Diversity and Abundance of Fish in The Bone Canal

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Abstract. This study aims to describe the species diversity and abundance of fish in the Gorontalo Bone Canal. This research was conducted in the Bone Canal, Bone Bolango district, Gorontalo province with a survey method. Fish identification was carried out at the Zoology Laboratory of the Biology Department, State University of Gorontalo. The sampling technique was random sampling using nets installed at four observation stations for 24 hours. Station I is the northern part of the canal (upstream), station II is in the middle of the canal, station III is in the southern part of the canal (downstream) and station IV is located at the mouth of the Bone canal. Measurements of the physical and chemical parameters of water were carried out at each station. The fish caught were identified by referring to the book: "Identification of Freshwater Fish in Western Indonesia and Sulawesi" by: Kottelat at al, (1993). Research results and conclusions: 185 individual fish were found consisting of 3 orders, 5 families and 7 species, including: *Cyprinus carpio* and *Barbonimus goionotus* (Cypriniformes: Cyprinidae), *Hypostamus* sp. (Siluriformes: Loriicaridae), *Oreocrhomis mosambicus* and *Oreochromis niloticus* (Perciformes: Cichlidae), *Oxyeleotris marmorata* (Perciformes: Eleotrididae), and *Anabas testudineus* (Perciformes:Anabantidae). The highest diversity index is at station IV with H'= 1.96 and the lowest is at station I with H'= 1.50. This shows that the level of diversity of fish species in the Bone canal is moderate, the productivity is sufficient, the ecosystem condition is quite balanced and the ecological pressure is moderate. *Hypostamus* sp. has the highest level of abundance in all stations with an average of K = 30.9%. The lowest abundance was *Cyprinus carpio* with an average of all stations K= 3.3%, indicating that the abundance in Bone canal was relatively moderate.

1 Introduction

The diversity of organisms in aquatic environments is influenced by the water quality, which encompasses the physicochemical properties such as water temperature, clarity, flow velocity, pH, salinity, and dissolved oxygen. One biotic component that is highly affected by water quality is fish. Fish are highly sensitive to environmental changes. Alterations in the aquatic environment can lead to a decrease in fish diversity [3]. The abundance of fish is also influenced by the condition of the water and the presence of predators and competitors. Poor water conditions render some fish unable to survive, resulting in only a few fish species with a high population within a given environment.

Fish, or Pisces, are aquatic organisms that respire using gills. Based on their habits, fish belong to the group known as nekton. Nekton refers to water organisms that are capable of swimming strongly enough to counteract the water current [2]. Fish require a favorable and suitable aquatic environment to support their survival. An unfavorable water environment can cause some fish to die, while others may migrate to areas that have not been contaminated. Only a few aquatic organisms can tolerate extreme or low water conditions, resulting in a small number of species with a high number of individuals and the dominance of specific organisms [1].

The ability of fish to tolerate water quality depends on the presence of pollutants entering the water and the condition of the fish. Toxic pollutants, such as pesticides, can cause massive mortality among most biota, while non-toxic pollutants can lead to gradual death of biota [2]. Additionally, young and weakened biota, such as larvae or old individuals, are more susceptible to pollutants. Biota with high mobility can avoid contaminated environments, whereas sessile organisms or those with limited mobility are highly vulnerable to pollutants.

Canals are water channels that serve the purpose of water flow for irrigation and also act as reservoirs during the rainy season to prevent water overflow and subsequent flooding. Canals are parts of river systems that have been expanded or deepened in specific areas, created by humans to meet various needs [4]. Canals are artificial ecosystems that contain both abiotic and biotic components. The presence of biotic components in canals can be assessed by measuring organism diversity.

The Bone Canal is a canal located in the Bone Bolango district of Gorontalo province. The Bone Canal stretches for 2.5 km with a width of 25 m and a depth of

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4 m. It extends from the upstream village of Poowo to the downstream village of Oluhuta. The Bone Canal is an extension of the Bone River designed by the government to prevent flooding. The transformation of the natural ecosystem into an artificial one can have an impact on aquatic organisms. Changes in water characteristics can affect the diversity and community structure of aquatic organisms [5]. Both sides of the canal have experienced sedimentation, leading to shallowing and some parts of the canal no longer being covered by water.

The Bone Canal serves as a flood control channel, collecting excess water during the rainy season and acting as a conduit for the Bone River. The local community also utilizes the Bone Canal for agricultural irrigation and as a disposal site for agricultural and household waste. Agricultural and household waste are pollutants that can contaminate the canal's water, thereby altering the physicochemical conditions of the water and impacting the diversity and abundance of organisms in the canal. The introduction of household and agricultural waste into the water can alter the diversity and abundance of aquatic organisms within it [6].

The utilization of the Bone Canal as a fishing ground to meet the consumption and economic needs of the community also affects the diversity and abundance of fish. Activities such as excessive fish exploitation and land use can lead to changes in the diversity and abundance of fish [7].

2 Methods

The research was conducted in the Bone Canal, Bone Bolango District, Gorontalo Province (Figure 1). The process of fish sample identification was carried out in the Biology Laboratory, Faculty of Mathematics and Natural Sciences, Universitas Negeri Gorontalo.

The research was conducted from October to December 2019. The tools used included the Global Positioning System (GPS), hand refractometer, secchi disk, pH meter, DO meter, current meter, identification book, writing materials, camera, and net. The material used was 70% alcohol, which was used as a sample preservative.

The data collection technique used was random sampling, which involved randomly selecting samples from three stations, each with a length of 80 meters. Station I was located in the northern part of the canal, characterized by relatively shallow and rocky water conditions. Station II was situated in the middle of the canal, which was considered deep, free from rocks, and also used as a disposal site for agricultural waste. Station III was located in the southern part of the canal, characterized by deep water and also used as a disposal site for agricultural waste. Station IV was positioned at the mouth of the Bone Canal, characterized by deep water and used as a sand mining location.

The obtained data was then analyzed descriptively to describe the identified fish species. Data of the diversity of mudskipper species were analyzed using the Diversity Index (H') [8]. $H' = -\sum_{i=1}^{S} pi \, ln \, pi$ where $pi = \frac{ni}{N}$. H' represents Shannon-Wienner Diversity index, S for total species, Ni for total individuals in a species, Ln for natural algorithm and N for total individuals found. The value of H' determines the level of species diversity in an area, where the definition of the value of species diversity according to Shannon-Wienner is: H'> 3: High species diversity, 1 ≤ H' ≤ 3: Medium species diversity, H' < 1: Low species diversity. The absolute abundance of each fish species is determined using Odum formula $K = {ni}/{A}$ where K for species abundance, *ni* is for total abundance of species I, and A is for observation transect area [9].

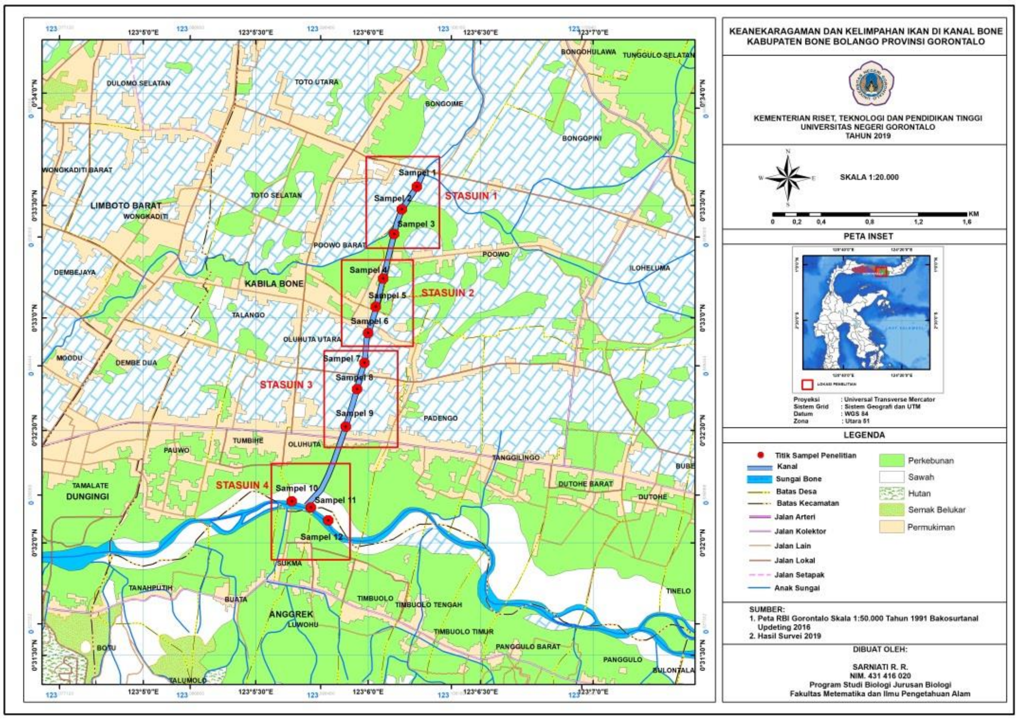

Fig. 1. Research Location Map

Relative abundance of fish is calculated using the formula $KRi = \Sigma \frac{Ki}{K} x\ 100\%$ where KRi is for the relative abundance, Ki is for the abundance of species i, and K is for the total abundance of all species. The criteria for relative abundance of fish are as follows: relatively rare if the total catch is < 25%, relatively moderate if the total catch is between 25% and 50%, and relatively high if the total catch is > 50% [10].

3 Result and discussion

Based on the research conducted in the waters of the Bone Canal and the Mouth of the Bone Canal, a total of 185 individuals were obtained, consisting of 3 orders, namely Cypriniformes, Siluriformes, and Perciformes (Table 1).

Based on the results of the analysis of absolute abundance and relative abundance data of fish obtained in the waters of the Bone Canal and the Mouth of the Bone Canal, they can be seen in Figures 2 and 3. The species diversity of fish in the Bone Canal and the Mouth of the Bone Canal can be seen in Table 2. The diversity of fish species in the Bone Canal. The measurement of physicochemical parameters of the water in the Bone Canal and the Mouth of the Bone Canal can be seen in Table 3.

3.1 *Cyprinus carpio*

Cyprinus carpio has an elongated and bilaterally symmetrical body. The body is compressed (flattened) where the width is smaller than the height, and the height is smaller than the length. The common carp has scale-like golden scales and a single-notched tail fin (Figure 4).

Table 1. The Number of Fish Individuals in the Waters of the Bone Canal and the Mouth of the Bone Canal

Class	Order	Family	Species	Station				Total number of individuals
				ST I	ST II	ST III	ST IV	
Actinopterygii	Cypriniformes	Cyprinidae	*Cyprinus carpio*	1	4	1	1	7
			Barbonimus goionotus	6	5	4	3	18
	Siluriformes	Loriicaridae	*Hypostamus sp.*	13	16	14	12	55
	Perciformes	Cichlidae	*Oreocrhomis mosambicus*	11	17	14	8	50
			Oreocrhomis niloticus	6	10	11	6	33
		Eleotrididae	*Oxyeleotris marmorata*	1	1	3	4	9
		Anabantidae	*Anabas testudineus*	1	3	4	5	13
			Total	39	56	51	39	185

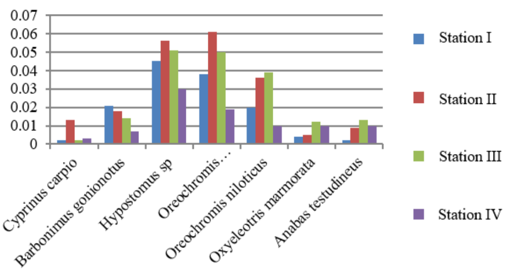

Fig 2. Absolute abundance data of fish obtained in the waters of the Bone Canal and the Mouth of the Bone Canal

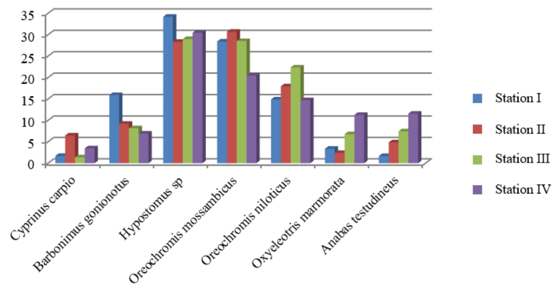

Fig 3. Relative abundance data of fish obtained in the waters of the Bone Canal and the Mouth of the Bone Canal

Table 2. The species diversity of fish in the Bone Canal and the Mouth of the Bone Canal

Station	Diversity index (H')	Category
I	1,50	Medium
II	1,65	Medium
III	1,65	Medium
IV	1,96	Medium

Table 3. The species diversity of fish in the Bone Canal and the Mouth of the Bone Canal

Environment parameters	Station		
	I	II	III
Current			
Flow rate	1,50	Medium	
Temperature	1,65	Medium	
Salinity	1,65	Medium	
Current	1,96	Medium	

3.2 *Barbonimus goionotus*

Barbonimus goionotus has a slightly whitish silvery body color, with the belly being slightly lighter in color compared to the back. It has a compressed (flattened) body shape, where the width of the tawes fish is smaller than its height, and the height is smaller than its length. The back of the tawes fish forms a triangular shape (Figure 4).

The mouth of the tawes fish is located in the middle and has small barbels, as well as a pointed snout. It has fins that are gray or yellowish in color. The tail fin of the tawes fish has a forked shape.

3.3 *Hypostamus* sp.

Hypostamus sp. belongs to the Loricariidae family (Figure 4). The plecostomus fish has a wide head and body, as well as a long tail stalk. Its dorsal fin is wide and starts with a hard spine. The plecostomus fish is black in color with fused lines on its back. It has a body covered with tough skin and a disc-shaped mouth.

3.4 *Oreochromis niloticus*

Oreochromis niloticus has an elongated and flattened body shape (Figure 4). It possesses pelvic, anal, dorsal, and caudal fins, as well as a stiff dorsal fin. There are slanted lines at the tip of the dorsal fin. The caudal fin is whitish-black with several straight lines.

The richness of a water body can be reflected in the diversity of fish species present within it. Based on the research, the Bone Canal and Bone River exhibit a moderate level of diversity. This is consistent with the calculated H' values falling within the range of 1-3. This fact indicates that the fish in the Bone Canal and its estuary have a moderate variety of species and moderate population sizes for each species. Several factors are believed to influence the diversity of fish species, including food availability. Some fish species rely on aquatic plants as their food source. Tilapia, rohu, and silver carp exhibit herbivorous tendencies that lean towards omnivory [11]. These fish commonly consume.

O*reochromis niloticus* has a subterminal mouth that is directed upward, with a pointed tip. It has prominent eyes, and the edges of the eyes are white in color.

3.5 *Oxyeleotris marmorata*

Oxyeleotris marmorata has a large head that gradually tapers towards the tail (Figure 4). The body of the marble goby is covered in small scales. It has a dark coloration on the back, while the belly is lighter than the back.

Oxyeleotris marmorata has 80-90 rows of scales along its body. It has a rounded abdomen. There are spots on the caudal fin, while no spots are present on the caudal peduncle. The caudal fin of the marble goby is rounded in shape.

3.6 *Anabas testudineus*

Anabas testudineus has a yellowish coloration and black spots on the sides of its body, closer to the dorsal region. It has hard scales and gill covers, as well as a rigid dorsal fin.

The tail of the *Anabas testudineus* is round in shape, and its body exhibits bilateral symmetry. The climbing perch has sturdy gill covers, pectoral fins, and pelvic fins, enabling it to support its body movement.

Aquatic plants such as water spinach and moss. Water currents also play a role in the availability of food for fish. Currents carry organic materials necessary for the aquatic organisms' survival [12].

The average diversity index for fish at Stations I, II, and III, which represent artificial ecosystems, is 1.60, while Station IV, representing a natural ecosystem, has an average diversity index of 1.96. These data indicate that the diversity of fish in natural ecosystems is higher compared to artificial ecosystems. This is likely due to the imbalance in the number of individuals for each species. Uneven species abundance can negatively affect the diversity index [9]. Additionally, the water

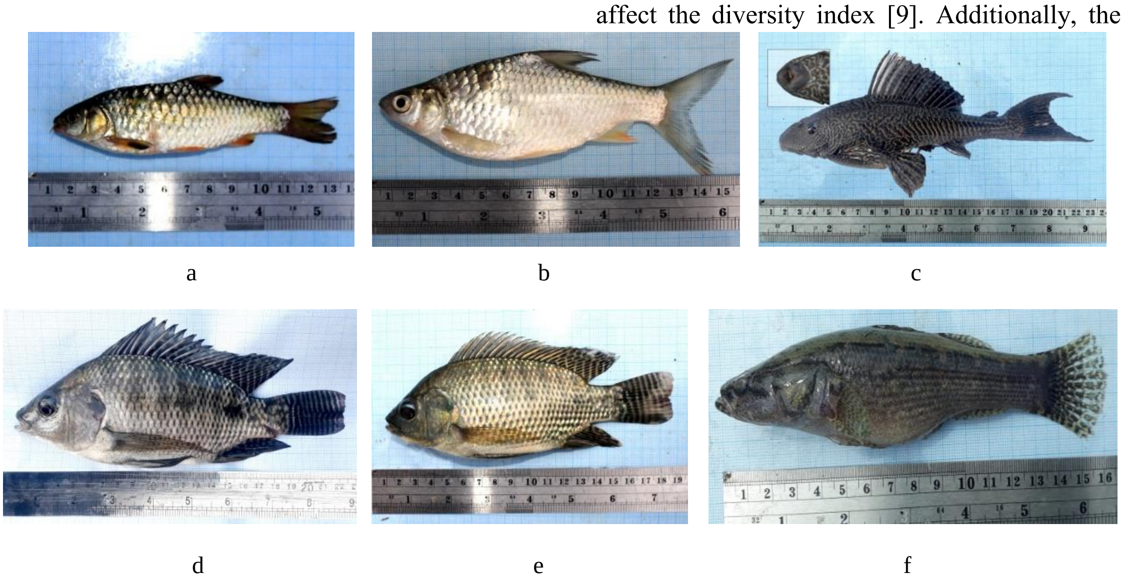

Fig 4. The fish species found in the Bone Canal and the Mouth of the Bone Canal. a. *Cyprinus carpio*, b. *Barbonimus goionotus*, c. *Hypostamus* sp., d. *Oreochromis niloticus*, e. *Oxyeleotris marmorata*, and f. *Anabas testudineus*

storage during the rainy season and water usage during the dry season in the canal can result in a decline in fish production. Unpredictable water conditions, such as flooding during the rainy season and reduced water levels during the dry season, can lead to the loss of fish spawning and nursery habitats [13].

The fish species found at all stations are classified the same, but the number of individuals for each species differs, resulting in different diversity indices for fish at each station. The lowest fish diversity is observed at Station I, with a diversity index of 1.50 and a total of 39 individuals representing all fish species. The high number of species and the number of individuals for each species within a region can indicate a high level of diversity in that region [14]. Conversely, if a region has a low number of species and a low number of individuals for each species, it indicates low diversity in that region.

The species found at Station I are classified as having low to moderate abundance. *Hypostomus* sp. (pleco catfish) and *Oreochromis mosambicus* (Mozambique tilapia) have higher abundance compared to other fish species, with abundance indices of 34.2% and 28.4%, respectively. The abundance of pleco catfish is attributed to its ability to thrive in various types of water bodies. Pleco catfish can inhabit rivers, swamps, and lakes [15]. Additionally, pleco catfish can tolerate low-oxygen environments, such as muddy waters. The abundance index of pleco catfish falls into the moderate category.

The high abundance of Mozambique tilapia compared to other fish species is believed to be due to food availability and the adaptability of Mozambique tilapia to its surrounding environment. Competition for food is suspected to influence fish abundance. *Oxyeleotris marmorata* has low abundance with an abundance index of 3.39%. This is attributed to the fish's limited adaptability to changes. *Oxyeleotris marmorata* is highly sensitive to environmental changes [16]. Additionally, factors contributing to the low abundance of *Oxyeleotris marmorata* are high mortality rates, low reproduction, and growth [17].

The highest abundance of fish is found at Station II, with an average abundance range of 2.4-30.7% for each species. Sapu-sapu and Mozambique tilapia still exhibit higher abundance compared to other fish. The abundance of food resources at Station II is believed to be a contributing factor to the increased abundance of each fish species. One of the crucial elements supporting fish growth is the food chain [18]. Furthermore, Nile tilapia and Mozambique tilapia exhibit herbivorous tendencies that lean towards omnivorous [11]. Nile tilapia and Mozambique tilapia commonly utilize aquatic plants such as water spinach and moss as food sources. The abundance of carp increases from 1.7% to 6.5%, which is likely due to the better environmental conditions at Station II compared to Station I.

The abundance of *Anabas testudineus* (climbing perch) and *Oxyeleotris marmorata* experienced an increase at Station IV, from 7.4% to 11.5% for *Anabas testudineus*, and from 6.7% to 11.2% for *Oxyeleotris marmorata*. Favorable environmental conditions and nutrient availability result in optimal growth for climbing perch. The flattened morphology of climbing perch enables it to thrive in fast-flowing waters such as rivers. *Oxyeleotris marmorata* is a carnivorous fish that feeds on natural prey such as shrimp, worms, and small fish [17]. The availability of food in the river is believed to affect the abundance of *Oxyeleotris marmorata*.

The water current strength in the Bone Canal and Bone River differs significantly. The canal has a slow flow velocity ranging from 0.013 to 0.015 m/s, while the river has a fast flow velocity ranging from 0.13 to 0.18 m/s. Flow velocity is influenced by the width of the water body [3]. The canal is wider than the river, causing the water to disperse evenly and resulting in slower flow velocity. Flow velocity of a water body affects the distribution of fish species in a habitat [1]. Fish diversity is higher in the river compared to the canal, but the number of each species found in the canal is higher than in the river.

Water clarity in the Bone Canal and Bone River ranges from 42 to 92 cm. Stations I, II, and III are classified as low clarity, ranging from 42 to 44 cm, while Station IV is classified as having good clarity with a value of 92.33 cm. Good water clarity for fish life is above 45 cm [19]. Water clarity ranging from 30 to 40 cm is considered less suitable for fish farming. Water clarity indicates the penetration of light into the water. The light penetrating into the water is used by living organisms for photosynthesis and primary production in aquatic environments [20]. If water clarity is less than 25 cm, the dissolved oxygen content will decrease drastically.

The salinity of the Bone Canal and Bone River waters does not differ significantly. The average salinity of the Bone Canal is 5.5‰, while in the river, it is 5.0‰. These values indicate a salinity level that is still suitable for fish life. Salinity values for freshwater range from 0.5 to 5.0‰, while brackish water ranges from 6.0 to 29.0‰, and seawater ranges from 30.0 to 40.0‰.

Every organism in the water has a tolerance limit to pH changes. The pH range in the Bone River and Bone Canal is between 6.8 and 7.2. The optimal pH range for fish growth is between 5.0 and 7.0 mg/l. Water conditions that are too acidic or alkaline can disrupt the metabolism and respiration of fish.

4 Conclusion

Based on the research findings, it can be concluded that the highest species diversity of fish is found at station IV with a diversity index of 1.96, while the lowest diversity is observed at station I with an index of 1.50. In terms of abundance, *Hypostomus* sp. exhibits the highest abundance with a relative abundance index of 30.9%, whereas *Cyprinus carpio* has the lowest abundance with a relative abundance of 3.3%.

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