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Abstract. The aim of this study was to determine the diversity of fish species, and the role of the Bogowonto River estuary as the nursery and feeding ground of fishes. Seven sampling stations were determined in the estuary of Bogowonto River. Fish samples were identified, and measured the length and weight. The results showed that 2235 fishes were caught consisting of 38 species. The monthly Shannon-Wiener diversity index (H') ranged from 1.05 to 2.38, while the evenness index (E) ranged from 0.44 to 0.74, and the species richness index (D) ranged from 0.22 to 0.45. The diversity index at each station showed the range of 1.72 to 2.29, and the evenness index ranged from 0.59 to 0.85, while the evenness index ranged from 0.22 to 0.34. The presence of the most numerous species namely *Mystus gulio* had the occurrence of 35.35%, and the second largest number was *Moolgarda engeli* 14.08% then *Ambassis macrachantus* 11.54%. Most fishes were juvenile with average size of <10 cm and weight <15 g. Bogowonto River estuary has played an important role in providing a nursery, feeding and spawning ground for marine, brackish and freshwater fishes.

Keywords: diversity, ecology, estuary, fishes, Yogyakarta

1. Introduction

Bogowonto River upstream is located in the Central Java Province, Indonesia, which empties into the Indian Ocean. The length of the river is approximately 67 km flowing from the north to the south direction. The mouth of the river is located in Kulon Progo Regency, and as an estuary it extends parallel to the coastline. Estuary of Bogowonto River is very unique because along the south side of the estuary there is a sand dune [1] that can protect the existence of the estuary from the waves of the Indian Ocean. The sand dune that covers the river mouth serves as a natural weir, and as the waters in the Bogowonto River estuary were inundated, the salinity was greatly reduced to near 0 ppt, and the estuary waters were dominated by fresh water. Subsequently, in the rainy season when the river water discharge from the upstream was very high causes the sand dune to collapse and the mouth of the river to open again. Then the seawater flowed into the estuary and back while the estuary waters were in tidal conditions. These conditions created Bogowonto River estuary ecosystems as tidal ecosystems and flooded ecosystems [2]. On both sides of the estuary there were mangrove plants that grew naturally and were intentionally planted by the community. Mangrove plants were found around the estuary and on both sides of the river mouth. The existence of mangrove plants in the estuary area became an important habitat for aquatic biotic, especially fish/crustacean in larvae stage [3].

Mangrove ecosystems could support not only ecologically valuable species, but also economically valuable fish/crustacean species that derived from their own mangrove ecosystems, as well as from

upstream rivers, coastal and offshore areas [4]. Mangrove habitat was also a nursery ground for both shrimp and fish. The presence of mangroves around Bogowonto River estuary was very beneficial as ecologic, economic and social as well as other benefits. Ecological benefits could serve as habitat for fish, crustaceans, birds, and other organisms [5]. Economic benefit was that the existence of mangroves could be used for tourism activities, hence the surrounding community could use to generate income [6]. Social benefits were the formation of community groups that take care about managing mangroves. Another benefit was that mangroves have played an important role especially in nutrient cycles and food webs [2].

The southern coastal areas of Kulon Progo and Purworejo Regency were widely used for agriculture, aquaculture, settlements and other uses. Aquaculture conducted by fish farmers were mostly shrimp farms that utilized the sand dunes that still extends over the coast. Vannamei shrimp farming began to be done by the community since around 2010 by utilizing sand along the south coast [1]. Ponds were made by digging sandy soil surfaces, then pond surface was covered using mulch sheet. Water sources were obtained by sucking from wells at a depth of 20-50 m using a water pump machine. The culture period ranged from 50-100 days with production of 10-20 tons/ha [7]. Shrimp farms wastes were mostly discharged directly into the surrounding environment without going through a waste treatment plant. The composition of shrimp pond waste was mostly in the form of organic material of uneaten feed, feces, skin and dead shrimp. These small amounts of organic matter could be broken down by microbials into simple elements useful for chlorophyll containing organisms, such as phytoplankton, mangroves and other plants. However, shrimp pond waste in large quantities would cause pollution and other environmental disturbances, including death of aquatic organism, disappearance of fish and shrimp larvae and other disturbances for living things. The aquatic organisms that were able to adapt to the wastewater would remain alive and reproduce, whereas those susceptible to waste disposal would decrease in population.

Information on the fish community structure of the Bogowonto River estuary was still limited, so it was important to study the fish communities' structure. In addition, the activities of shrimp farming along the coast of Kulon Progo and Purworejo regency were increasing, so the volume of sludge was also increasing and would certainly have an impact on the fish community in the estuary area. The purpose of this study was to evaluate the impact on shrimp farming activities on the structure of fish communities in Bogowonto River estuary. The results of this study were expected to be a reference to policy makers for coastal area management in Kulon Progo regency and Purworejo.

2. Materials and Methods

2.1. Study site

Seven stations (figure 1) were selected based on ecological character difference to examine the effect of disturbance and pollution from shrimp aquaculture on fish fauna. All sites were approachable by motorcycles. The characteristics of each station are described below. Station 1 has a strong current due to this station being a meeting point of the three water currents i.e. rivers upstream, tidal current and estuary current. The bottom at this station was sand and rocky with mangrove trees and vannamei shrimp aquaculture. Station 2 was located near the waste disposal section of the vannamei shrimp farm. The bottom at this station was sandy with mud and had a slow current, and there were many mangrove trees in this station, vannamei shrimp farms, buildings of wood for tourist attractions and houses. Station 3 has shallow waters with slow currents and sandy bottom beds. Vegetation at this station included many mangrove plants that grow along the river, and there were also shrimp farms and wooden buildings that were used for tourist attractions.

Station 4 was located at the river mouth with fast-flowing water. This station has a muddy sand bed and for vegetation, had several large terrestrial trees, grass on the edge of the river, in addition to a lot of garbage piled up along the river from the sea and flood from upstream. Position of station 5 was adjacent to an active pond outlet. On the north and the south side of the estuary was mangrove vegetation, and was close to residential houses. The substrate type was muddy and rocky. The environmental characteristics of station 6 have mangroves on the north and south sides that were very lush when

compared to other stations. Station 6 was adjacent to ponds and farms. Substrate type of mud and garbage was found. The station 7 has a characteristic of the river branching. On the north and south there were vegetation of wild plants, while the mangrove was found only slightly. Station 7 was adjacent to ponds and tourist areas. Mangroves at this station was very rare when compared with the other stations and substrate type was muddy.

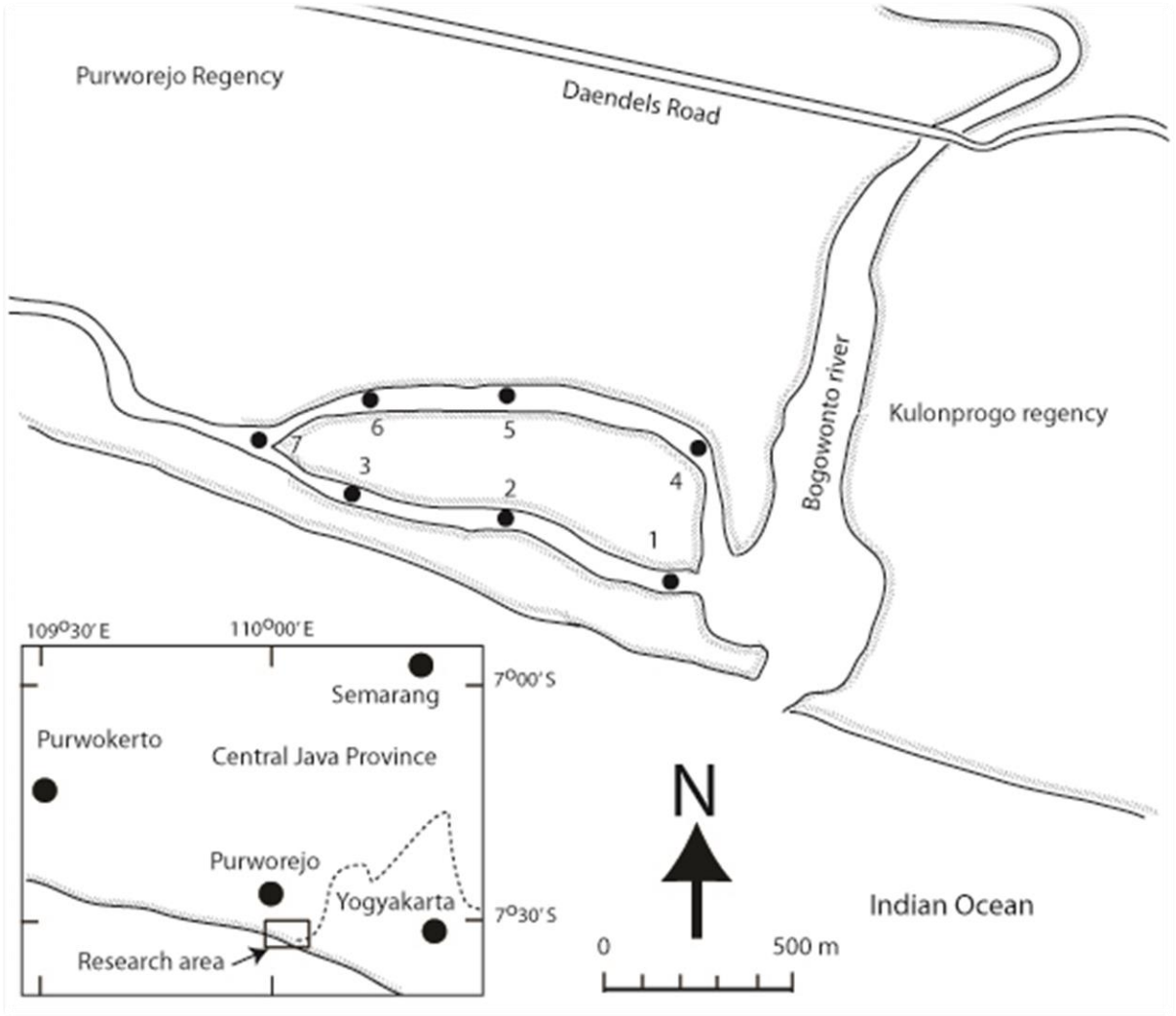

Figure 1. A map showing the location of the research at the Bogowonto River estuary. ● the sampling station (1-7).

2.2. *Data collection*

Water quality parameters were measured at each station along with fish sampling. The water quality was measured using the water quality checker YSI 556 MPS, namely temperature (°C), salinity (ppt), dissolved oxygen (ppm) and pH. Fish samples were obtained by catching using a hand cast net operated by a local fisherman. The size of the cast net used was 5 m in diameter and the mesh size was 1 cm. Fish sampling was conducted once a month for a year from October 2016 to September 2017, but there was no sampling in March. Fish catching was conducted during the daylight hours coincided with the ebb tide in unobstructed areas with gently sloping banks.

All the fish caught were collected, and then transferred to the laboratory, and stored in the refrigerator until further laboratory analysis, namely identification, counting, and measurement of length and weight. Identification of fish species was done based on a fish identification guidebook, namely [8], and then were compared with available data by FishBase [9]. Total length of each individual fish was meassured using a ruler glued to the board. The length of the fish was measured from the front end of the maxilla to the tip of the caudal fin and the accuracy of measurement length was to the nearest

millimeter. The biomass of each fish species was determined on an electric balance to the nearest weight.

2.3. Data analysis

To understand the fish composition in estuaries, the fish community was classified into several groups based on migratory behavior, spawning habits, foraging habits, and salinity preferences following to [9, 10]. The fishes were classified as an estuarine resident fish (ER) (those that inhabit estuarine waters throughout their life cycle), estuarine-dependent marine fish (ED) (marine species which are predominantly found in estuary at some stage of their life cycle), or an estuarine nondependent marine fish (EN) (species commonly found in both estuarine and coastal inshore areas and do not depend upon estuarine).

The diversity, evenness, and richness indices were calculated for understanding the status of diversity using the following formula [11]. Shannon-Wiener diversity index as follows:

$$H' = -\sum pi \ln pi \quad (1)$$

Note: pi= the proportional abundance of the species i.

Uniformity or "evenness" using the similarity index of individuals' distribution, as follows:

$$E = H'/\ln S \quad (2)$$

Note: S= total number of species obtained at each sampling.

Species richness was calculated as follows:

$$D = \frac{S}{\sqrt{N}} \quad (3)$$

Note: N= total number of individual fish obtained at each sampling.

3. Results and Discussion

Water quality that was meassured at each sampling station in the research area are temperature, salinity, dissolved oxygen content and pH (figure 2). The average water temperature at all sampling stations ranged from 26.9 to 30.2^{o}C, the lowest temperature was at station 4 while the highest temperature was at station 1. At station 4 there were a lot of mangroves and terrestrials plants and was a meeting point of the main river with tributaries, so that the temperature was the lowest. The least difference maximum with minimum temperature was at station 2, while the highest difference in the maximum with minimum temperature was at station 5. Very large temperature fluctuations in station 5 was due to the lowest amount of mangroves that could shade the surrounding water, hence the water is exposed to more sunlight than other stations.

The average salinity of all sampling stations ranged from 6.6 to 10.3 ppt, the lowest was at station 4 while the highest was at station 1. The location of station 1 was closest to the river mouth, so it gets the most seawater intake. Station 4 was close to the rice fields and settlements so that they get the most freshwater sources. The highest salinity was 13.7 ppt which occurs in the dry season, while the lowest was 0.5 ppt occurs in the rainy season. During the rainy season which runs from October to March, the Bogowonto River was very often flooded, so the salinity of the estuary was very low, and vice versa occurs during the dry season between April and September. Overall salinity in the estuary area among stations was relatively the same and tend to be low, which was due to more fresh water input from the Bogowonto River.

The mean dissolved oxygen content ranged from 2.0 to 4.5 ppm. Although the dissolved oxygen content among stations was relatively uniform, the dissolved oxygen content tend to be low in stations adjacent to shrimp aquaculture and tend to be high at stations adjacent to the main river. Dissolved oxygen content tends to be low because there was a lot of organic material from the pond waste. The biggest difference in the maximum and minimum oxygen content was at station 6. The location of station 6 received the most organic waste from its surroundings.

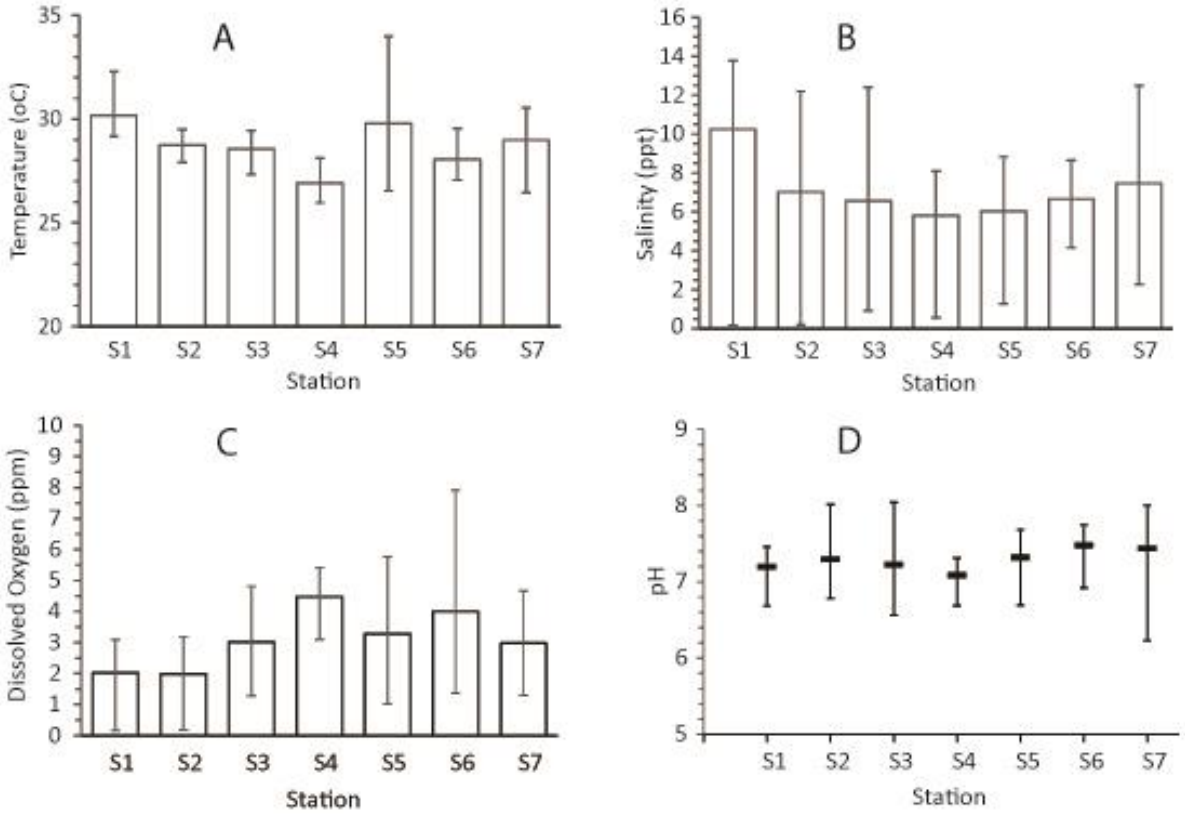

Figure 2. Water quality at each sampling station (S1-S7) in the Bogowonto River Estuary (description of panel: (A) temperature; (B) salinity; (C) dissolved oxygen; (D) pH). The bar lines in each panel are the maximum and minimum value limits.

The pH between stations showed the average ranges of 7.0-7.5. The average pH between stations was relatively the same and in the normal range. Maximum-minimum variation in pH tends to be high in areas that receive a lot of pond waste. Farmers use lime to increase the pH of shrimp farming and fertilizer to grow natural food. Shrimp aquaculture waste discharged into the estuary area will affect the pH.

The fish collected during sampling totalled as much as 2,235 individuals consisting of 38 species and 27 families (table 1). At station 4 we caught the most fish (33.6%), while the least at station 1 (3.3%). Station 4 was a meeting point of the main river with tributaries and has the thickest mangrove density, so it has the highest fertility. This condition was very supportive of a nursery ground of fish.

Table 1. List of fish species identified and caught at each sampling station (S1-S7) during the study period at the Bogowonto River Estuary.

Family	Species	S1	S2	S3	S4	S5	S6	S7	Total	%
Ambassidae	*Ambassis macrachantus*	27	58	2	37	22	88	24	258	11.54
Anabantidae	*Anabas testudienus*						11	1	12	0.54
Apogonidae	*Apogon hyalosoma*		3	1					4	0.18
Bagridae	*Mystus gulio*	14	17	110	204	146	153	146	790	35.35
Carangidae	*Carangoides malabaricus*	3	7	4	35	11	2		62	2.77
	Trachinotus blocii	2							2	0.09
Channida	*Channa striata*						1		1	0.04
Cichlidae	*Oreochromis niloticus*					14	25	31	70	3.13
	Oreochromis mossambicus					6	13	11	30	1.34
Clupeidae	*Clupeonella tscharchalensis*						2	3	5	0.22
	Sardinella lemuru		1						1	0.04
Cynoglossidae	*Cynoglossus puncticeps*			1	9				10	0.45
Cyprinidae	*Hampala macrolepidota*							5	5	0.22
Eleotridae	*Ophiocara porocephala*	1	3	5	3	23	21	26	82	3.67
Gerreidae	*Gerres filamentosus*	1	6	30	4	1			42	1.88
	Gerres limbatus		3	3	8	3	1		18	0.81
Gobiidae	*Periophthalmus gracilis*		1	3					4	0.18
	Glossogobius aureus					2			2	0.09
	Boleophthalmus boddarti						1		1	0.04
Haemulidae	*Plectorhinchus gibbosus*				3	1			4	0.18
Leiognathidae	*Nuchequula flavaxilla*			94	163				257	11.50
	Leiognathus equulus		1	1	56				58	2.60
Lutjanidae	*Lutjanus argentimaculatus*	2	2	3	7	9	2	1	26	1.16
Mugilidae	*Moolgarda engeli*	5	60	61	145	11	29	2	313	14.00
	Chelon subviridis	8	4	4	46	22	7	11	102	4.56
	Ellochelon vaigiensis				1				1	0.04
Osphronemidae	*Trichopodus tricopterus*					3	9	2	14	0.63
Paralichthyidae	*Pseudorhombus arsius*			1	4				5	0.22
Platycephalidae	*Platycephalus indicus*	2		1	3				6	0.27
Polynemidae	*Eleuteronema tetradactylum*				6				6	0.27
Scatophagidae	*Scatophagus argus*	4	3		5	1			13	0.58
Serranidae	*Epinephelus coioides*	1							1	0.04
Sillaginidae	*Sillago sihama*	1	2		1				4	0.18
Terapontidae	*Terapon jarbua*	1	1		6			1	9	0.40
Tetraodontidae	*Tylerius spinosissimus*	2	6	1					9	0.40
	Chelonodon patoca				4				4	0.18
	Arothron reticularis			2	1				3	0.13
Zenarchopteridae	*Zenarchopterus rasori*				1				1	0.04
	Total	74	178	327	752	275	365	264	2235	
	%	3.3	8.0	14.6	33.6	12.3	16.3	11.8		

The most dominant fish species caught were *M. gulio* (35.35%) family of Bagridae, followed by *M. engeli* (14.00%) family of Mugilidae, and then *N. flavaxilla* (11.50%) family of Leiognathidae. The contribution of the three species reached 60.85% of the total fish collected. There were as many as 6 species caught at each station, namely *A. macrachantus, M. gulio, O. porocephala, L. argentimaculatus, M. engeli,* and *C. subviridis*. Likewise, there were 6 species caught only one and caught at station 4, namely *C. striata, S. lemuru, B. boddarti, E. vaigiensis, E. coioides* and *Z. rasori*. There were 21 species of fish caught very few or less than 10 individual, with a total of 88 individual (3.90%).

Fish were grouped by ecological categories, habitat, life cycle, an individual composition of each species and biomass, presented in table 2. Based on the ecological category, the fish community in the Bogowonto River estuary was dominated by the occasional marine visitor group (OMV), a group of fish that were sometimes in the estuary for a certain period to look for food and shelter. While other categories of ecological groups, namely occasional freshwater visitor (OFV), estuarine-dependent marine (EDM), estuarine-dependent freshwater (EDF), Estuarine (Est) and freshwater fish (FW) were relatively balanced. This shows that the OMV group more efficiently utilized the existence of estuaries. The OMV group was dominated by fish in the juvenile stage, so it was clear that the OMV group utilized the existence of estuaries for nursery ground.

Based on habitat categories, most of the fish caught (20 species), their habitat was in brackish waters, while the rest were relatively comparable. Brackish water habitats were characterized by very high daily salinity changes, so that brackish waters inhabitants have extensive salinity tolerance. Fish groups with brackish water habitats were generally in juvenile and young stages. Most fish species (> 52.6%) found were in juvenile stadia. Based on the number of individuals, the most caught individuals were *M. gulio* (35.35%). However, when viewed based on the biomass, the most fish biomass was *M. engeli* (26.62%). So that individually, the size of the *M. engeli* was bigger.

The length and weight distribution of the fish community are shown in figure 3. The average length of fish ranged from 4.5 to 24.5 cm. The length of the fish was dominated by the average total length <10 cm, and the most average length of fish was in the range between 4 and 14 cm (> 92.2%). The smallest fish weight was *P. gracilis*, while the longest was *C. striata*, which was caught only one. Average fish weight ranged from 2.0 to 139.7 g, and more than 68% average fish weight were less than 20 g. The average weight of seven species, namely *A. macrachantus, A. reticularis, C. puncticeps, H. macrolepidota, M. gulio, P. arsius, P. gracilis* and *T. jarbua* was less than 5 g, thirteen species was between 5 and 10 g, while the rest (18 species) was more than 10 g. Based on the average length and weight of individual fish caught, most of the fish in the juvenile stage.

Spatial and temporal variation in biomass and species number, index of diversity, evenness, and richness are given in figure 4. The amount of biomass and fish species during sampling at the Bogowonto River Estuary varies greatly. The greatest number of biomass and species was found in November, while the least in June. The biomass weight and the amount of fish caught in the rainy season was higher than the dry season. In the rainy season, there were many nutrients from the upstream which dissolve and were carried by the river flow until the estuary. Abundant nutrients cause the growth of plankton which preys on juvenile fish. The greatest number of species and biomass of fish caught based on sampling station was at station 4, while the least was at station 1. The weight of fish biomass caught at station 4 was almost three times more than that of other stations.

The monthly Shannon-Wiener diversity index (H') ranged from 1.05 to 2.38, while the evenness index (E) ranged from 0.44 to 0.74, and the species richness index (D) ranged from 0.22 to 0.45. Inter-station diversity index shows the range of 1.72 to 2.29, and the evenness index ranged from 0.59 to 0.85, while the evenness index ranged from 0.22 to 0.34. Based on the diversity index and evenness, the highest diversity and evenness found in February, while the lowest was in August. Conversely, the highest species richness index occurred in March and the lowest in August. Based on the sampling station, the highest diversity index was at station 4, while the lowest was at station 7. On the contrary, the highest evenness and richness species were found at station 1 and the lowest at station 7. The number of species

and fish diversity values found during the study varied between months and between sampling locations.

Table 2. Ecological categories (EC): occasional marine visitor (OMV), occasional freshwater visitor (OFV), estuarine-dependent marine (EDM), estuarine dependent-freshwater (EDF), estuarine habitat (Est) and freshwater fish (FW); habitat (F-freshwater; B-brackishwater, M- marine); life cycles (J-juvenile; JA-juvenile+ adult; A- adult); total abundance, biomass of fishes caught during the study period at the Bogowonto River estuary.

No	Species	EC	Habitat	Life Cycle	N (ind)	% N	Rank	Biomass (g)	% Biomass	Rank
1	*Ambassis macrachantus*	EDF	B	J,A	258	11.54	3	850.8	4.08	7
2	*Anabas testudienus*	OFV	F	J	12	0.54	16	253.0	1.21	14
3	*Apogon hyalosoma*	OFV	F	JA	4	0.18	25-29	169.5	0.81	16
4	*Arothron reticularis*	OMV	B	J	3	0.13	30	12.3	0.06	33
5	*Boleophthalmus boddarti*	EDF	B	J,A	1	0.04	33-38	38.2	0.18	27
6	*Carangoides malabaricus*	OMV	M	J	62	2.77	8	465.2	2.23	11
7	*Channa striata*	OFV	F	A	1	0.04	33-38	139.7	0.67	19
8	*Chelon subviridis*	OMV	B	J,A	102	4.56	5	1,697.2	8.13	3
9	*Chelonodon patoca*	OMV	B	J	4	0.18	25-29	30.8	0.15	29
10	*Clupeonella tscharchalensis*	EDF	B	J,A	5	0.22	22-24	140.2	0.67	18
11	*Cynoglossus puncticeps*	OMV	M	J	10	0.45	17	42.9	0.21	26
12	*Eleuteronema tetradactylum*	Est	B	J	6	0.27	20-21	168.7	0.81	17
13	*Ellochelon vaigiensis*	Est	B	J	1	0.04	33-38	10.1	0.05	34
14	*Epinephelus coioides*	OMV	M	J	1	0.04	33-38	8.8	0.04	36
15	*Gerres filamentosus*	EDF	B	J	42	1.88	10	448.3	2.15	12
16	*Gerres limbatus*	EDM	B	J,A	18	0.81	13	180.2	0.86	15
17	*Glossogobius aureus*	EDF	B	A	2	0.09	31-32	17.1	0.08	32
18	*Hampala macrolepidota*	OFV	F	J	5	0.22	22-24	23.9	0.11	30
19	*Leiognathus equulus*	OMV	B	J	58	2.60	9	290.4	1.39	13
20	*Lutjanus argentimaculatus*	OMV	M	J	26	1.16	12	665.5	3.19	9
21	*Moolgarda engeli*	OMV	B	J	313	14.00	2	5,556.0	26.62	1
22	*Mystus gulio*	EDF	B	J	790	35.35	1	4,233.2	20.28	2
23	*Nuchequula flavaxilla*	OMV	M	J,A	257	11.50	4	1,044.7	5.00	6
24	*Ophiocara porocephala*	Est	B	J,A	82	3.67	6	1,211.4	5.80	5
25	*Oreochromis mossambicus*	OFV	F	J,A	30	1.34	11	738.8	3.54	8
26	*Oreochromis niloticus*	OFV	F	J	70	3.13	7	1,405.6	6.73	4
27	*Periophthalmus gracilis*	Esr	B	J,A	4	0.18	25-29	7.8	0.04	37
28	*Platycephalus indicus*	OMV	M	J	6	0.27	20-21	43.3	0.21	25
29	*Plectorhinchus gibbosus*	OMV	M	J	4	0.18	25-29	33.1	0.16	28
30	*Pseudorhombus arsius*	EDM	B	J	5	0.22	22-24	21.8	0.10	31
31	*Sardinella lemuru*	EDM	B	J	1	0.04	33-38	6.4	0.03	38
32	*Scatophagus argus*	EDM	B	J	13	0.58	15	507.3	2.43	10
33	*Sillago sihama*	OFV	F	A	4	0.18	25-29	55.7	0.27	23
34	*Terapon jarbua*	OMV	M	J,A	9	0.40	18-19	50.5	0.24	24
35	*Trachinotus blocii*	OMV	M	J	2	0.09	31-32	80.8	0.39	22
36	*Trichopodus tricopterus*	OFV	F	J,A	14	0.63	14	133.7	0.64	20
37	*Tylerius spinosissimus*	MFV	M	J,A	9	0.40	18-19	81.0	0.39	21
38	*Zenarchopterus rasori*	Est	B	A	1	0.05	33-38	9.3	0.05	35

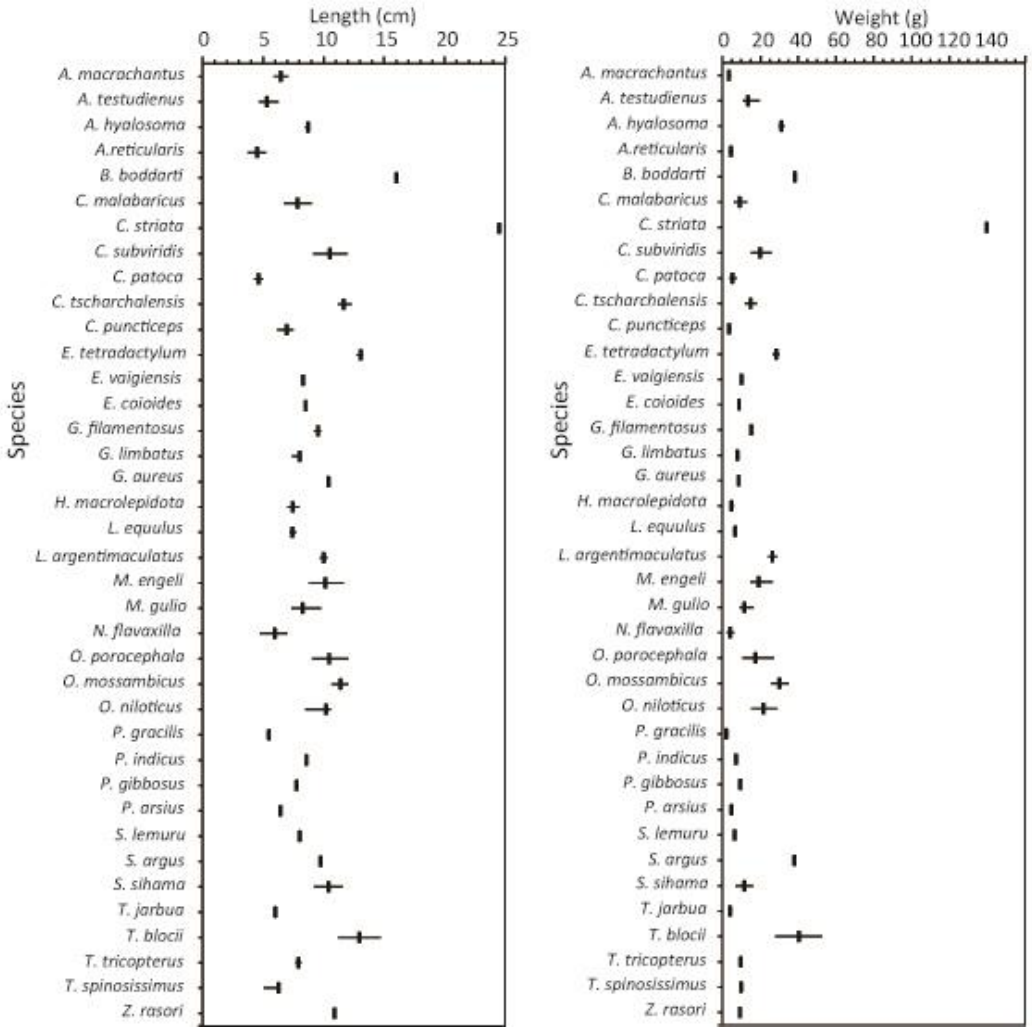

Figure 3. Horizontal bars showing from minimum to maximum distribution of length (left) and weight (right) of fishes collected at the Bogowonto River Estuary, vertical bars as average length and weight.

The collection of larvae and juvenile fishes found at the Bogowonto River Estuary consists of several species with high abundance and a large number of rare species whose number was low. This is a common feature of fish communities in estuary waters. The number of fish species found at the Bogowonto River Estuary was more than previous studies carried out in other areas such as the number of fish species found in the Sepang Besar Estuary (Selangor-Malaysia, 29 species) [12], the Aksu River Estuary (Antalya-Turkey, 26 species) [13], and Mar Chiquita coastal lagoon (Argentina, 28 species) [14], but fewer than the Lima Estuary (Portugal, 50 Species) [15], and coastal lagoon in the Gulf of California (México, 95 species) [16]. Visiting, distribution, clustering and assemblage for fish larvae in estuaries were influenced by a complex combination of biotic and abiotic factors. The estuary and adjacent shallow areas of the continental shelf was a critical habitat for many fish species characterized by variability in oceanographic conditions. This habitat served as spawning and nursery ground for many commercial and recreational species of fishes. The estuary area also supports a variety of very diverse human activities, such as fishing and aquaculture which have various impacts on aquatic biota, including variability in overall abundance, productivity and community structure [17]. The area of Bogowonto River Estuary provides a habitat for growing up for most fishes with the discovery of various species of marine, brackish and fresh water fishes in the juvenile stage.

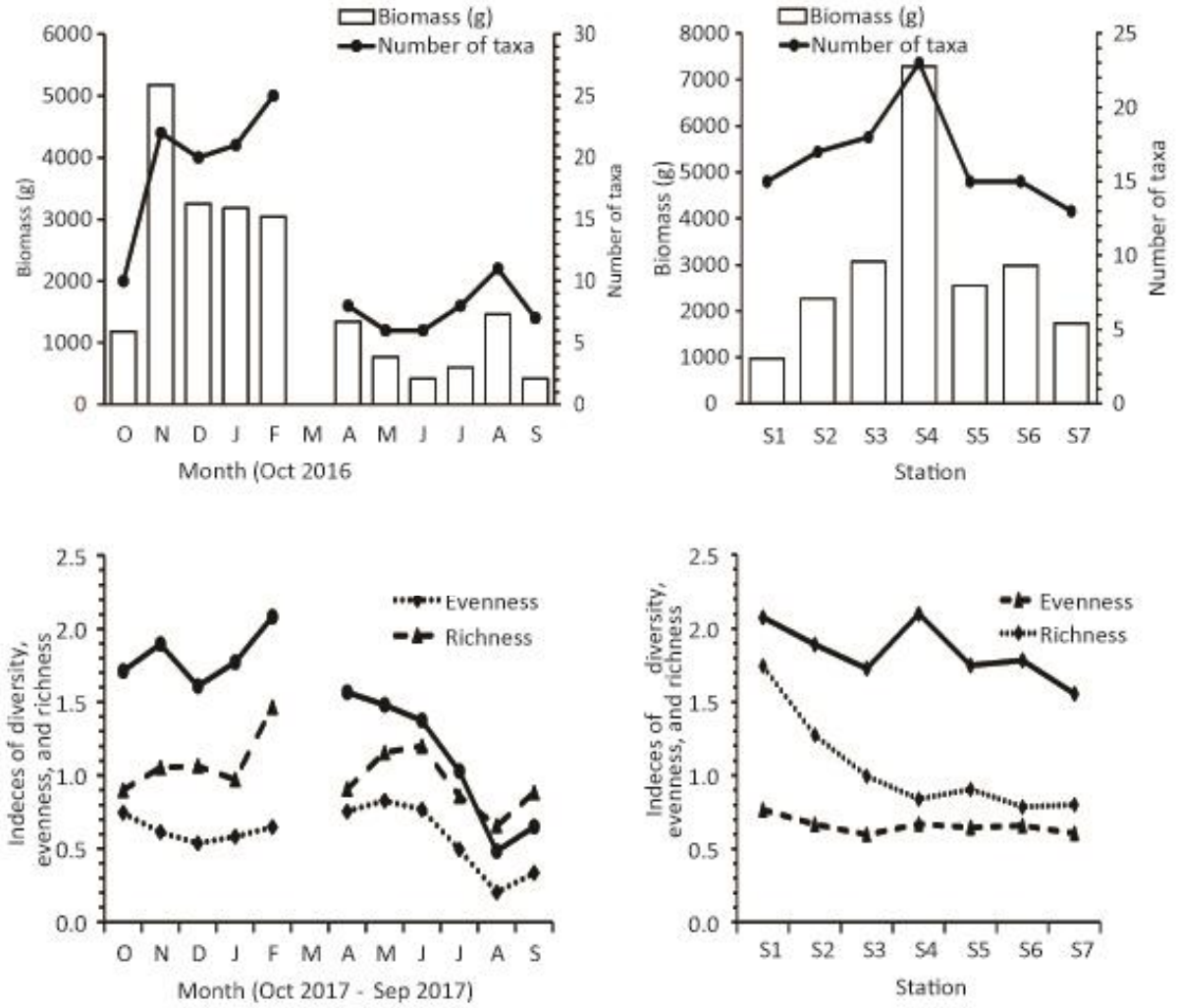

Figure 4. Temporal and spatial variations of biomass, number of taxa, indices of Shannon, Evenness and richness of species during the study period at the Bogowonto River Estuary, biomass; number of taxa (top); diversity (bottom); everness (left); richness (left); richness (right); everness (right).

Estuaria is a coastal environment which naturally experiences high variability in physicochemical conditions, which affects the composition of the aquatic community [13]. Most fish species that live permanently or temporarily at the Bogowonto River Estuary have a wide tolerance limit to the fluctuating conditions found in this ecosystem. Physical interactions and biological factors affect the assemblage, distribution, abundance, and diversity of fishes in tropical estuaries. Among these physicochemical factors were water salinity, temperature, dissolved oxygen, pH and ordinary or irregular fluctuations on different time scales, which have been identified as determinants with estuarine ecology [14]. Bogowonto River estuary has very wide monthly salinity fluctuations, so that fish species with very wide adaptability could be found in abundant quantities at each sampling station [10]. Several fish species in the larval and juvenile stage were found abundantly at each station and sampling time in the Bogowonto River Estuary, namely *M. gulio, M. engeli, A. macrachantus.*

Fish communities in the estuary ecosystem have long been known to be dominated by opportunistic marine species of estuaries, with species partners from freshwater replacing them over a period of time [14]. In This finding is similar to the results of a fish community study in Sepang Besar Estuary [12] and a choked temperate coastal lagoon Argentina [14]. The number of native marine fish found in estuary ecosystems may be due to the high tolerance of salinity changes. Although the OMV group was dominant in various places in the estuary system mainly because of the four most abundant species. The

highest abundance was observed at station 4 which was located near the estuary which was marked by the influence of considerable sea water. The abundance of individual fishes at station 4 was twice as much as that found at stations 3 and 6 even 10 times from station 1. Station 4 was located adjacent to the main river with the lowest environmental variability, so it looks very suitable for all types and groups of fish as a habitat to take refuge. In addition, it was alleged that there was an abundant source of food originating from residents' settlements and organic material from brackish water culture waste.

The fish found in the Bogowonto River Estuary were mostly fish that were often found in rivers, estuary and marine environment in the southern of the Java Island. Of all fish species caught, some fish species found abundantly able to grow > 50 cm for example, *C. malabaricus*, *E. tetradactylum*, *L. argentimaculatus*, *P. indicus*, so that they have very important economic value. All fish species caught were euryhaline so they were able to tolerate wide salinity changes. Based on the proportion of the number of individuals caught in abundance, for example *M. gulio* (35.35%), *M. engeli* (14.00%), that was targeted by fishermen in the southern coast of Java Island. The fish was caught abundantly at each sampling station. The few caught fish, for example *E. coioides*, *C. striata*, were a carnivorous fish that migrate from the sea or river when high tide to find food. *C. striata* is a freshwater fish that is opportunistically looking for food to estuary area [15].

4. Conclusion

The Bogowonto River Estuary is a habitat for more than 38 species of fishes originally from marine, brackish water, and freshwater, as a habitat for shelter, nursery ground and finding food. Fishes found mostly in juvenile stadia that utilize mangroves to find food. The highest species diversity was found in February, and at station 4 which was the main river meeting point with tributaries. Most of the fish came from the marine waters at the larval stage to the estuary, then stayed temporarily in the estuary region. The three dominant fishes caught were *M. gulio*, *M. engeli* and *A. macrachantus*. The average length of fishes caught was less than 10 cm and weighs less than 20 grams. The Diversity of fish species at low to moderate levels, in areas with high ecological pressures, have low species diversity and vice versa.

It is recommended to manage the estuary area of the Bogowonto River to be better and orderly. Management is carried out by involving the community in preserving the Bogowonto River Estuary as an ecological and fisheries reserve.

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