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Length-Weight Relationship and Condition Factor *Channa marulioides* (Bleeker, 1851) In Kapuas River – West Kalimantan as a Conservation Aquatic Resources Effort

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Abstract

Channa marulioides is one of the species that is facing a population decrease due to high fishing activity. This study aims to determine the value of the length-weight relationship and condition factors of *C. marulioides* in the Kapuas River as a relevant conservation effort. Several sampling areas in this study were used to represent the Kapuas River, including Kapuas Hulu River in Kapuas Hulu Regency, Putussibau District; The central part of the waters area of Sintang Regency in Sintang Regency; and in the downstream waters of Pontianak City. The study carried out the sampling by analyzing the criteria for specimens with a dimension weight > 500 grams and length > 30 cm, with the same amount for each sex. The results showed that the growth type in the upper and middle waters was positive allometric with a value of b 3.1; however, it is negative allometric in the middle and upstream waters with b values of 2.5 and 1.7. After research, the condition factor of the upstream and middle waters was observed to be in good condition with a value of 1. However, in the downstream waters, the condition of the fish was rather bad with a value below 1, namely 0.99. The study concludes there is a decrease in the quality of the aquatic environment and the food availability from the middle waters to the downstream. This is what underlines conservation efforts in the form of domestication activities within the scope of structured fish farming.

INTRODUCTION

One of the potentials to improve the economy is by fully utilizing the economically valuable aquatic species and keeping the diversity in the resources. The Indonesian constitution states that fisheries are one of the primary resources and must be utilized for the Indonesian citizens' prosperity (Purwanto *et al.,* 2022). There is potential in various ecosystems in Indonesia, one of which is various species of freshwater fish that have economic value but their potential cannot be maximized in various ecosystem conditions in Indonesia. (Gustiano *et al.,* 2021). Freshwater fish represent half of all fish species and are the most threatened vertebrate group (Valdez and Mandrekar, 2019). The most relevant freshwater ecosystems utilized are

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riverwater areas, where one of the potential riverwater ecosystems in Indonesia is the Kapuas River located in West Kalimantan. The water of Kalimantan Island is one of the hotspots for various freshwater species (Kottelat, 2013). Therefore, there is a need for a comprehensive analysis of the potential freshwater species in the waters of the Kapuas River.

Channa marulioides is a type of freshwater fish with a distribution area in the freshwater waters of western Indonesia and Malaysia (Gustiano *et al.,* 2021) so the supply of *C. marulioides* to meet market demand comes from Kalimantan waters. Market demand for this species is increasing. The Pontianak City Coastal and Marine Resources Management Center stated that there are restrictions on permits for sending *C. marulioides* via the official website (KKP-BPSPL Pontianak, 2021), this limitation is because the level of utilization of this species is already high enough so that it is feared that it will face a decline in population and even the threat of extinction. which can harm the ecosystem and its population. Efforts to design conservation patterns through the initial stages of domestication by identifying population dynamics in natural habitats. *C. marulioides* is found in the waters of the Kapuas River in its natural habitat, namely flowing waters, with reproduction in nature becoming increasingly worrying (Susilawati *et al.,* 2022). A relevant first step is identifying the growth patterns and condition factors of C. Marulioides in nature. This can become initial literature in the design of continued intensive and periodic fish cultivation.

Apart from increasing natural catches, the high level of pollution in the area around the Kapuas River is increasingly worrying. Activities on the Kapuas River have the potential to pollute the environmental waste produced (Nengsih *et al.,* 2023). Waste disposal and activities on the Kapuas River can cause a decrease in the water quality of the Kapuas River (Yanti *et al*., 2022). It is important for several parties, including academics, to analyze fish population estimates to obtain comprehensive information to support sustainable conservation activities (Gebremedhin *et al.,* 2021). Environmental conditions and fish stock information related to the length and weight of fish in a particular ecosystem (Giarrizzo *et al.,* 2015). It can also estimate the biomass population of fish in certain species (Mehanna and Farouk, 2021).

The relationship between the length and weight data for several fish species will help contribute to further studies on fisheries conservation and management (Xia *et al.,* 2023). The length-weight relationship can be used to estimate the condition of fish, assuming heavier fish of a certain length are in better condition (Hamid *et al.,* 2015) so that it can be used as a reference in assessing the condition of fish and fish isometric and allometric growth patterns (Asriyana *et al.,* 2020). The condition factor (K) is an essential biological factor for determining the suitability of a particular body of water for fish growth and the average size Index in a species (Alam *et al.,* 2014). The parameters of length-weight relationships and condition factors are critical for some species domesticated from wild fish to become aquaculture species (Freitas *et al.,* 2014). To further assess the initial analysis in conservation efforts through domesticating *C. marulioides*, it's necessary to study these parameters on *C. marulioides* that live in their natural habitats, such as the Kapuas River.

Morphological analysis studies, including length-weight relationships and condition factors, have been found in many *Channa* fish species. However, there are still few for *C. marulioides* in their natural habitat as a conservation effort. The study is crucial to provide factual information about the biological status of *C. marulioides* in the Kapuas River with morphological studies and existing population stocks. The study aims to determine the value of the long-weight relationship and

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the condition factor *C. marulioides* of the Kapuas River as a relevant effort for conservation in the form of a structured long-term domestication activity. This research is expected to be useful as information about the importance of conserving other aquatic resources with a comprehensive morphological approach.

METHODOLOGY

Ethical Approval

There are no animals were harmed or treated inappropriately during this study. The test animal in this study, namely *C. marulioides*, was given good and consistent treatment throughout the weight and length observation process. The caught fish are immediately returned to nature in good condition without morphological defects according to their initial condition. This research procedure was by the Ethical Clearance that applies at the Faculty of Fisheries and Marine Sciences, Diponegoro University.

Place and Time

Sampling was carried out for approximately 2 months in February – March 2023, with the observation location being the Kapuas River, West Kalimantan Province, Indonesia. The study takes the samples by analyzing *C. marulioides* from the local fishermen in the area. The sampling areas representing the Kapuas River in West Kalimantan province-Indonesia are: 1. Kapuas River upstream in the Kapuas Hulu Regency on Putussibau District (0.844263, 112.932467); 2. Kapuas River in the central part of the territory of Sintang Regency Sintang Sub-District Water Area (0.079894, 111.488667); and 3. Kapuas River is downstream in the region of the City Of Pontianak, part of the waters of the District of North Pontianak (-0.021366,109.342540). The three sampling areas can accommodate the consideration of sampling points and the availability of *C. Marulioides* in the Kapuas River.

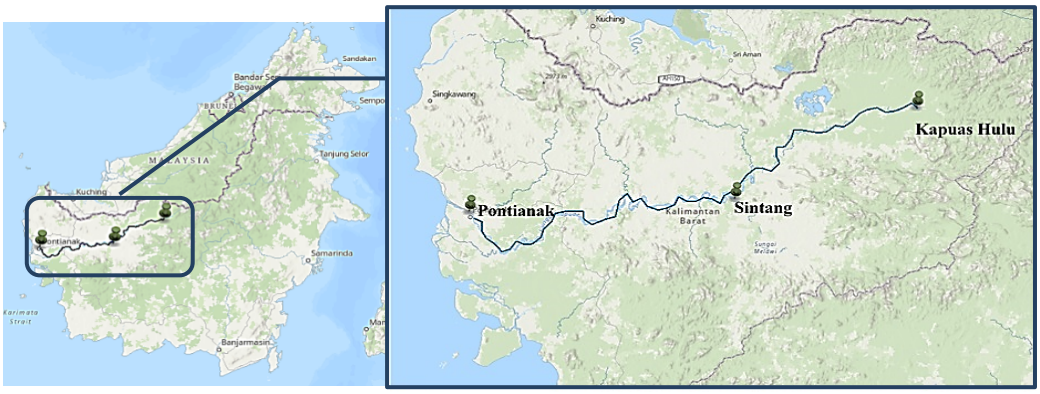

Figure 1. The sampling area in the Kapuas River, Kalimantan Island.

Research Materials

The equipment used in this research are Digital scale (Sojikyo, Digital Scale 2000g Gen 2, Indonesia), and Plastic Ruler with a 100cm scale. Meanwhile, the equipment used to catch fish is a net made from polyethylene plastic, modified by local fishermen.

Research Design

The method used in this study is a descriptive experimental method, where the observation process is carried out directly in a predetermined area. Samples obtained from catches are ensured following sampling criteria to avoid fluctuations in data diversity. The first observation carried out was identifying gender, then measuring length, and finally weighing. Data is collected according to the sample area, and the logarithm of growth patterns and condition factors is calculated. This process is carried out after all data has been collected.

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Work Procedure

Determine the Sampling Area

The Kapuas River has a length of 1,086 km (Herawati *et al.,* 2017), so an analysis is needed to determine three fish sampling points, including; 1. Water conditions with the most dynamic level of pollution are around densely populated areas which are vulnerable to industrial and household waste pollutants; 2. Areas often experience a decline in the number of species due to changes in habitat conditions, including supporting river ecosystems that pass through the area. 3. The water area experiencing a decline in river quality is the downstream area of the Kapuas River.

Determining Sample Criteria *for C. marulioides*

The samples are the catch from local fishermen with specific criteria. The *C. marulioides* chosen for the study are fish weighing >500 g and length >30 cm with 15 males and 15 females per sampling area. The samples must consider the fish size to maintain the sustainability and availability of fish in nature. They are conditioned to stay alive, do not damage morphology, and are environmentally friendly—the fishermen's fishing nets keep the fish alive and still environmentally friendly. If the weight and length of the fish caught do not meet the criteria, the fish will be released back to nature. The team measures the length and weight immediately after the catch and before releasing the fish to avoid weight decrease during transportation.

Fish weight was found by weighing the fish individually with a digital hanging scale with an accuracy of two decimal digits. In comparison and measuring the fish from the mouth tip to the tail base. The team determines the sex by visually observing secondary sexual characteristics, namely the shape of the head, body shape, and sex shape and genital organs from the Channa clan then comprehensively adjusting to the *C. marulioides*.

Data Analysis

The study uses the equation $W = aL^b$ to measure the fish length and weight. Where W is total body weight (g), L is the total length (mm), and in the log transformation version, log W = log a + b log L where log a and b are the intercept and slope points, respectively. The slope of relation (b) was compared with the cube values using Student's t-test to investigate whether *C. marulioides* exhibits an isometric (b=3.0), positive allometric (b>3.0), or negative allometric (b<3.0) growth model (Epa and Narayana, 2016). The long-weight relationship must also test the length-weight correlation between both sexes. To assess the fish condition using the Fulton condition factor (K) from the relationship K=100W/L3 (Hamid *et al*., 2015). The average value of the length-weight relationship and the condition factor represent the research sampling area with various aquatic habitat conditions. Data on the length-weight relationship of fish and condition factors are further analyzed specifically on the growth patterns to show the fish condition in the Kapuas River.

RESULTS AND DISCUSSION

Length-Weight Relationship

The study uses 90 individual fish samples of 30 individuals, between 15 individuals per sex in each observation area. The study found *C. marulioides* caught are in good condition and relevant from a morphological point of view. They meet the requirement to measure length and weight for the observation. The results showed that the length of the *C. marulioides* length ranged between 35 - 39 cm, with an individual weight between 500 - 660 g. Morphological identification of sex determination in *C. marulioides* during field observations shows the following characteristics.

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Table 1. Differences in male and female morphology of *C. marulioides*.

Male	Female
Body shape is Relatively slender and elongated with wilder movement	Body shape is relatively fatter and rounder.
The belly is slimmer, with a lighter orange-yellow.	The belly is rounded, with a darker orange-yellow.
The head is an elongated oval	The head is flat with an indentation under the operculum
The genital organs have tiny protrusions, with white fluid (sperm) which is white when striped.	The genital organs are round, with a yellow-orange liquid (egg) when stripped.

The population distribution of *C. marulioides* in the upper waters of the Kapuas River weighs between 510.5 g to 665.75 g. The length ranges between 35.4 cm to 38.25 cm. Male fish have an average weight of 581.52 grams with an average length of 36.55 cm, while female fish have an average weight of 602.02 grams with a length of 37.08 cm. The data shows that females of *C. marulioides* in the upstream waters' population are bigger than the males. Upon this data, comprehensive observations on the length and weight relationship in the upstream waters are in the graph below:

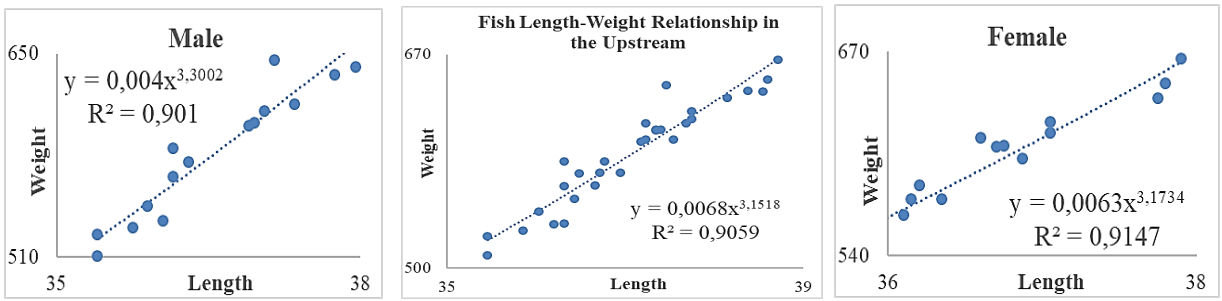

Figure 2. Length-weight relationship in Kapuas River upstream.

The analysis of the length and weight relationship in the upstream waters shows a positive allometric (b>3) growth pattern of *C. marulioides* in the Kapuas River for male, female, and general fish. The coefficient b value is 3,30 for males 3,17 for females and 3,15 for both. The results also show that weight growth is more dominant than length for both male and female *C. marulioides* in the upper waters of the Kapuas River as the analysis result shows R^2 as 0,90 in males, 0,91 in females, and 0.90 for both. This shows a reasonably close relationship between the two factors, the length and weight gain influence the growth of *C. marulioides* in the Kapuas River upper water. These two factors have up to 90% influence on the fish growth. The remaining 10% are other factors such as in the aquatic environment and internal factors such as genetics and age.

The observation pool on *C. marulioides* fish in the Kapuas River middle waters also consists of 15 males and females that meet the study criteria. The male fish weighs range between 505 - 646 g and of 35 - 39 cm in length. while the female fish weighs range between 508 - 642 g and 35-38 cm in length. On average the sample pool in the middle water measures 589,31 g and 37,57 cm. Reviewing the observations result, male fish have a wider range of length and weight distribution than female fish. The following is a graph of the length and weight relationship for *C. marulioides* in the Kapuas River.

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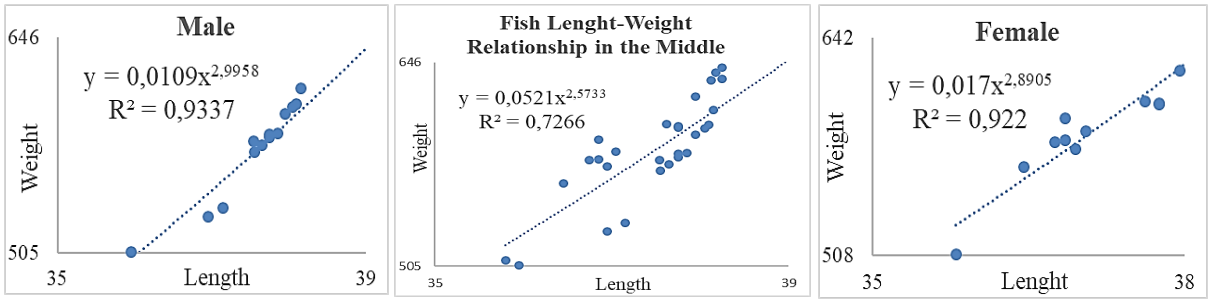

Figure 3. Length-weight relationship in the middle Kapuas River.

Upon observation, the length and weight relationship of *C. marulioides* in the Upper Kapuas River middle water shows a negative allometric growth pattern (b<3). Both male and female fish have the same growth pattern and a combination of the two. The coefficient b shows 2.99 for male fish, 2.89 for female fish, and 2.57 for both. The R^2 values in male and female fish, namely 93% and 92%, show a close correlation between length and weight, but the combination shows an R^2 value of 72.6%. This means that apart from increasing weight and length, other factors in the form of environmental intervention also influence the growth of *C. marulioides* fish in the middle waters of the Kapuas Hulu River.

The observation result on the length and weight of *C. marulioides* in the lower reaches of the Kapuas River showed an average weight of 522.33 g and length of 36.79 cm in both males and females. The male fish weighs between 500 - 535 g and is 35 - 37 cm in length. while the weight range for female fish is 503 - 558 g with a length of 36 - 37 cm. Compared to the average weight range of fish in the upstream and middle waters, the fish size is smaller in the downstream area. There is a relatively minor distribution of the fish length and weight, with the female fish being bigger than the male ones. The graph reflecting the relationship is as follows.

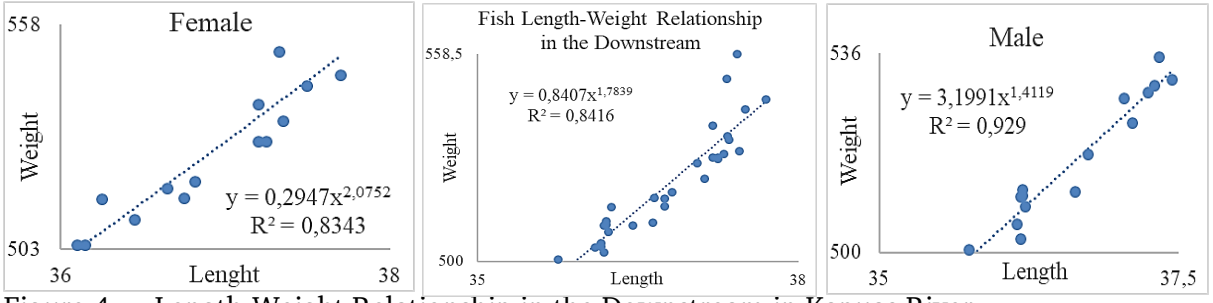

Figure 4. Length-Weight Relationship in the Downstream in Kapuas River.

Figure 3 above shows that the b value in the length and weight in male fish is 1.41, and in female fish is 2.07, while the combination is 1.78. It is possible that *C. marulioides* in the Kapuas River lower water has a negative allometric growth pattern (b<3). The R^2 value shows 83% in female fish, 92% in male fish, and 84% for both. The result shows a reasonably close relationship in length and weight that influence the growth of *C. marulioides* fish in the downstream water.

Based on sampling results in the upstream, middle, and downstream waters of the river, a relationship was found between differences in the growth patterns of length and weight of *C. marulioides* in the waters of the Kapuas River. Length-weight relationships have different coefficients between different species and even between stocks of the same species related to sex (Borges *et al*., 2003). Differences in growth patterns in the upstream waters indicate the influencing factors. It also

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shows high exploitation of the *C. marulioides* from the middle to downstream. Different length and weight relationships in each area also indicate the amount and dynamics of fish populations related to resource exploitation and utilization (Osho and Usman, 2019). In addition to the high exploitation, a decrease in the quality also happens in the habitats that support growth. The length-weight relationship among fish species shows how environmental factors influence body conditions, and eventually affect biology and food availability in the waters (Mehanna and Farouk, 2021). This shows that many factors influence the differences in growth patterns in these fish. Apart from the exploitation factor in the estuary area, the availability of food in the form of small fish is increasingly decreasing in the estuary.

The "b" value in this study indicates a decrease in water quality due to high levels of pollutants which have an impact on the physiological quality of fish growth patterns in upstream to downstream waters. Yanti *et al* (2022) stated that the Kapuas River in Mukok District, Sanggau Regency is included in the lightly polluted category. The potential pollution load resulting from domestic activities around river tributaries will increase by 8% each year from each parameter as follows: BOD = 4,612 kg/day, COD = 8,841 kg/day, Nitrogen = 1,975 kg/day and Phosphate = 331 kg/day, so efforts are needed to control water pollution in the Kapuas River, Pontianak City (Febrianti *et al*., 2014). The growth pattern of *C. marulioides* in the upstream waters indicates the expectations for food availability and the physiological conditions of fish in the upstream waters are still in optimal condition. Mathematical models of fish growth patterns are accurate estimates of biomass and the amount of food needed to optimize fish production (Furuya *et al.,* 2014). This study shows that there is a gap in the differences in growth patterns in the upstream, middle, and downstream areas of the Kapuas River which needs to be re-examined in terms of water dynamics and food availability in nature.

The decrease in the 'b" value in this study shows that the b value in upstream waters (b>3) indicates a fairly good morphological physiological condition, however, there is a decrease in the b value in upstream waters (b=2.8) and further decreases in downstream waters (b =1.7). Understanding this length-weight relationship shows a decline in fish condition from upstream to downstream. This is the basis for immediate action as a follow-up to maintain the balance of the aquatic ecosystem. Parameter "b" in the length-weight relationship can provide information about population dynamics and life history strategies for fish species to assist sustainable management and conservation efforts (Rodríguez-Garcia *et al.,* 2023). Reviewing the results of the analysis of the length-weight relationship between fish in the waters of the Kapuas River raises the urgency to design domestication activities as an effort for conservation management.

Condition Factors

To observe the condition factors of the sampled pool in the waters the team calculated the coefficient values a and b of the length-weight relationship algorithm at each point of the sampling area namely the upstream, middle, and downstream of the Kapuas River. The total number of fish samples is 90 individuals, with a distribution of 30 individuals per point of the sample area and 15 individuals in male and female fish. The following table is the result of the condition factors observation:

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Table 2. Condition factors of *C. marulioides* in the Kapuas River waters.

Study Area	N	Male Condition Factor	Mean	N	Female Condition Factor	Mean	N	General Condition Factor	Mean
Upstream	15	0,975-1,070	1,012	15	0,967-1,037	1,002	30	0,966-1,069	1,007
Middle	15	0,935-1,001	0,999	15	0,979-1,058	1,028	30	0,935-1,058	1,001
Downstream	15	0,985-1,008	0,996	15	0,989-1,037	1,003	30	0,985-1,037	0,999

The condition factor is a morphological condition with the level of body shape density, influenced by the length, weight, and sex of a species in certain waters. The observations show that overall, the condition factor is worth or close to 1. The sex factor in the condition factor value shows that male fish in the upstream waters have a better growth pattern than the middle and downstream waters. However, the growth conditions in female fish are relatively the same in all river water areas. The overall condition factor values above in the upstream and middle waters indicate good growth conditions. However, the value in the downstream waters is 0.99 or less than ideal. The condition factor value is good, when it's equal to or greater than 1 and in poor growth conditions when the value is less than 1 (Jisr *et al*., 2018).

The decrease in condition factor values from upstream to downstream waters shows that fish growth conditions are deteriorating along with the rate of movement of the Kapuas River waters. The research results show that growth in upstream waters is better than in middle and downstream waters, this shows that the Kapuas River has a high potential for domestic waste pollution activities from central to downstream waters. This can indicate a decrease in the quality of aquatic environmental habitats to support the growth of *C. marulioides* in the middle to lower waters of the Kapuas River. Based on the latest water quality data in June 2023 observed by Anggraini *et al*. (2023), the dissolved oxygen level in the Kapuas River is 4.98 mg/l, with a pH of 4.68, dissolved density of 24.6 mg/l, speed of 1.6 m/s, level water turbidity is 22.1 KTU, saturation is 65.3%, dissolved pollutant content is 29.6 mg/l, and salinity is 0.0% so that the water quality status of the Kapuas River is classified as polluted in the upstream part of the river from Sintang City to the downstream part of Pontianak City which experienced a decline in quality due to domestic waste. Factors influencing fish growth conditions include the reproductive cycle, food availability, season, and sex (Ali *et al.,* 2016).

Analysis of the condition factor of *C. marulioides* in the Kapuas River shows the fish are in generally good growth condition. However, further examination there is a decrease in the overall condition factor value for the population in the middle waters and continues to decline in the downstream waters. The value of the condition factor in the middle and downstream waters is below the value of 1 (0.99). It raises a specific concern for the continuity of the availability of *C. marulioides* in nature. The decrease in condition factors in this study shows that there is a decrease in air quality which has an impact on Kapuas River pollution (Anggraini *et al*., 2023), so it has an impact on condition factors or body density levels in adult *C. marulioides* which decreases from the middle to the downstream Kapuas River. The decrease in condition factors in fish impacts the population and dynamics of fish stocks in the waters as a recommendation for managing conservation activities (Haberle *et al*., 2023) through domestication activities.

CONCLUSION

There is a decrease in the growth pattern and body density of *C. marulioides* in Kapuas River waters from upstream to downstream. The fish in the upstream waters have a positive allometric, growth pattern while in the middle and downstream,

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the growth pattern turns negative. This is thought to be due to differences in water habitat conditions and profiles in upstream to downstream waters, thus having an impact on food availability which influences the growth of *C. marulioides* fish in the waters of the Kapuas River. The trend in the length-weight relationship of the *C. marulioides* sample (>500 g) in upstream waters, is also in line with the trend in condition factor values, in general, the condition factor in middle waters is more than 1, indicating fairly good growth, while in the upstream it is less than 1, or negative growth. The results of the observations showed that there were differences in growth patterns and decreasing factors in the condition or body density of *C. marulioides* from upstream to downstream of the Kapuas River. Examining this, it can be categorized as necessary to carry out a conservation design in the form of domestication within the scope of cultivation, this is intended to be able to conserve the *C. marulioides* species comprehensively and not depend on natural catch. Therefore, it is important to carry out a more in-depth and comprehensive study regarding pond design and relevant cultivation media for *C. marulioides*.

CONFLICT OF INTEREST

The authors declare that they have no known competing financial interests or personal relationships that could have affected to work reported in this paper.

AUTHOR CONTRIBUTION

The contribution of each author is as follows; Rizal Akbar Hutagalung is the field researcher contributes in the form of survey implementation, identification of research objects, and analysis of test parameter data; Sutrisno Anggoro is the Research Controller, contributing to the planning of sampling activities, directing the feasibility of test parameters, and physiological analysis of research objects; Suryanti Contributing to the concept of population dynamics sampling, a vital part of this research; Max Rudolf Muskananfola contributes regarding considerations in determining the concept of culture, which is a consideration in predicting the physiological conditions of research objects.

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