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Study of the Dynamic Density and Diversity of Plankton at Different Brackishwater Pond Managements in Gresik, East Java

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Abstract. The success of fish and shrimp farming is strongly influenced by the improvement of water quality, which is measurable from physical, chemical and biological parameters. Biological parameter refers to the presence or absence of plankton. Plankton is a microscopic-sized organism whose life drifts with the current. Plankton has a favorable type of group, and this type of adverse group is affected in pond production. A way to understand the group, the density and diversity of plankton in a pond one of them is to know the management of ponds, both traditional ponds and semi-intensive ponds. This research was conducted in traditional pond of Pandanan village and Tambak Semi Intensive Village of Ambeng-ambeng Gresik, East Java. It aimed to find out the dynamics of density and plankton diversity with different management. The method employed was survey method, which is a research method aimed to describe the phenomena that exist regardless the time of occurrence. The results were presented in descriptive form. The result of total density of plankton of traditional pond was about 102-793 ind / l, while semi intensive density of total plankton density reached 59-980 ind / l. The results of traditional ponds diversity index ranged from 0.119 to 0.159 ind / l in semi intensive ponds 0.121-0.159 ind / l. Traditional fish dominance index values ranged from 0.1 to-0.338ind / l, and semi intensive ponds ranged from 0.172-0.558 ind / l. The nitrogen values of traditional and semi-intensive ponds were 0.042 - 0.314 mg / l and 0.048 - 0.224 mg / l respectively. The result of measurement of phosphorus value of traditional pond successively ranged from 0,02 to 0,042 mg / l and 0,007 - 0,031 mg / l for semi-intensive pond. The result of measurement of N / P ratio of traditional ponds consecutively ranged between 3,545 and 8 mg / l, and semi intensive pond fpr 4,272 - 9.857 mg / l. The results of water quality assessment increased and decreased in the value of dissolved oxygen, ranging between 3.28 and 5.32 mg / l for traditional ponds and 5-8.25 mg / l for semi-intensive ponds. The pH of traditional pond ranged from 6 to 7.89 and 7 to 9.2 for semi-intensive ponds. The temperature of traditional ponds ranged between 28 and 31°C and semi intensive pond at 29-31°C. Research has been done to conclude that.

Keywords. Plankton Density, Dominance Index, Diversity Index, Water Quality.



1. Introduction

Pond farming activity is the use of land as a place of cultivation so that it can open a large number of job opportunities. Management of aquaculture areas that do not pay attention to the carrying capacity of the environment will result in environmental degradation characterized by a decrease in water quality (Suparjo, 2008). Water quality that is less than optimal can affect the presence and activity of plankton. The presence of plankton in water can provide information about the condition of a water; hence, plankton is a biological parameter that can be used as an indicator to determine the quality and fertility level of water. (Effendi, 2003). In general, aquaculture activities are managed by the community, both monoculture and polyculture, in traditional ponds and in small-scale semi-intensive ponds. In the production of small-scale farmers, they often face water quality problems and management of ponds. Threats that occur in aquaculture activities do not always come from the outside environment, but also from the inside such as food residue, biota feces and remnants of pesticides used in cultivated land (Effendi, 2003).

The cultivation success can be measured from the water quality, which is observable through physical, chemical and biological parameters. Biological parameter in water can be seen from the presence of plankton organisms. Plankton is an organism that lives in water, and its ability to move around is very limited, following the water current (Yulianna, et al., 2012). Plankton is divided into two groups, namely holoplankton and meroplankton. Plankton can be differentiated into two types: phytoplankton and zooplankton. Plankton has its ecological function as a primary producer and the initial link in food networks, making it as a scale of fertility measurement ecosystem (Alamanda et al. 2012).

2. Material and method

2.1. Place and period of research

The research was conducted on April 16-22 2017 in the traditional village of Pandanan and semi-intensive ponds in Ambeng-ambeng village, Gresik, East Java.

2.2. Tool and material

The tools used in this study were DO meter, pH pen, plankton net 10, drop pipette, microscope, glass object, sample bottle, 2 ml volume pipette, Sedgwick rafter, secchi disk, Styrofoam box, and handtally counter. The materials used in research were pond water sample and ice.

2.3. Research procedure

This research began on April 16-22 2017. This research began with the measurement of water quality and plankton abundance, plankton sampling was done by purposive sampling, a sampling technique used when the sample has certain considerations (Fachrul, 2007). Plankton sampling was carried out at 5 sampling points, namely A, B, C, D, E where 4 points were at the edge and 1 point in the middle. Sampling of each point was carried out with 3 variations inside.

2.4. Method of water quality assessment

Water quality assessment has main and supporting parameters. Temperature measurement and dissolved oxygen was done using DO meter (YSI 550A), pH measurement using pH pen (TI senz pH) while the assessment of nitrogen and phosphorus was carried out at the Surabaya Health Laboratory Center.

2.5. Sampling method and observation of plankton abundance

Plankton sampling was done by using plankton net with a mesh size of 10 microns. The collection of plankton samples in ± 70 cm-depth water could be done with a bottle whose volume is known. The volume of water taken was 1500 ml. In this study the filtered water sample was 600 ml.

Water samples obtained were filtered using plankton net. Water samples were labeled with information containing the sampling point. Plankton samples obtained were observed using an

enlarged microscope 100-1000x. Plankton samples can be preserved in low temperatures and can be preserved using 4% formalin (Notjin, 2008).

Plankton observation included the identification of plankton to find out the types of plankton at the plant, plankton density, plankton diversity, dominance of plankton, nitrogen, phosphorus and N / P ratio. Plankton abundance observation was carried out by sweeping method above the glass object of Sedwick Rafter (Fachrul, 2007) with the following formula:

$$N = \frac{n \cdot V_r \cdot 1}{V_o \cdot V_s}$$

Index :

N = Abundance (ind/ml)

n= Observed cells (ind)

V_r= Filtered water volume (ml)

V_o= Observed water volume (ml)

V_s= Filtered water volume (m)

Observation of diversity index was done to find out whether the value of Diversity index increases well when the number of species increases and when evenness increases. For a certain number of types, the diversity index value is maximized when all types are equally abundant. Observing the diversity index used the formula as follows:

$$H' = - \sum_{i=1}^N p_i \log p_i$$

Index:

H' = Shannon-Wiener Diversity Index (nits/individual)

N_i = Total number of individual type ke-i

N = Total number of individual

The value of H' with the following criteria.

H' < 2,30 = low diversity and low community stability.

2,30 < H' < 6,91 = Medium diversity and medium community stability

H' > 6,91 = High diversity and high community stability

Observation of dominance index was carried out to find out certain types that dominate in a water. The calculation of dominance index uses the following formula:

$$C = \sum [n_i / N]^2$$

Index:

C = Simpson Dominance Index

n_i = Total number of individual type i

N = Total number of individual

s = Total type

2.6. Observation and Data Collection

The main parameters in this study were plankton density, plankton diversity, plankton dominance index, while supporting parameters were water quality data during the study of temperature, pH, DO dissolved oxygen, nitrogen, phosphorus, N / P ratio.

2.7. Data analysis

To find out the dynamics of plankton density and diversity in pond with different managements, survey and descriptive data analysis were used. Analysis of plankton observation data included plankton identification, plankton density, diversity index, plankton dominance index.

3. Result and discussion

3.1. Dynamic of plankton

The results of the plankton observations showed that the species that had the highest composition was the Cyanophyta group with a percentage of 41%, while the other groups – Chlorophyta and Diatom Euglena – were 36% and 18%, 5% respectively. Plankton density in semi-intensive ponds ranged from 59 to 980. It had a relatively higher range of individuals compared to the number of individuals in traditional pond waters, ranging from 102 to 789 ind / l. This is due to the fact that semi-intensive aquaculture systems are equipped with intake and drainage channels as well as waterwheels that are used to supply oxygen to the waters. The pond's location and construction are well organized, which can improve water quality supported by the availability of nutrients from feed remnants that can affect the growth of plankton individuals than traditional ponds. The distribution and density of plankton is strongly influenced by the condition of the aquatic environment, especially in the management of water quality parameters that need to be done so that the density of plankton can remain stable (Soedibjo, 2006).

Table 1. Density of plankton in traditional and semi-intensive ponds.

Traditional Pond				
Spot	Day			
	Day 1	Day 2	Day 3	Day 4
Spot 1	299000	208000	363000	525000
Spot 2	281000	310000	477000	793000
Spot 3	209000	164000	304000	517000
Spot 4	108000	102000	179000	210000
Spot 5	370000	345000	625000	764000
Semi-intensive Pond				
Spot	Day			
	Day 1	Day 2	Day 3	Day 4
Spot 1	59000	78000	59000	61000
Spot 2	594000	446000	885000	413000
Spot 3	109000	82000	980000	262000
Spot 4	177000	162000	216000	96000
Spot 5	137000	89000	210000	180000

The plankton diversity index in traditional pond during the study ranged from 0.123 to 0.159 ind / l, while in semi-intensive ponds it was around 0.121-0.159 ind / l. This reveals that the condition of plankton in traditional and semi-intensive ponds is not stable. This unstable condition is attributed to several environmental factors such as leftovers. The entry of waste in water becomes a very influential factor and may cause degradation of the aquatic environment (Basmi, 2000).

Table 2. Diversity of plankton in traditional and semi-intensive ponds.

Traditional pond				
	Day 1	Day 2	Day 3	Day 4
Spot 1	0.143	0.123	0.152	0.159
Spot 2	0.125	0.131	0.152	0.157
Spot 3	0.133	0.119	0.151	0.156
Spot 4	0.134	0.131	0.156	0.159
Spot 5	0.132	0.128	0.156	0.159
Semi-intensive pond				
	Day 1	Day 2	Day 3	Day 4
Spot 1	0.146	0.157	0.146	0.148
Spot 2	0.151	0.137	0.159	0.133
Spot 3	0.148	0.134	0.143	0.137
Spot 4	0.153	0.159	0.152	0.142
Spot 5	0.145	0.121	0.159	0.156

The dominance index value of plankton in traditional and semi-intensive ponds shows values of 0.111-0.338 ind / l and 0.172-0.558 ind / l respectively. The value of traditional ponds shows that species domination is comprehensive because of the high density. Furthermore, the value in traditional and semi-intensive ponds is close to 0. It means that there is no extreme domination in the community structure in water. However, if the value of dominance in water is close to 1, then, there is a type that dominates the other one in community structure of a water (Pirzan and Pong-Masak 2008).

Table 3. Plankton dominance index in traditional and semi-intensive ponds

Traditional Pond				
Spot	Day			
	Day 1	Day 2	Day 3	Day 4
Spot 1	0.128	0.338	0.16	0.098
Spot 2	0.283	0.171	0.327	0.272
Spot 3	0.334	0.174	0.289	0.242
Spot 4	0.208	0.251	0.301	0.225
Spot 5	0.151	0.127	0.111	0.128
Semi-intensive Pond				
Spot	Day			
	Day 1	Day 2	Day 3	Day 4
Spot 1	0.405	0.391	0.531	0.279
Spot 2	0.447	0.527	0.551	0.172
Spot 3	0.369	0.338	0.305	0.088
Spot 4	0.371	0.341	0.271	0.378
Spot 5	0.252	0.558	0.233	0.221

3.2. Nitrogen dynamics (N)

The value of nitrogen level in traditional ponds ranged from 0.042 to 0.314 mg / l, while in semi-intensive ponds the range was between 0.048 and 0.224 mg / l. This denotes that the value of nitrogen in traditional and semi-intensive ponds is still very far from the specified limit of 10 mg / l. Nitrogen levels in a waters occur as a result of fertilization in the aquaculture land. Nitrogen in water is the main source of nutrition for the growth of plankton and aquatic plants. The nitrate content of more than 5 mg / l in water signifies existing pollution (Tatangindatu, 2013). Organic materials in water are the result of metabolic processes by plankton, which are decomposed with the help of bacteria to be C, H, O, N, S, and p so that they can be used again by other living things (Astuti, 2014).

Table 4. Nitrogen (N) content value of plankton in traditional and semi-intensive ponds.

Number of Nitrogen test	Pond				
	Spot				
	Spot 1	Spot 2	Spot 3	Spot 4	Spot 5
Traditional Pond 1	0.042	0.039	0.072	0.091	0.086
Traditional Pond 2	0.162	0.229	0.314	0.282	0.295
Semi-intensive Pond 1	0.052	0.048	0.069	0.083	0.094
Semi-intensive 2	0.118	0.224	0.175	0.247	0.104

3.3. Phosphorous dynamics (P)

Phosphorus level in traditional ponds ranged from 0.02-0.042 mg / l while in semi-intensive ponds it was between 0.007 and 0.031 mg / l. This illustrates that phosphorus level is quite low and still optimal in aquaculture activities. The Government Regulation (PP No. 2 of 2001) states that the threshold for phosphorus in water that can be used in aquaculture activities is 0.2-1 mg / l. Phosphorus is a nutrient that plays an important role in the process of growth and metabolism of plankton, serving as an indicator of water fertility (Fachrul et.al 2007).

Table 5. Phosphorous (P) content value of plankton in traditional and semi-intensive ponds.

Number of phosphorous test	Traditional Pond				
	Spot				
	Spot 1	Spot 2	Spot 3	Spot 4	Spot 5
Traditional Pond 1	0.006	0.011	0.009	0.016	0.02
Traditional Pond 2	0.034	0.039	0.042	0.036	0.028
Semi-intensive Pond 1	0.008	0.008	0.007	0.018	0.022
Semi-intensive Pond 2	0.016	0.012	0.023	0.031	0.029

3.4. Ration N/P dynamics

The N / P ratio in traditional ponds ranged from 3.545 to 8 mg / l, and it was around 4.272-18.666 mg / l in semi-intensive pond. The yield value of traditional pond N / P ratio and semi-intensive ponds is still within the optimal range for aquaculture activities. In semi-intensive ponds, the range was 10, meaning that Green Algae (*Chlorella* sp.) is dominant in semi-intensive ponds (*Chlorella* sp.). Lagus (2009) states that the N / P ratio in the waters will affect the composition of the dominant plankton species. If the N / P ratio is over 20, the environment will be dominated by plankton diatome. The case is different if the the N / P ratio is in the range of 10. The green plankton (*Chlorellasp.*) is the dominant type.

Table 6. N/P ration value of plankton in traditional and semi-intensive ponds.

Ratio N/P	Traditional Pond				
	Spot				
	Spot 1	Spot 2	Spot 3	Spot 4	Spot 5
Traditional Pond 1	7	3.545	8	5.6875	4.3
Traditional Pond 2	4.764	5.871	7.476	7.833	10.535
Semi-intensive Pond 1	6.5	6	9.857	4.611	4.272
Semi-intensive Pond 2	7.375	18.666	7.608	7.967	3.586

3.5. Temperature dynamics

Based on the results of the research, the temperature values in traditional ponds ranged from 28 to 31°C. The condition in traditional ponds is still relatively reasonable for cultivation and the growth of plankton. The temperature in semi-intensive ponds varied between 28 and 32°C. The temperature in semi-intensive ponds can still be tolerated according to Bhatnagar et al. (2004). The optimal temperature range for cultivation is around 15-35°C.

Table 7. Temperature dynamic (°C) in traditional ponds.

Parameter	Time	Spot	Day			
			1	2	3	4
temperature (°C)	07.00	1	28.2	28.3	28	29
		2	28.3	28.3	28.6	29.5
		3	28.7	29	29	29.9
		4	28	29.5	30	30
		5	29	30	30	31

Table 8. Temperature dynamic (°C) in semi-intensive ponds.

Parameter	Time	Spot	Day			
			1	2	3	4
temperature	07.00	1	29	29.5	29	29
		2	29	28	30	29.5
		3	31	30	31.5	30
		4	29.2	31.2	31	31
		5	29.5	31	32	32

3.6. DO dynamics

The amount of dissolved oxygen in traditional ponds ranged from 4-6 mg / l, while in semi-intensive ponds was 4.12-7.88 mg / l. This condition can be optimized for plankton growth. According to Wijayanti (2011), plankton can grow and live optimal in a place with oxygen concentration of more than 3 mg / l. Below 3 mg / l is a decrease which can adversely affect the life of plankton. High and low dissolved oxygen in the water is influenced by water quality factors that flow into the water (Yazwar, 2008).

Table 9. DO value dynamics in traditional ponds.

Parameter	Time	Spot	Day			
			1	2	3	
DO	07.00	2	4.44	4.84	3.28	4.15
		3	4.54	5.07	4.61	5.2
		4	4.42	4.21	4.47	5.25
		5	4	5	5.09	6

Table 10. DO value dynamics in semi-intensive ponds.

Parameter	Time	Spot	Day			
			1	2	3	
DO	07.00	2	4.12	5	6.66	7.88
		3	5	6.15	7.15	8.25
		4	4.85	5.24	6.12	7.85
		5	7.63	7.32	7.15	7.62

3.7. pH Dynamics

The results revealed an increase and a decrease of pH in traditional ponds, ranging between 6.8 and 8. Similarly, in semi-intensive ponds, there was an increase and decrease ranging from 7-9.2. Increased pH is due to the fertilization process in the water, while increased pH in general water is due to the presence of material contaminated by human activities and the amount of waste. pH in traditional and semi-intensive ponds can be considered to be normal because the pH value indicates that the pond is in an alkaline state and neutral. The pH value in water is very influential in aquatic biochemical processes. Most aquatic biota are sensitive to changes in pH. If pH amount is less than 4, aquatic plants cannot live because they are not tolerable towards low pH (Effendi, 2003)

Table 11. Dynamics of pH value in traditional ponds.

Parameter	time	spot	day			
			1	2	3	
pH	07.00	2	7	7	7.81	8
		3	7	7.69	8	7.89
		4	7	7.12	8	7.51
		5	6.8	7.5	7	7.25

Tabel 12. Dyanamics of pH value in semi-intensive ponds.

Parameter	time	spot	day			
			1	2	3	
pH	07.00	2	7.2	7.9	8	8
		3	8	8.1	8	8.5
		4	7.3	8.5	8.9	8.1
		5	7.5	9	9.2	9

4. Conclusion and recommendation

The research that carried out found that the density and diversity of plankton in the management of ponds of different types of plankton are found in the cyanopyta, Chlorella, diatome, Navicula sp, Oscillatoria sp., Euglena sp. The types of plankton that dominate the traditional ponds and semi-intensive ponds are the cyanopyta genus *Annabaena* sp class. *Spirulina* sp. Plankton density in traditional ponds is higher than semi-intensive ponds. The plankton diversity of traditional pond is higher than 0.119-0.159 ind / l compared to semi-intensive ponds 0.121-0.159 ind / l. Traditional pond dominance index is lower than 0.111-0.338 ind / l compared to semi-intensive ponds, which are 0.172-0.558 ind / l. There needs to be a further research on the dynamics of plankton density and diversity of different pond management.

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