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Gastropod Community Structure as a Water Quality Bioindicator in Lake Rawa Pening Aquaculture Area, Semarang, Central Java, Indonesia

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Abstract— **Gastropods are a group of animals that have a soft body and are protected by a shell on the outside of their body. This group of animals usually tends to live sedentary with slow movements. These animals are also sensitive to changes in water quality so that they can be used as bioindicators of aquatic environmental quality. Lake Rawa Pening is a freshwater area which has an area of 2,380 hectares. The purpose of this study was to analyze the structure of the gastropod community and determine the condition of environmental quality and environmental status in the Lake Rawa Pening aquaculture area. Sediment sampling was carried out in polyculture, monoculture aquaculture areas and the Lake Rawa Pening reference area with a distance between sampling locations of ±1 km. Sampling was carried out by purposive sampling, consisting of three sampling locations with three replications. The results showed that there were 8 species of gastropods found in three locations. The most dominant species in polyculture, monoculture and reference locations were Filopaludina javanica, Ferrisia sp, and Melanoides tuberculata. The diversity index (H') at polyculture, monoculture and reference cultivation locations is in the low category with low community stability. Evenness index (e) in polyculture, monoculture and reference areas in October tends to be stable and has a high level of uniformity. However, there was a downward trend in the Evenness Index (e) in November and December. The dominance index (D) at polyculture, monoculture and reference areas is in the high category which indicates that certain species dominate. Abiotic factors that affect the abundance of macrobenthic molluscs are temperature, pH, dissolved oxygen (DO), and also soil sediment structure. The environmental status obtained in the polyculture and monoculture cultivation areas from October to December and the reference areas in October and November showed disturbed conditions. Meanwhile, the environmental status of the reference area in December showed that the condition of the waters in the area was slightly disturbed.**

Index Terms- **Gastropod, Community Structure, Biomonitoring, Polyculture, Monoculture, Lake Rawa Pening**

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I. INTRODUCTION

Rawa Pening waters are a water resource with an area of 2,380 Ha which is located at an altitude of 463.30 asl. The Rawa Pening waters have potential fishery resources that can be utilized by fishermen and fish farmers in fish catching and cultivating activities. In 2009, fish production from the swamps and rivers around Rawa Pening reached 1,150.1 tons. The types of fish found in Rawa Pening are carp, carp, carp, tawes, curses, tilapia, mujaher, eel, catfish, catfish, pomfret, and cethol (Semarang Regency BPS 2010). Rawa Pening is one of the 15 priority lakes that needs to be saved because of its very poor condition. This happens because of a decrease in water quality, a decrease in water discharge and siltation of the lake due to sedimentation (Soeprobowati, 2011).

Many fish cultivators in Rawa Pening use floating net cages in cultivating fish. However, cultivation activities that are not matched by paying attention to environmental friendliness are one of the problems in Lake Rawa Pening. According to (Febrianto, Agriculture, and Indonesia, , 2016) waste water used to raise fish has a relatively large portion and contains high organic matter. This condition is caused by the remains of feed and fish metabolism, such as urine and feces. Not all of the fish feed is eaten so that the remaining feed will settle to the bottom of the lake and be decomposed by microbes. Thus increasing the rate of sedimentation which causes siltation and eutrophication. The decomposition of organic waste, apart from directly reducing dissolved oxygen concentrations and producing other gases that can endanger the lives of other organisms, also produces nutrients that can cause eutrophication and result in excessive growth of phytoplankton (blooming) (Garno, 2002).

Cultivating fish in floating net cages can use monoculture or polyculture systems. Monoculture is a pattern of cultivating one type of commodity, while polyculture is a pattern of cultivating two different types of commodities with different eating habits and aims to get more yields at lower costs (Murachman et al, 2010). The polyculture-level floating net cage cultivation system is a more efficient alternative to replacing conventional cultivation systems by taking into account environmental friendliness and increasing production capacity. The flexibility of its structure makes The polyculture-level floating net cage remain strong and afloat even when the water level changes. The larger capacity also makes it possible to cultivate more than one species of biota in the same area/system at the same time without increasing the area of cultivation. According to Putro et al (2014). The

application of Multilevel Floating Net Cages is one of the right solutions towards productive and sustainable aquaculture practices. One of the efforts to increase production capacity without increasing the horizontal area of the floating net cages system's cultivation area is the modification of the floating net cages into multilevel floating net cages.

In aquatic systems, one of the most effective ways to evaluate anthropogenic is the use of bioindicators, namely organisms or communities with functional characteristics that are very closely related to certain environmental factors so that any environmental change can trigger predictable biota shifts (Silva et al, 2010; Miguel et al., 2017). Gastropods are a class of Mollusca from the phylum Invertebrates, and are a community of benthic animals that are usually found in waters, both on the surface of the waters and on the bottom of the waters. Gastropods are a class of aquatic animals that are sensitive to ecological pressures and disturbances to certain aquatic ecosystems. This causes gastropods to be often used as bioindicators of changes in the aquatic environment (Gundo, 2010). This gastropod is an animal that has a soft body and is also protected by a shell on the outside of its body. This animal is synonymous with the presence of antennae on the head, the number of which depends on its classification. Gastropods will usually secrete mucus which leaves an impression when their body is used to move (Heryanto, 2013). Based on the main issues above, namely regarding the problem of water quality in the aquaculture area, Lake Rawa Pening, this research will look at the quality of the waters in the area using biological bioindicators in the form of gastropods so that they can complement the results of research that has previously been done.

II. Material and Methods

This research was conducted from October to December 2021 in the Rawa Pening lake floating net cage aquaculture area, Asinan Village, Bawen District, Semarang Regency. The sampling locations were carried out in three different locations, namely the polyculture fish farming area, the monoculture fish farming area and the non-aquaculture area, namely the reference area. Location I is located in the polyculture-level floating net cage aquaculture area at the coordinate point 7°16'13.499"S-110°26'18.178"E with the species being cultivated in the form of tilapia and tilapia fish, Location II is 1 km from location I which is located in an aquaculture area monoculture fishery at coordinates 7°16'46.652"S-110°26'11.598"E with tilapia fish being cultivated, Location III is a reference area with coordinates 7°17'19.414"S-110°26'8.856"E within 1 km from location II, this location is in the middle of Lake Rawa Pening which is a non-aquaculture.

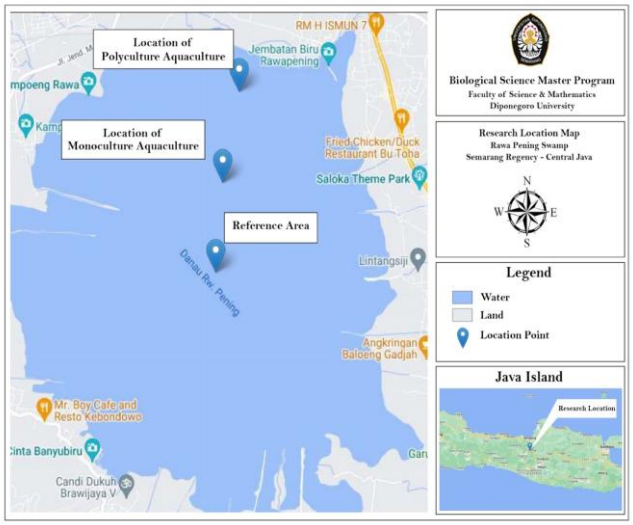

Figure 1. Map of sampling locations for Monoculture, Polyculture and Lake Rawa Pening Reference Areas, Semarang, Central Java, Indonesia.

The tools used in the study were Ekman grab, Horiba U-50 water checker, 1 mm benthos filter, sample bottles, sample boxes, plastic boxes, tweezers, gloves, petri dishes, dropper pipettes, plastic bags, masks, labels, cameras, macrobenthos identification book, stationery, optilab microscope, GPS (Global Positioning System). The materials used in the study were samples of macrobenthic molluscs and sediments in Lake Rawa Pening, 10% formalin solution, 70% ethanol solution and distilled water.

Sediment collection was carried out using an Ekman grab tool at each station with a size of 250 cm^2 which had been tied with a long rope. Mollusc sampling was carried out by taking sediment and biota samples using an Ekman grab. Sediments and molluscs were taken by means of an Ekman grab released into the water body to the bottom of the waters as deep as ±3-4 m. This tool is suitable for taking sand, gravel, muddy or clay sediment samples (Wildlife Supply Company, 2010). The sediment samples obtained and placed in a sample box, then 4 caps of 10% formalin were given for fixation and 2 caps of 70% ethanol and labeled with the location of the study and the time of sampling. All samples were brought to the Ce-MEBSA Laboratory UPT Diponegoro University Semarang for sorting, identification and data analysis.

Analysis of research data was carried out quantitatively including the Dominance Index, Diversity Index, and Evenness Index.

III. Results and Discussion

Gastropod species found in the Lake Rawa Pening aquaculture area as a whole are 83 individuals which are divided into 8 different species namely *Filopaludina javanica*, *Lymnaea rubiginosa*, *Melanoides maculata*, *Melanoides tuberculata*, *Pila ampulacea*, *Pomacea insularum*, *Ferrisia sp.*, and *Sulcospira terstudinaria* (Figure 1 and Table 1).

Table 1. Gastropod Species Data in the Lake Rawa Pening Aquaculture Area

No	class	Family	Species	Location									Amount per species
				Polyculture			Monoculture			Reference			
				Month			Month			Month			
				Oct	Nov	Dec	Oct	Nov	Dec	Oct	Nov	Dec	
1	Gastropoda	Viviparidae	*Filopaludina javanica*	3	3	4	0	16	3	4	19	4	56
		Lymnaeidae	*Lymnaea rubiginosa*	0	0	0	0	2	0	0	0	0	2
		Thiaridae	*Melainoides maculata*	0	0	0	0	0	0	0	0	1	1
			Melanoides tuberculata	0	1	0	0	2	0	1	3	1	8
		Ampullaridae	*Pila ampullacea*	0	0	1	2	0	0	0	3	0	6
		Planorbidae	*Ferrisia sp.*	0	1	1	0	0	2	0	4	0	8
		Pachychilidae	*Sulcospira terstudinaria*	0	0	0	0	0	0	1	0	0	1
Number of species per station				3	5	6	2	21	5	6	29	6	83

Gastropod species *Filopaludina javanica* were found in almost all sampling locations. Meanwhile, overall in the three sampling locations, there were 56 individuals of the species *Filopaludina javanica*. This species was found as many as 12 individuals in the polyculture area with details per month of 3 individuals in October, 3 individuals in November, and also 4 individuals in December. Then at the monoculture location, the results obtained were 19 individuals of *Filopaludina javanica* of which 16 individuals were found in November and 3 individuals were found in December. Meanwhile, at the reference location, 27 *Filopaludina javanica* individuals were found. Meanwhile, at the reference location, 4 individuals were found in October sampling, 19 individuals in November, and individuals in December. Then other species that are commonly found in this location are *Melanoides tuberculata* and *Ferrisia sp*. Where the two species as a whole in three different locations found as many as 8 species. As for the total number of species found in this aquaculture area, this is as illustrated in table 1.

Tabel 2. Shannon-Wiener diversity index (H'), evenness index (E) and dominance index (c) of Gastropod in the study area.

Index	Lokasi								
	Polikultur			Monokultur			Referensi		
	Oct	Nov	Dec	Oct	Nov	Dec	Oct	Nov	Dec
Shannon-Wiener diversity index (H')	1.03	1.16	1.12	1.03	1.23	1.03	1.301	1,203	1.127
Evenness index (E)	0,93	0,8	0,77	0,93	0,57	0,93	0,73	0,66	0,77
Dominance index (c)	0,38	0,36	0,37	0,38	0,36	0,38	0,33	0,36	0,375

A. Diversity

The species diversity index is a description of the state of a population of organisms mathematically to make it easier to analyze information on the number of individuals of each species that make up a community. A community is said to have high diversity if the community is composed of many species, conversely if the community is composed of a few species, the diversity is low (Hasan et al, 2020).

The average value of the Shannon-Wiener Diversity Index (H') at polyculture cultivation sites was 1.03 - 1.16, at monoculture locations 1.03 - 1.23 and reference areas 1.127 - 1.301. According to Krebs (1989) diversity is classified as high, if the index is ≥ 3.5, it is classified as medium if the index is 1.5 – 3.5 and it is classified as low if the index is ≤ 1.5. Based on these criteria, the Shannon-Wiener Diversity Index (H') values at the three study locations were low. it can be said that all sampling locations in Lake Rawa Pening are in an unstable condition, meaning that the water conditions are unfavorable or disturbed, which indicates that the conditions in these waters are changing. Such conditions can be influenced by several factors that are closely related to life for molluscs. The diversity of molluscs in lake waters is influenced by several factors including habitat (substrate) factors and water chemistry factors. According to Lihawa (2013) the diversity of molluscs in nature is influenced by several abiotic and biotic factors such as environmental conditions, food availability, predation by predators and competition. in environmental conditions polluted ecosystem diversity tends to be low.

B. Evenness

The average Evenness Index value (e) at polyculture cultivation locations was 0.77 – 0.93, at monoculture locations 0.57 – 0.93, and reference areas 0.66 – 0.77. This difference is influenced by the level of dominance and species diversity (Sirait et al., 2018). According to Odum (1993) if the E value is more than 0 to 0.5 then the level of uniformity is low and the community is in a depressed condition, if the E value is more than 0.5 to 0.75 then the community is in an

unstable condition and the level of uniformity is moderate, and if the E value is more than 0.75 to 1, the community is in a stable condition and high uniformity.

Based on these criteria, evenness index values (e) at polyculture, monoculture and reference areas in October tend to be stable and have a high level of uniformity. However, there was a downward trend in the Evenness Index (e) in November and December. This is presumably because in November Rawapening Lake revitalization activities were carried out which affected the stability and uniformity of the molluscs. High uniformity shows that the distribution of the number of individuals of each species is the same so that there is no domination by certain biota, while low uniformity shows that the distribution of the number of individuals of each species is not the same and tends to be dominated by certain species (Nephinet et al., 2014). The distribution of species is closely related to species dominance, if the evenness index value is small (less than 0.5) it indicates that some species are found in greater numbers than other species.

C. Dominance

The average value of the Simpson dominance index (D) at polyculture cultivation sites was 0.36 – 0.37, monoculture 0.36 – 0.38, and reference areas 0.33 – 0.375. According to Odum (1993) the dominance index ranges from 0 to 1, where the smaller the dominance index value indicates that no species dominates, conversely the larger the dominance index value indicates that certain species dominate.

The Dominance Index values at the three sampling locations were low and close to 0 indicating that at these three locations no species dominated and included an even distribution. Dominance is expressed as the species richness of a community and the balance of the number of individuals of each species. The existence of dominant species indicates that there are differences in the adaptability of each species to the environment. It is suspected that at each sampling location there are species that are often found which means that the distribution of individual mollusk species is not the same at each point of the study location. Ridwan et al. (2016) states that the dominance of an organism indicates that not all organisms have the same adaptability and ability to survive in one place. Kendra et al. (2013) added that species that are able to adapt to the environment will dominate the area.

IV. CONCLUSION

Based on the research and data analysis that had been carried out at the three research locations, 8 species of the gastropod class were found. The most common species found in polyculture, monoculture and reference locations were Filopaludina javanica, Ferrisia sp, and Melanoides tuberculata. The diversity index (H') at polyculture, monoculture and reference cultivation locations is in the low category with low community stability. Evenness index (e) in polyculture, monoculture and reference areas in October tends to be stable and has a high level of uniformity. However, there was a downward trend in the Evenness Index (e) in November and December. The dominance index (D) at the polyculture, monoculture and reference area cultivation sites is in the low category indicating that no species dominates in the three areas

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