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Short Communication

Growth Patterns and Ecological Classification of *Tor tambra* (Valenciennes 1842) in the Mamis River, Leuser Ecosystem Area, Aceh Province, Indonesia

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Abstract

This research was aimed to examine the habitat characteristics, growth patterns and condition factors of *T. tambra* in the Mamis River, Leuser Ecosystem Area, Aceh, Indonesia. This research was conducted on the Mamis River in three different river conditions from July to August 2023. The ecological parameters of *T. tambra* were conducted by observing the main, broodstock, spawning, and nursery ground habitats based on diversity of catch size at a location, water quality, aquatic substrate, aquatic vegetation, and water shade. The growth pattern parameter was also analysed to reveal the condition of *T. tambra*. The *T. tambra* habitat in the Mamis River includes broodstock and spawning habitat with the criteria from small to large rocks overgrown with *Bryophytes,* gravel and sand substrates, clear water color, slow to swift water currents, and river environment. Most of it is primary forest. In the main habitat, there is dominant riparian vegetation in the form of forest timber trees such as *Pometia pinnata, Ficus fistulosa, Hydnocarpus castanea*, and *Aglaia tomentosa*. The habitat for the juvenile is in the form of rocks, gravel substrate, clear water color, and fast water currents. In the nursery habitat, the dominant riparian vegetation is *Balakata baccata.* Based on the results of the water quality analysis at the three stations show that temperature, pH, DO, currents, BOD, COD are significantly different, but brightness levels are not significantly different. The analysis of the length-weight relationship shows that the condition of the fish is stable, and sufficient food is available.

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1. Introduction

Four species of *Tor* fish have been identified in the freshwaters of Aceh, Indonesia, consisting of *Tor douronensis*, *T. tambroides*, *T. tambra*, and *T. soro* (Muchlisin and Azizah, 2009; Maghfiriadi *et al*., 2019; Akmal *et al*., 2020; Akmal *et al*., 2022). *T. tambra* is the predominant species found and has been included in the IUCN red list of threatened species as an endangered species (data deficiency category) because there is an increased threat of exploitation and environmental destruction (Muchlisin *et al*., 2015; Kottelat *et al*., 2018; Febri *et al*., 2023). The *T. tambra* can reach a maximum length of one meter, with medium-sized lobes on the lower lip but not touching the tip of the lip (Kottelat *et al*., 1993; Firdaus *et al*., 2021). Saanin (1984) states that fish from this taxa have the characteristics of a smooth dorsal fin, the head is not conical, and there are 3.5 rows of scales between the linealateral line and the dorsal fin. The *T. tambra* also has a clearly visible linealateral line, a prominent snout, an inferior mouth position and thick lips (Haryono and Tjakrawidjaja, 2006; Jaafar *et al*., 2021).

The life of *T. tambra* is under threat of extinction due to high exploitation, forest destruction, water pollution and land conversion (Pinder *et al*., 2019; Chew *et al*., 2021). High demand for domestic and export markets causes high exploitation of *T. tambra* (Jaafar *et al*., 2021). Furthermore, forest destruction results in loss of habitat and food sources of *T. tambra* (Chong *et al*., 2010; Farinordin *et al*., 2017). Water pollution also affects the life of the *Tor* species. Land use change has an impact on natural movements, such as spawning migration (Sikder *et al*., 2012; Ali *et al*., 2014; Pinder *et al*., 2019). *Tor* fish has high cultural and economic value, so it is included in the exclusive consumption fish group (Arifin *et al*., 2015; Barus *et al*., 2023). *Tor* fish has a high albumin content, so it can be used as raw material for medicine in postoperative healing (Sumiati *et al*., 2022).

The condition of the aquatic environment, the condition of organisms and the availability of food can influence the magnitude of the value of condition factors, fish health, productivity and physiological conditions of fish populations (Effendie, 1997; Blackwell *et al*., 2000; Cavraro *et al*., 2019). Environmental conditions that decline and are below the minimum required for fish species will cause stress and death (Manangkalangi *et al*., 2014; Rahel, 2022). Reducing the percentage of forest cover around water catchment areas will cause the release of coarse particulate organic matter into rivers (England, 2003), thereby disrupting reproductive habitat and shelter for fish larvae (Manangkalangi *et al*., 2009; Chen *et al*., 2023). This research will provide new information regarding the habitat characteristics, growth patterns, and condition factors of *T. tambra* in the Leuser Ecosystem Area and efforts to develop the conservation of native Indonesian freshwater fish.

This research aims to examine the habitat characteristics, growth patterns and condition factors of *T. tambra* in the Mamis River, Bunin Village, Leuser Ecosystem Area, Aceh, Indonesia.

2. Materials and Methods

2.1 Materials

Wild *T. tambra* fish obtained from the catch were used and explored in this study, especially when observing their growth patterns and ecological environment. Some of the equipment used in this research activity includes casting nets, gillnets and rods. The fishing tools were made and modified by the fishermen themselves based on the needs and environmental conditions of the Mamis River and the Leuser Ecosystem Area in Aceh.

2.1.1 Ethical approval

This study does not require ethical approval because it does not use experimental animals.

2.2 Time and Site

The location of the station was determined using a purposive sampling method. A method for determining sampling locations based on the information from fishermen regarding the presence of fish and vegetation characteristics. The water area studied is the Mamis River, East Aceh Regency, Aceh Province, Indonesia, where the upstream part of the river is in the Leuser Ecosystem Area (Figure 1). The locations were chosen as 3 stations included downstream (97° 36' 35.644" E - 4° 33' 5.468" N), middle (97° 36' 48.938" E - 4° 31' 59.621" N), and upstream (97° 36' 12.391" E - 4° 29' 19.262" N) is expected to represent the research site. The research period was from July to August 2023. The *T. tambra* used in this study was obtained through direct capture or from fishermen using alternative fishing techniques, including casting nets, gillnets and rods (Figure 2). The gill nets have been installed at 17.00 pm and will be lifted again the next day at 06.30 am. The nets are placed across the river body. The distance between nets is ± 50 m with a net span (width) of ± 20 m and a height of 1 m (Hidayat *et al*., 2023). A minimum of 30 fish samples were collected per location.

2.3 Analysis of Ecological Aspects of T. tambra

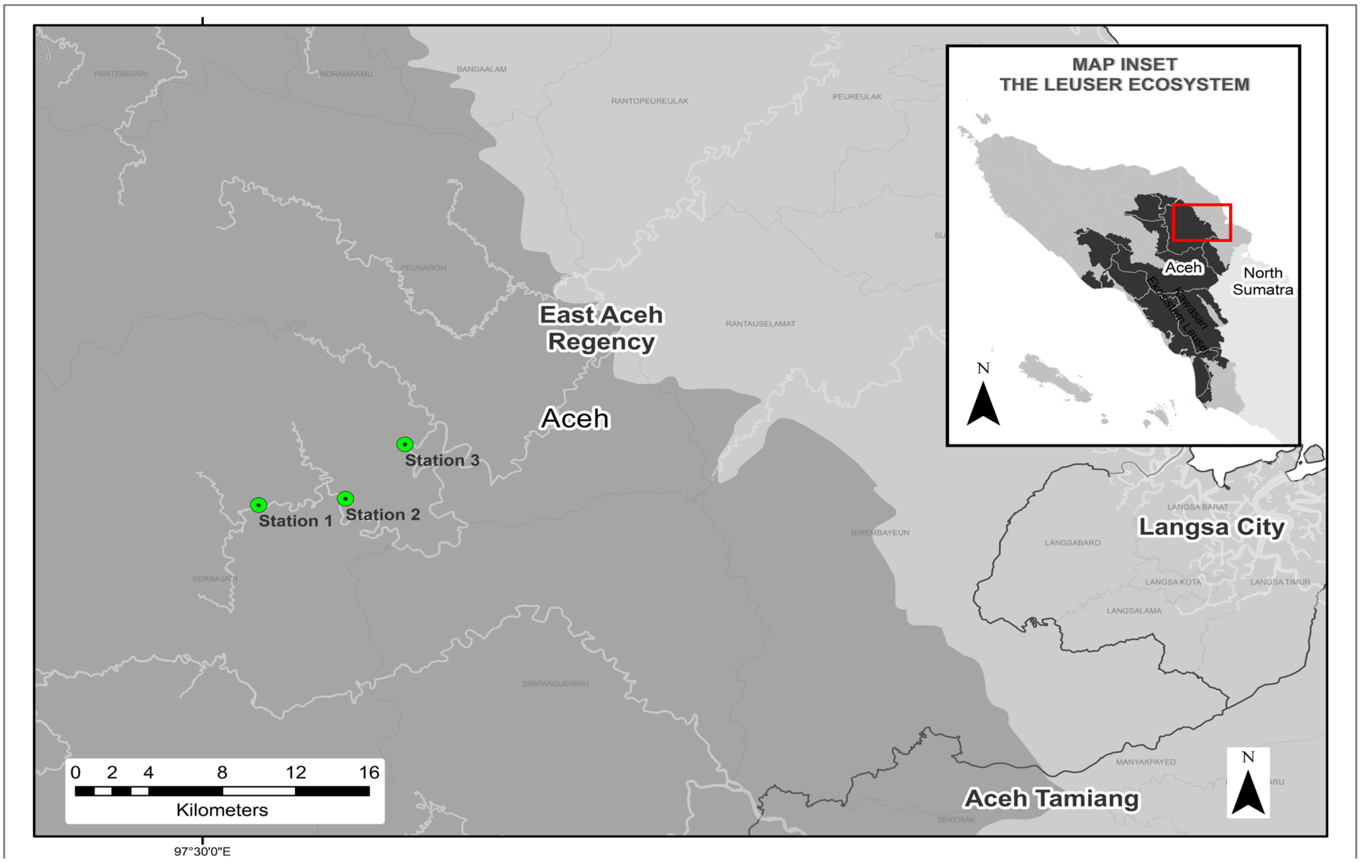

Figure 1. Fish sampling station in the Mamis River, East Aceh Regency, Aceh Province, Indonesia. Station 1: residential area, Station 2: plantation area, Station 3: natural forest area

Figure 2. Samples of *T. tambra* obtained from the Mamis River. (A) *Tor tambra* juveniles, and (B) *T. tambra* adults. Scale bar: 3cm

The ecological parameters of *T. tambra* were measured by observing the main, broodstock, spawn ing, and juvenile habitats. Each habitat was determined by observing the diversity of catch size at a location, water quality, aquatic substrate, aquatic vegetation, water shade, and other environmental factors. Physical and chemical water quality parameters, including current, temperature, pH, brightness, and dissolved oxygen, were observed in situ at each station. The current was measured using a floating draught, temperature was measured using a digital thermometer, pH was measured using a pH meter, brightness is measured using a Secchi disk, and dissolved oxygen is measured using a DO meter. Biological Oxygen Demand (BOD) value was measured using the Winkler/Iodometry method, which was conducted by measuring the reduction in dissolved oxygen levels in samples stored in tightly closed bottles and incubated at 20^{o}C for five days. Chemical Oxygen Demand (COD) value was measured using a UV-Vis spectrophotometer. Observation of the riverbed substrate was done by considered the dominance of the substrate on the riverbed, namely stone, sand, or silt. Moreover, habitat of *T. tambra* found in this study was categorized as follows: i (Broodstock habitat was determined by catches of fish dominated by adult fish with various levels of gonad maturity), ii (Spawning habitat was determined by catches of fish dominated by adult fish with a high level of gonad maturity (fish ready to spawn)), iii (Juvenile habitat was determined by catches of fish dominated by juvenile fish).

2.4 Length-Weight Relationship Analysis

The fish length was measured using callipers with the smallest unit value of 0.01 mm, while fish weights were measured using digital scales with the smallest unit value of 0.01 g. The formula for the length weight relationship is expressed in the following equation Effendie (2003):

$W = a.L^b$..(i)

Where :

W : total weight (g)

a : intercept

L : total length (mm)

b : slope

To test the value of b = or b ¹ a t-test (partial test) is carried out with the hypothesis:

H0 : b = 3, the relationship between length and weight is isometric

H1 : b ≠ 3, the relationship between length and weight is allometric

Positive allometric, if b>3 (weight gain is faster than length gain)

Negative allometric, if b<3 (length gain is faster than weight gain).

The condition factor is calculated based on the length and weight of the fish using the following formula: If the value is b = 3 (the growth type is isometric), then the formula used is:

$K = W/aL^b$.. (ii)

Where:

K : condition factor

L : total length (mm)

W : total weight (gram)

a and b : constant

2.5 Analysis Data

Data on ecological aspects was analysed descriptively (habitat condition, riverine, and aquatic vegetation) and presented in the tables and figures. Water quality parameters for each station and condition factors were statistically analysed using one-way ANOVA with software SPSS ver. 21.

3. Results and Discussion

3.1 Results

3.1.1 Habitat characteristics

The conditions of the research locations are divided into residential, plantation, and natural forest areas, which have different regional characteristics (Figure 3). Residential areas were indicated by turbid waters, strong currents, sandy, and muddy substrates. The plantation area was indicated by turbid waters, strong currents, sandy and gravel substrates. Natural forest areas were indicated by clear waters, strong currents, and gravelly and rocky substrates. Numerous large boulders were found in natural forest areas and thought as a hiding place for *T. tambra* during threatened.

The results of observations on the habitat of *T. tambra* in the Mamis River are generally on bottom waters for broodstock and spawning habitat with the criteria of small to large rocks overgrown with *Bryophytes*, gravel, sand substrates, clear water color, slow to swift water currents, and river environment most of it is primary forest (Table 1). In the main habitat, there is dominant riparian vegetation in the form of forest timber trees such as *Pometia pinnata*, *Ficus fistulosa*, *Hydnocarpus castanea*, and *Aglaia tomentosa*. Meanwhile, the habitat for the juvenile is in the form of rocks, gravel substrate, clear water color, and fast water currents. In the nursery habitat, the dominant riparian vegetation is *Balakata baccata*.

The habitat of *T. tambra* in the Mamis River can be divided into three types based on size, namely habitat for larvae, juveniles and adults. The larvae habitat is generally on the banks of the river, which is characterized by a substrate of sand, calm currents, clear watercolor, shallow (<50 cm), and there is aquatic vegetation such as *Homonoia riparia* and *Bryophytes*. This is thought to be related to its still low ability to resist water currents. Habitats like this are also the spawning ground for *T. tambra*.

Water temperature condition in each *T. tambra* habitat was categorized in the normal range category (26.1 to 27.1°C). Water temperature, dissolved oxygen, and current speed in the juvenile habitat are higher compared to the spawning habitat and broodstock habitat. The water pH value, water clarity level, BOD, and COD levels in the adult habitat are higher than in the spawning habitat and juvenile habitat (Table 2). The water quality characteristics in each habitat were though to be influenced by riparian vegetation cover. In the adult fish habitat, riparian vegetation tends to be more closed than in the larvae and juvenile habitat, which is more open.

3.1.2 Composition and size distribution

Habitat for larvae to juvenile size with the following characteristics: rock bottom with diameter <60 cm, moderate to strong water current, clear water, river width 20-25 m, water depth <4 m, substrate

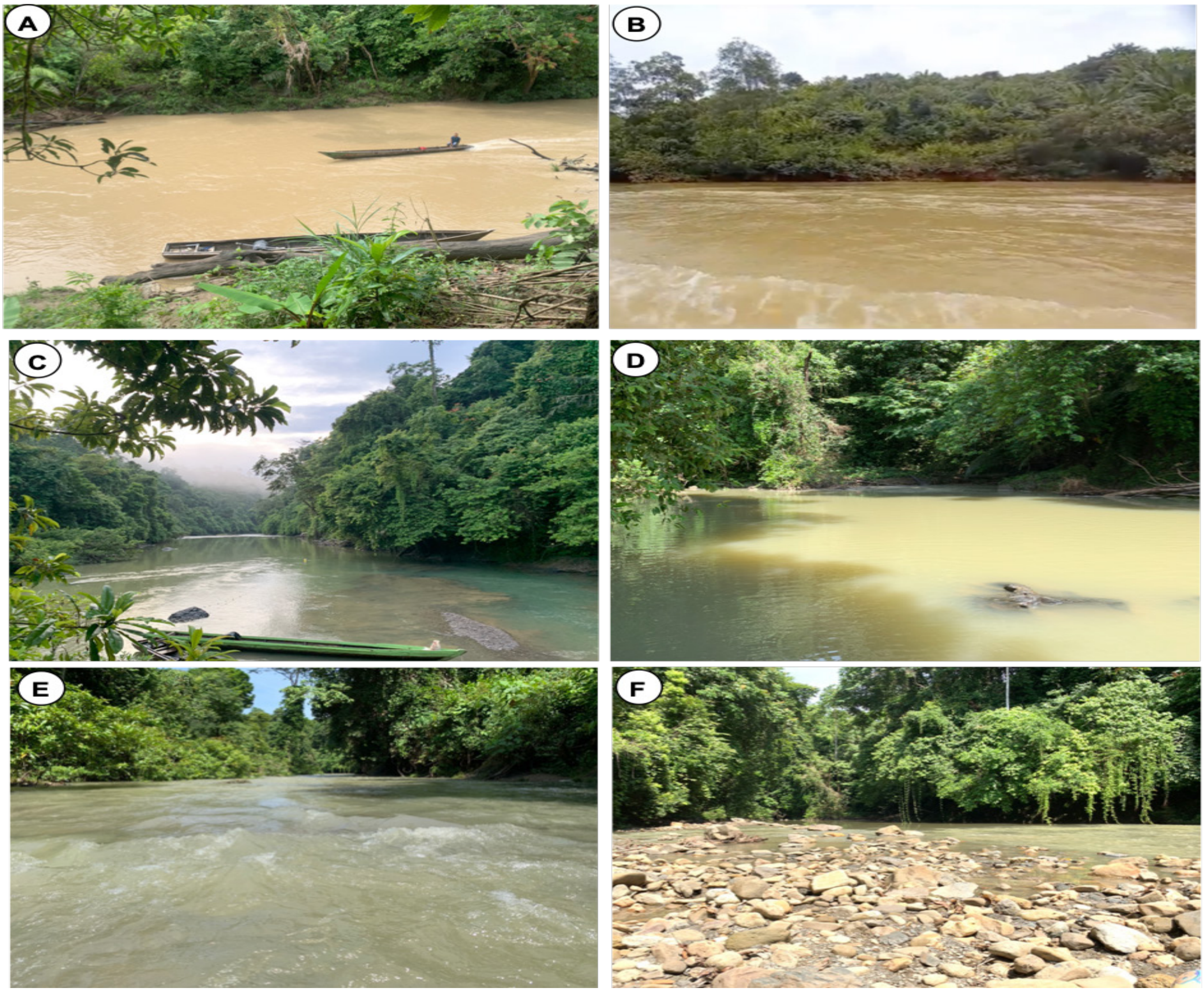

Figure 3. Habitat conditions for *T. tambra* fish in the Mamis River. (A) Station 1: residential area, (B) Station 2: plantation area, (C) Station 3: natural forest area, (D) mature and spawning habitat, (E) and (F) juvenile habitat

Table 1. Characteristics of the waters in the *T. tambra* habitat of the Mamis River

Parameters	Water substrate	Dominant riparian vegetation	Dominant aquatic vegetation
Broodstock habitat	Large rocks, sandy, and muddy	*Pometia pinnata*, *Ficus fistulosa*, *Hydnocarpus castanea*, *Aglaia tomentosa*	*Bryophytes*
Spawning habitat	Pebbles and sand	*Pometia pinnata*, *Ficus fistulosa*	*Bryophytes*
Juvenile habitat	Pebbles	*Balakata baccata*	*Homonoia riparia*, *Bryophytes*

composed of gravel and sand, canopy closure 40-75% and aquatic vegetation in the form of *Bryophytes*. The habitat of large/breeding fish is generally a riverbed with a river width between 10-15 m, a length of 40-60 m, calm to slow current, water depth >12 m, rock bottom, substrate composed of sand and gravel, muddy in color. Clear water and canopy closure >75% and aquatic vegetation in the form of *Bryophytes* (Figure 4).

During the research at three stations, 111 *T. tambra* were caught with a total biomass of 109.323 kg, included Station 1, 33 individual; Station 2, 36 individual; and Station 3, 42 individual. Total length ranged from 202-628 mm and body weight between 85-3553 g, which were grouped into 6 classes. The most commonly caught size for *T. tambra* juvenile with body lengths between 202-350 mm was the highest at Station 1 with 18 individuals (45%) and the low-

Figure 4. Riverine and aquatic vegetation at the research site, (A) *Pometia pinnata*, (B) *Ficus fistulosa*, (C) *Balakata baccata*, (D) *Homonoia riparia*

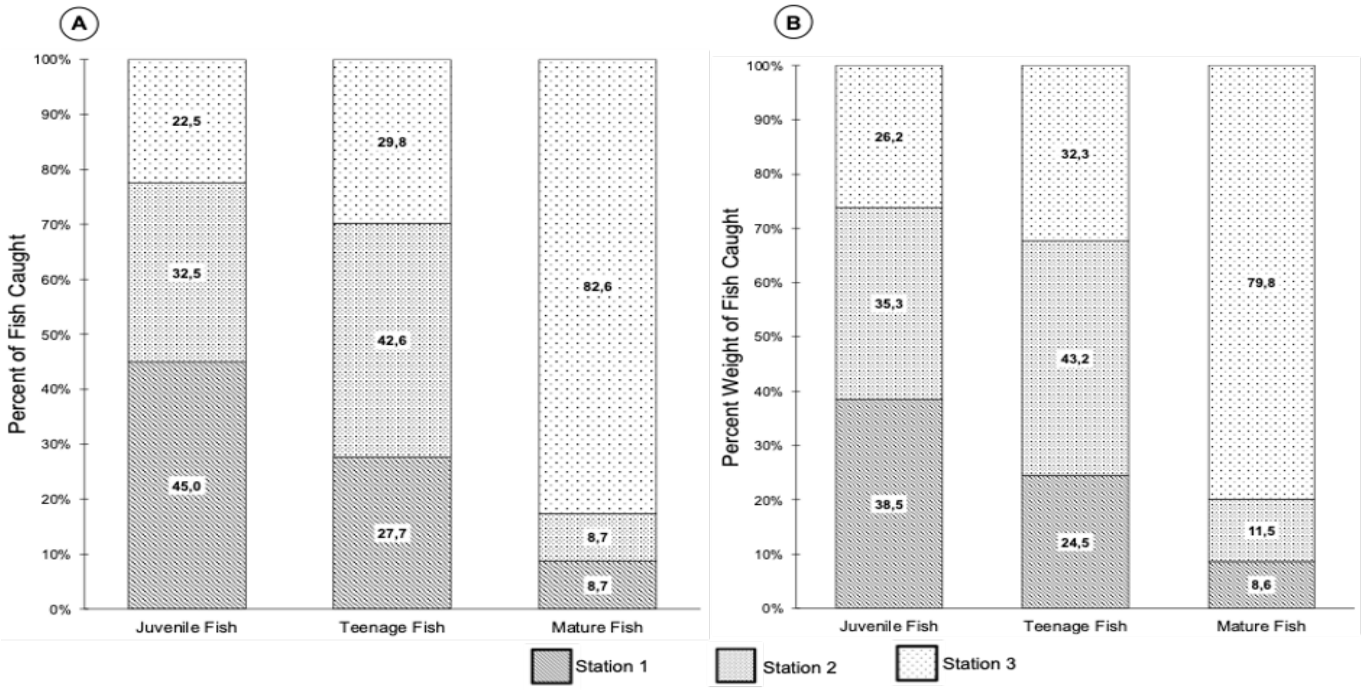

Figure 5. Percentage of number and weight of *T. tambra* catch in the Mamis River based on size class. (A) number of fish caught, (B) weight of fish caught

est at Station 3 with nine individuals (22.5%). Station 1 had the highest total weight of catches, namely 3920 g (38.5%), while the lowest total weight of catches at Station 3 was 2662 g (26.2%) (Figure 5).

The most commonly caught juvenile *T. tambra* with a body length of between 350-500 mm, the highest was at Station 2 with 20 individuals (42.6%), and the lowest was at Station 1 with 13 individuals (27.7%). Station 2 had the highest total weight of juvenile catches, namely 16425 g (43.2%), while the lowest total weight of juvenile catches at Station 1 was 9304 g (24.5%). The most commonly caught adult *T. tambra* sizes with body lengths above 500 mm were highest at Station 3 with 19 individuals (82.6), and the lowest were at Stations 1 and 2 with 2 individuals each (8.7%). Station 3 had the highest total weight of adult catches, 48796 g (79.8%), while the lowest total weight of juvenile catches was at Station 1, reaching 5270 g (8.6%).

The results of the water quality analysis for each station showed that the highest temperature was at Station 2 while the lowest temperature was at Station 3, namely 27.53 ± 0.55°C and 25.73 ± 0.47°C respectively. The results of the statistical analysis showed that there was no significant difference between the water temperature at Station 1 and Station 2 ($p > 0.05$). On the other hand, the water temperature at Station 3 showed a significant difference when compared to Station 1 and Station 2 ($p < 0.05$). The highest water pH level was found at Station 1 while the lowest water pH was found at Station 3, namely 8.57 ± 0.47 and 7.42 ± 0.29, respectively. The results of statistical analysis showed that there was no significant difference between the pH of the water at Station 1 and Station 2 ($p > 0.05$). On the other hand, the pH of the water at Station 1 showed a significant difference when compared to Station 3 ($p < 0.05$).

The highest dissolved oxygen levels were found at Station 3, while the lowest dissolved oxygen were found at Station 1, namely 8.17 ± 0.25 ppm and 7.23 ± 0.15 ppm, respectively. The results of the statistical analysis showed that there was no significant difference between the dissolved oxygen levels at Station 1 and Station 2 ($p > 0.05$). On the other hand, dissolved oxygen at Station 3 showed a significant difference when compared with Station 1 and Station 2 ($p < 0.05$).

The highest current speed was found at Station 2, while the lowest current speed was found at Station 3, namely 0.85 ± 0.11 s/m and 0.34 ± 0.06 s/m, respectively. The results of the statistical analysis showed that there was no significant difference between the current velocity at Station 1 and Station 2 ($p > 0.05$). On the other hand, the current speed at Station 3 shows a significant difference when compared with Station 1 and Station 2 ($p < 0.05$).

The highest brightness level was at Station 3, while the lowest brightness level was at Station 2, namely 38.8 ± 26.3 cm and 14.53 ± 32.01 cm, respectively. The results of statistical analysis show that there is no significant difference between the brightness levels at Station 1, Station 2 and Station 3 ($p > 0.05$).

The highest BOD level was at Station 1, while the lowest BOD level was at Station 3, namely 5.73 ± 1.27 mg/L and 1.10 ± 0.56 mg/L, respectively. The results of the statistical analysis showed that there was no significant difference between the BOD levels at Station 2 and Station 3 ($p > 0.05$). On the other hand, the BOD levels at Station 1 showed a significant difference when compared to Stations 2 and Station 3 ($p < 0.05$).

The highest COD level was found at Station 2, while the lowest COD level was found at Station 3, namely 36.59 ± 0.46 mg/L and 23.93 ± 3.38 mg/L, respectively. The results of the statistical analysis showed that there was no significant difference between COD levels at Station 1 and at Station 2 and Station 3 ($p > 0.05$). On the other hand, COD levels at Station 2 showed a significant difference when compared with Station 3 ($p < 0.05$).

3.1.3 Length weight relationship and condition factors

The total length class of *T. tambra* collected at Station 1 ranged from 202-618 (271±10.99) mm. The highest frequency of total length of *T. tambra* at Station 1 was in the range 256-309 mm from 11 fish, while the lowest frequency of total length was in the range 310-363 mm, 526-579 mm and 580-633 from 1 fish, respectively. The total length class of *T. tambra* collected at Station 2 ranged from 243-596 (365±9.27) mm. The highest frequency of total length of *T. tambra* at Station 2 was in the range 418-471 mm from 10 fish, while the lowest frequency of total length was in the range 580-633 mm from 1 fish. The total length class of *T. tambra* collected at Station 3 ranged from224-628 (515 ± 12.06) mm. The highest frequency of total length of *T. tambra* at Station 3 was in the range 526-579 mm from 10 fish, while the lowest frequency of total length was in the range 202-255 mm, 256-309 mm and 310-363 mm from 3 fish, respectively (Table 3 and Figure 6).

The weight of *T. tambra* collected at Station 1 ranged from 85-3150 (244±428.95) g . The highest weight frequency of *T. tambra* fish at Station 1 was in the range 85-518 g from 21 fish, while the lowest weight frequency was in the range 1821-2254 g and 3123-3556 g from 1 fish, respectively. The weight of *T. tambra* fish collected at Station 2 ranged from 129-2490 (606±360.70) g. The highest weight frequency of *T. tambra* at Station 2 was in the range of 85-518 g from 15 fish, while the lowest weight frequency was in the range of 1821-2254 g, only 1 fish. The weight of *T. tambra* collected by Station 3 ranged from 112-3553

Table 2. Characteristics of water quality in the upper reaches of the Mamis River

Parameter	Broodstock habitat	Spawning habitat	Juvenile habitat
Themperature (^{0}C)	26.1-26.3	26.2-26.4	26.7-27.1
pH of water	7.68-8.01	7.63-7.86	7.51-7.72
Dissolved oxygen (ppm)	7.2-7.8	7.1-8.2	8.2-9.2
Currents (s/m)	0.28-0.39	0.27-0.34	0.81-1.03
Brightness level (cm)	45.2-66.3	10.1-14.3	32.5-50
BOD (mg/L)	1.2-2.2	1.2-1.8	0.5-1.1
COD (mg/L)	20.2-26.8	22.4-26.7	16.37-19.65

Table 3. Composition and size distribution of *T. tambra* in the Mamis River

Parameter	Station 1	Station 2	Station 3
Number of samples (fish)	33	36	42
Total biomass (g)	18494	27072	63757
Total length range (mm)	202-416 (271±10.99)	243-596 (365±9.27)	224-628 (515±12.06)
Body weight range (g)	85-3150 (244±428.95)	129-2490 (606±360.70)	112-3553 (407± 584.34)

Table 4. Observation results of water quality parameters at three research locations

Parameter	Station 1	Station 2	Station 3
Temperature (^{0}C)	26.90 ± 0.30^b	27.53 ± 0.55^b	25.73 ± 0.47^a
pH of water	8.57 ± 0.47^b	7.61 ± 0.50^{ab}	7.42 ± 0.29^a
Dissolved oxygen (ppm)	7.23 ± 0.15^a	7.50 ± 0.26^a	8.17 ± 0.25^b
Currents (s/m)	0.60 ± 0.12^b	0.85 ± 0.11^b	0.34 ± 0.06^a
Brightness level (cm)	24.6 ± 12.77^a	14.53 ± 32.01^a	38.8 ± 26.3^a
BOD (mg/L)	5.73 ± 1.27^b	2.97 ± 0.46^a	1.10 ± 0.56^a
COD (mg/L)	30.68 ± 5.84^{ab}	36.59 ± 0.46^b	23.93 ± 3.38^a

Table 5. Results of analysis of the relationship between length and weight and condition factors of *T. tambra*

Parameter	Station 1	Station 2	Station 3
Intercept (a)	0.00001	0.00002	0.000003
Regression coefficient (b)	3.019	2.925	3.244
Determination coefficient (R^2) (%)	96.7	94.7	97.4
Correlation coefficient (r) (%)	98.3	97.3	98.7
Regression equation	$W= 0.00001\ L^{3.0191}$	$W= 0.00002L^{2.9249}$	$W= 0.000003L^{3.2444}$
Growth pattern	Isometrik	Allometrik negatif	Allometrik positif
Average condition factor	1.012 ± 0.158	1. 1.015 ± 0.174	1.011 ± 0.145

(1407±584.34) g. The highest weight frequency of *T. tambra* at Station 3 was in the range 2255-2688 g from 11 fish, while the lowest weight frequency was in the range 2689-3122 g, only 2 fish (Table 3 and Figure 7). Most of the *T. tambra* collected at Station 3 tended to have higher lengths and weights compared to Stations 1 and 2. The highest length measurements from Station 1 found in this study were not much different from the range of fish lengths from Station 2.

Analysis of the length-weight relationship at Station 1 with a total of 33 fish obtained results $W = 0.00001L^{3.0191}$ with a value of $R^2 = 0.967$ and a value of $r = 0.983$ (Table 2). The equation for the rela-

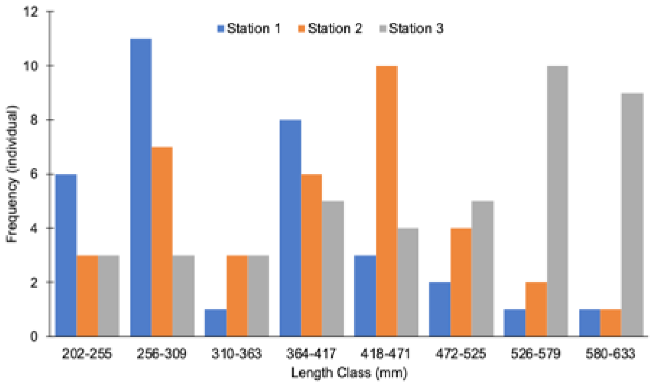

Figure 6. Length class intervals of *T. tambra* at Station 1 (population area), Station 2 (plantation area) and Station 3 (natural forest area)

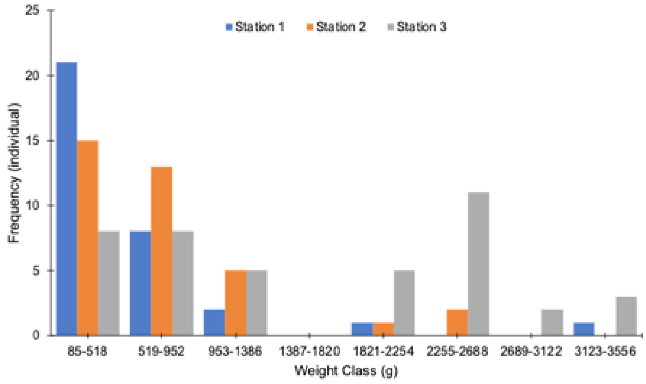

Figure 7. *T. tambra* weight class interval at Station 1 (residential area), Station 2 (plantation area) and Station 3 (natural forest area)

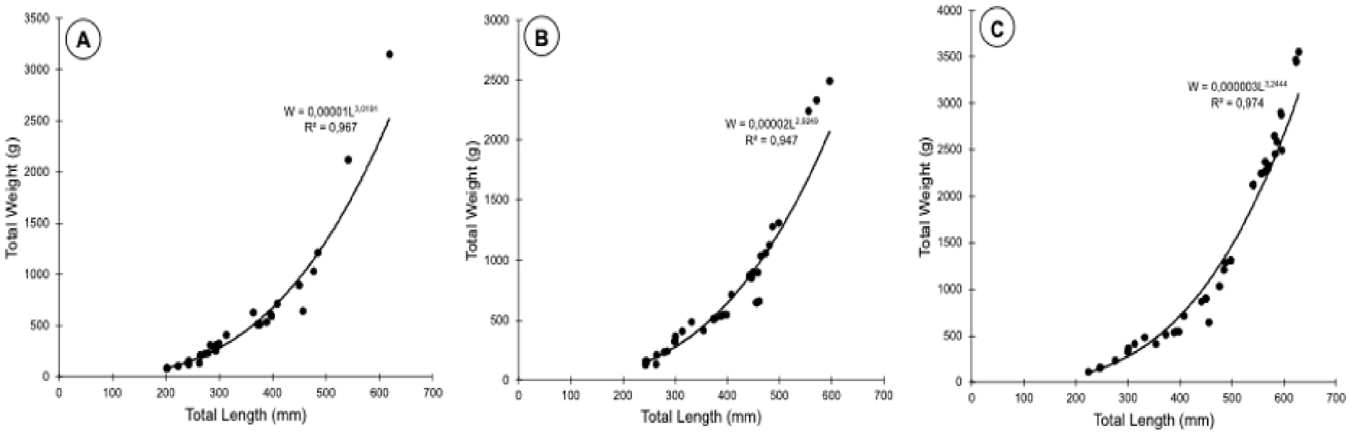

Figure 8. Length weight relationship of *T. tambra* in the Mamis River, (A) Station 1: residential area, (B) Station 2: plantation area, (C) Station 3: natural forest area

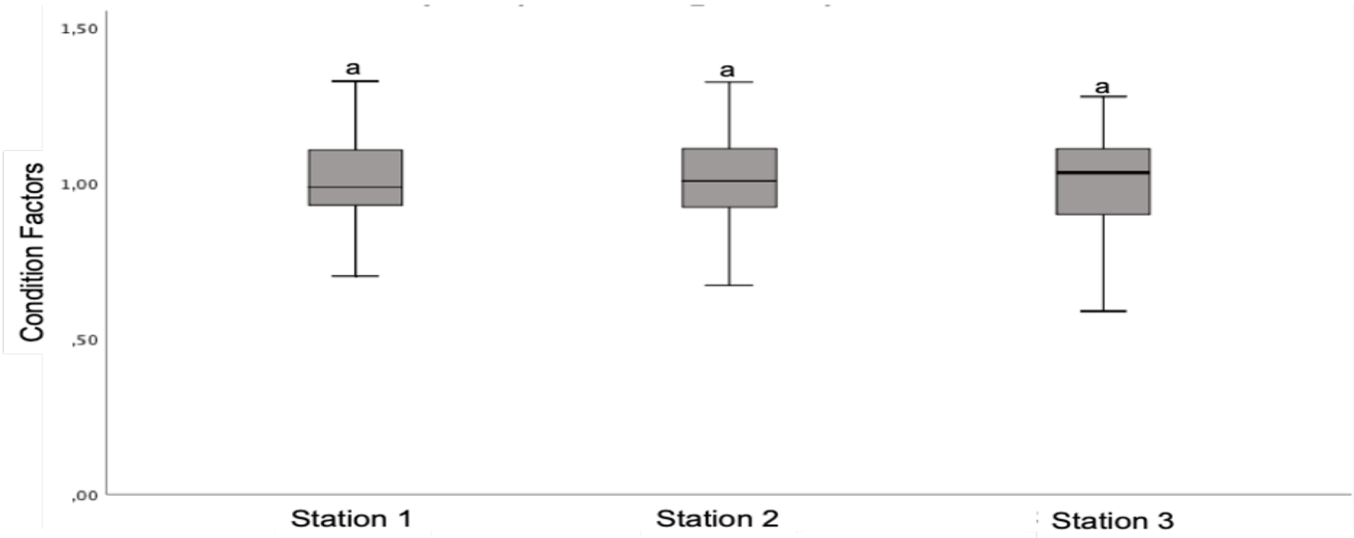

Figure 9. Condition factor values for *T. tambra* in the Mamis River. Note: Station 1: residential area, Station 2: plantation area, and Station 3: natural forest area

tionship between length and weight was obtained by a value of (a) of 0.00001 with a growth coefficient (b) of 3.019 (Figure 8). Then, the b value shows an isometric growth pattern, where the growth of fish weight and length is balanced. The coefficient of determination was obtained with a value of 0.967, which indicates that 96.7% of the growth in length of fish occurs due to the growth of fish body weight, while the other 3.3% is caused by other factors, such as environmental factors and age.

Analysis of the length-weight relationship at Station 2 with a total of 36 fish obtained results $W = 0.00002L^{2.9249}$ with a value of $R^2 = 0.947$ and a value of $r = 0.973$ (Table 2). The equation for the relationship between length and weight is obtained by a value of (a) of 0.00002L with a growth coefficient (b) of 2.925 (Figure 8). Then the value of b indicates a growth pattern that tends to be isometric, where the growth pattern in length and weight is balanced. The coefficient of determination was obtained with a value of 0.947 which indicates that 94.7% of the growth in fish weight occurs due to the growth of the length of the fish's body, while the other 5.3% is caused by other factors such as environmental factors and age.

Analysis of the relationship between length and weight at Station 3 with the number of 42 fish resulted in $W = 0.000003L^{3.2444}$ with a value of R^2 = 0.974 and a value of r = 0.987 (Table 2). The equation for the relationship between length and weight obtained a value (a) of 0.000003L with a growth coefficient (b) of 3.244 (Figure 8). The b value indicates a positive allometric growth pattern, where the weight growth pattern is more dominant than length. The determinant coefficient was obtained with a value of 0.974, which indicates that 97.4% of the growth in fish length occurred due to growth in fish body weight, while the other 2.6% was caused by other factors such as environmental factors and age.

The value of the condition factor of *T. tambra* between research stations tended to show almost uniform results. The highest average condition factor value was found at station one, namely 1.012±0.158, while the lowest value was found at station three, namely 1.011±0.145 (Table 2). The results of the statistical analysis showed that the condition factor values between research stations did not show a significant difference (*p>0.05*) (Figure 9).

3.2 Discussion

The distribution of *T. tambra* in rivers can be influenced by current, depth, substrate and rivarian vegetation. This fish is usually found in rivers and streams that flow quite fast. They prefer habitats with strong currents and clear water. *T. tambra* tends to inhabit areas that have varying water depths, from shallow water to deeper water. They can be found in shallow streams and also in deeper pools formed by rivers (Dwirastina and Wibowo, 2022). Additionally, *T. tambra*'s natural habitat often has rocky riverbeds. These rocks can provide hiding places and are important habitats for these fish. Around rivers and streams in their natural habitat, riparian vegetation (plants that grow on the banks of rivers) such as trees, shrubs and grasses can be found (Izzati and Hasibuan, 2019). This vegetation provides shelter, hiding places, and also serves as a habitat for various species of invertebrates that are food for *T. tambra*.

The increasing distribution of broodstock in upstream areas can be influenced by the depth of the water, the number of large rocks and the availability of sufficient food. In addition, upstream is an ideal habitat for spawning. The habitat of the juveniles is generally on river banks which are characterized by sandy substrates, calm currents, clear and shallow water (<50 cm) (Haryono and Subagja, 2008), and there is aquatic vegetation such as *Homonoia riparia* and *Bryophytes* (Sukamawati *et al*., 2023). This is thought to be related to its low ability to resist water currents (Muhtadi *et al*., 2017).

Studies related to growth patterns and condition factors are needed as a basis for mapping the characteristics of fish from a habitat. Differences in habitat can affect the size distribution of fish, growth patterns and fish condition factors. There are three types of habitats studied in Mamis Rivers; residential areas, plantation areas and natural forest areas. *T. tambra* collected from residential areas is generally in the juvenile phase, meanwhile in plantation and natural forest conditions it tends to be dominated by adults and broodstock. Differences in the distribution of the number of juveniles, adults and broodstock can be related to habitat conditions, including current speed, depth, substrate type, water clarity, and canopy cover factors (Haryono and Subagja, 2008).

Based on growth patterns, the upstream area has a higher b value than other areas. This is thought to be influenced by water quality and optimum food availability. The length weight relationship of fish is closely related to the availability of food in the fish's environment (Ningsih *et al*., 2023). Abundant food availability tends to result in faster growth in fish. Fish that have abundant access to food usually weigh more than similar fish that live in conditions where food is limited. This condition often results in a positive relationship between fish length and weight, meaning the longer the fish, the heavier the fish. Several types of food for *T. tambra* are mosquito larvae, aquatic insects and aquatic plants (Asyari, 2017). Several types of aquatic plants, such as water hyacinths or algae, can also be part of the *T. tambra* diet (Suraya, 2019). These plants can provide additional fibre and nutrients. In accordance with this research, temperature, dissolved oxygen, habitat condition, and aquatic vegetation provide the need for water quality and food sources for *T. tambra*. In this research, a lot of *Ficus fistulosa* vegetation was found, which, based on research by Muchlisin *et al.* (2015), revealed that the main food source of *T. tambra* is the fruit of *Ficus* sp.

Study of fish condition factors helps in understanding fish growth and reproduction. Fish that have good physical conditions tend to grow faster and have better reproductive abilities. In addition, the condition of the fish can provide insight into the quality of aquatic habitats. If the fish are in bad condition, this could be an indication of a problem in the aquatic ecosystem, such as pollution, decreased food availability, or changes in water temperature (Nilsson and Renöfält, 2008; Bhateria and Jain, 2016). Information about the physical condition of the fish helps in making decisions on the management of fishery resources. For example, if fish are in poor condition, it may be necessary to reduce catch quotas or other restrictions to protect fish populations (Gustiano *et al*., 2022). In general, the condition of the fish found in the rivers observed was in good condition.

4. Conclusion

T. tambra habitats in the Mamis River that can be categorized as broodstock and spawning habitat have characteristics of small to large rocks overgrown with *Bryophytes*, gravel and sand substrates, clear water color, slow to swift water currents, and primary forest. In the main habitat, there is dominant riparian vegetation in the form of forest timber trees such as *Pometia pinnata*, *Ficus fistulosa*, *Hydnocarpus castanea*, and *Aglaia tomentosa*. Meanwhile, the habitat for the juvenile is in the form of rocks, gravel substrate, clear water color, and fast water currents. In the nursery habitat, the dominant riparian vegetation is *Balakata baccata*. Analysis of the length weight relationship of *T. tambra* showed that the condition of the fish was stable (isometric and allometric positive) at the three sampling locations. Based on this study, it is recommended that *T. tambra* fishing should be carried out with a sustainable approach by limiting catch size (adults only) and avoiding the use of poisons and destructive fishing gear.

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Authors' Contributions

YA, II, MM and IZ: contribution to conception, acquisitions of data, analysis data, drafting data, and approval final version. MY, HP and YD: contribution to validation, drafting data critically revising and approval final version. ASB: contribution to analysis data, drafting data, and approval final version.

Conflict of Interest

The authors declare that they have no competing interests.

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