.92 to 1.06. The growth of *Mystus gulio* in both rivers has an average value of 1. Each fish has a different condition factor value, depending on its internal and external factors. The condition factor is also influenced by the size of the fish, with smaller fish tending to have larger condition factors compared to larger ones (Tamsil et al., 2019).

Differences in morphology between species are a form of adaptation for fish to defend themselves and survive in their environment. The environment can serve as a limiting factor for the growth and population of fish, affecting both morphometric and genetic determinations (Bhagawati et al., 2013). This aligns with the statement by Saputra et al. (2014), which emphasizes that the environment is utilized by fish as a limiting factor for both the growth and population of fish, influencing morphometric and genetic determinations. The environmental factor influencing the differences in length is water quality. Water quality parameters that exceed the standards for fisheries in Gembong and Rejoso affect the growth rate of *Mystus gulio*. The average water quality data in Gembong and Rejoso can be seen in Table 2.

The average water temperature downstream of Gembong is 29.1°C, while downstream of Rejoso, it is 28.2°C. According to Yudha et al. (2018), the optimal water temperature for the growth of *Mystus gulio* is between 24-29°C. The average Total Suspended Solids (TSS) downstream of Gembong is 129.2 mg/l, while in Rejoso, it is 103 mg/l. Based on Government Regulation Numb. 22 of 2021, the TSS values in Gembong and Rejoso have exceeded the threshold of 100 mg/l. The average pH value in Gembong is 7, while in Rejoso, it is 7.2. According to Hamuna et al. (2018), the optimum pH for aquatic organisms ranges from 6.5 to 8.0. The average Dissolved Oxygen in Gembong is 6.3 mg/l, whereas in Rejoso, it is 6.8 mg/l. Based on Government Regulation Numb. 22 of 2021, the DO values in both water bodies still meet the water quality standards allowed for aquatic organisms, with a minimum of 3 mg/l.

Table 2. Average Water Quality Conditions in the Gembong and Rejoso

Parameter	Gembong	Rejoso
Temperature (°C)	29.1	28.2
TSS (mg/l)	129.2	103
pH	7	7.2
Dissolved Oxygen (mg/L)	6.3	6.8
Salinity (ppt)	1	0.4
COD (mg/l)	34.3	30.2
Pb	3.09	2.21

According Supardiono et al. (2023), low dissolved oxygen levels in waters will directly affect the life of aquatic biota. Aquatic biota use oxygen for respiration, growth and reproduction. The average salinity value downstream of Gembong is 1 ppt, while downstream of Rejoso, it is 0.4 ppt. According to Iqbal et al. (2024), *Mystus gulio* live in waters influenced by salinity. However, *Mystus gulio* also migrate to waters with zero salinity, such as rivers, canals, and lakes. The average Chemical Oxygen Demand (COD) value in Gembong is 34.3 mg/l, while in Rejoso, it is 30.2 mg/l. According to Pohan et al. (2017), the high COD values in river streams are often caused by the discharge of industrial waste into the river. This research data can be utilized as an effort in the management of *Mystus gulio* in the Gembong River as well as the Rejoso River. According to Elfiza et al. (2023), that Water temperature affects the level of toxicity of heavy metals, including the heavy metal lead (Pb).

Conclusion

Downstream areas of Gembong and Rejoso River in Pasuruan, East Java, *Mystus gulio* exhibit the same morphometric characteristics and growth patterns, namely negative allometric. The Condition Factor in both rivers also shows similarity, averaging around 1. However, the average growth of *Mystus gulio* in Gembong is relatively larger compared to Rejoso. The waters quality results in Gembong and Rejoso are still in optimum condition, except for Total Suspended Solid and Lead (Pb). The data in this study can be used as a reference in the capture of *Mystus gulio* and can be utilized as an effort for the management of *Mystus gulio* in both Gembong and Rejoso River.

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The authors in this research are into executor and advisor.

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Conflicts of Interest
The author declares no conflict of interest in this research.

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