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Environmental quality assessment using microalgae structures adjacent fish farming at Setoko Island, Batam City, Kepulauan Riau Province

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Abstract. Along with the increasing challenges that come with the demand for national and international fisheries' products and the potential emergence of various environmental concerns, various efforts have been made to increase production capacity through intensification and intensification programs. This study aimed to assess the environmental quality and the level of disturbance in the floating net cage aquaculture area based on the microalgae community structure. The research was conducted from August to October 2017 at the water ecosystem used for aquaculture at Setoko Island, Batam City, Kepulauan Riau Province. Purposive random sampling was used by determining 3 sampling stations with three replicates. Data was analyzed using saprobic, Shanon-Wiener (H') diversity, abundance and domination indices. The result showed that 13 genus microalgae (bawal fish farming), 9 genus (fish farming kakap) and 11 genus of microalgae (kerapu fish farming) consisting of *Chlorophyta*, *Chyanophyta*, *Chrysophyta* and *Dinophyta* were recorded. The value of H' index at the farming area ranged from 0.73 to 1.5. Microalgae abundance was dominated by *Phacus* sp, *Coscinodiscus* sp, *Climacosphenia* sp and *Spirogyra* sp. Based on the saprobic index, the farm area has an index value of 1.92, thus it can be referred to as the oligo/ β -meso-saprobic phase, indicating light disturbance by organic enrichment.

Keywords: Bio-indicator, Stratified Double Floating Net Cage, Microalgae.

1. Introduction

The increasing challenges that come with the demand for national and international fisheries' products, the limited terrestrial aquaculture areas and the potential emergence of various environmental concerns have left the Indonesian fishery industry in need of productive and sustainable developments in aquaculture.

Nowadays, the increasing number of fish cages to satisfy market demand has led to the emergence of organic enrichment that impacts the quality of the aquatic environment. This is due to fish farms tending to keep fish in high density and limited cage volume for extended periods of time. Organic matter that is sedimented in waters can affect the ecosystem imbalance in the area of farming [1]. Integrated farming and application of biomonitoring techniques are considered appropriate solutions to sustainable productive aquaculture practices.



Microalgae is greatly influenced by water quality changes. Thus, one can use the microalgae community structure as an indicator of the quality of the aquatic environment by looking at the composition and abundance of its species. In water quality assessment, the measurement of species diversity often gives better results than the direct measurement of pollutants. Microalgae has an important role in the aquatic ecosystem, owing to its function in the food chain as primary producer. According to Ref[2], this is largely due to microalgae's ability of photosynthesis. The process of photosynthesis carried out by microalgae provides a major source of nutrition for other groups of water organisms that make up and balance the food chain in the ecosystem. According to Ref [3], the change of water quality greatly affects the life of biota such as microalgae that live in the waters. Their abundance and diversity are highly dependent on tolerance and sensitivity to environmental change. Environmental components, both living (biotic) and soluble dead materials (abiotic), affect the abundance and diversity of aquatic biota present in water. As such, the abundance of individuals of each species can be used to assess the quality of the water. This study explains to what extent the diversity and abundance of microalgae are impacted by fish farming at Setoko Island, Batam City, Kepulauan Riau. This study aims to identify the diversity of microalgae species and the structure of the aquatic community in the aquacultural area as well as to assess the quality of the aquatic environment of the fish farming area based on a saprobic index.

2. Methods

The research was conducted in the aquacultural area of Setoko Island, Batam City, Kepulauan Riau Province. Identification and data analysis were conducted at the Center of Marine Ecology and Biomonitoring for Sustainable Aquaculture (Ce-MEBSA), Integrated Laboratory, Diponegoro University as well as at the Laboratory of Ecology and Biosystematics, Faculty Sains and Mathematics, Diponegoro University. Materials and equipment used exist of water samples taken from the aquacultural area, plankton net no.25, 10% formalin solution for fixation, 70% ethanol solution for preservation, and Horiba U-10 water quality checker for measuring water quality parameters.

The sampling method was purposive random sampling with 4 stations each having three replicates, namely:

- station 1 situated at the reference area;
- station 2 situated at the fish cage for pompano fish (*Trachinotus blochi*);
- station 3 situated at the fish cage for white snapper fish (*Lates calcarifer* Bloch);
- station 4 situated at the fish cage for grouper fish (*Epinephelus fuscoguttatu* Forsskal).

Water sampling was carried out using 25 size-plankton nets by sieving 30 liters of water and thus filtering microalgae. Filtered water in the net was then collected into plankton bottles and fixed and preserved using formalin and ethanol respectively. Observation of samples was done under a 400x magnified microscope lens using a Sedgewick Counting Rafter. The microalgae were identified in the highest taxa resolution (genus and species level). Data analysis was performed using diversity and density indices [4], similarity and dominance indices [5], and a saprobic index according to Ref [6].

3. Result

The results indicated that *Coscinodiscus* sp and *Climacosphenia* sp form the majority species of microalgae in the fish farming areas, whereas at the reference area the *Phacus* sp is the most abundant. *Phacus* sp and *Climacosphenia* sp spread most evenly in the sampled waters. During the sampling period a total of 13 species were found: two species of Chlorophyta, namely *Spirogyra* sp, and *Leptocylindricus* sp, one species of Cyanophyta, namely *Oscillatoria* sp, nine species of Chrysophyta, namely *Coscinodiscus* sp, *Closterium* sp, *Diatom* sp, *Gyrosigma* sp, *Climacosphenia* sp, *Neidium* sp, *Nitzschia* sp, *Rhizosolenia* sp, *Synendra* sp, and one species of Dinophyta/ Euglenophyta, namely *Phacus* sp.

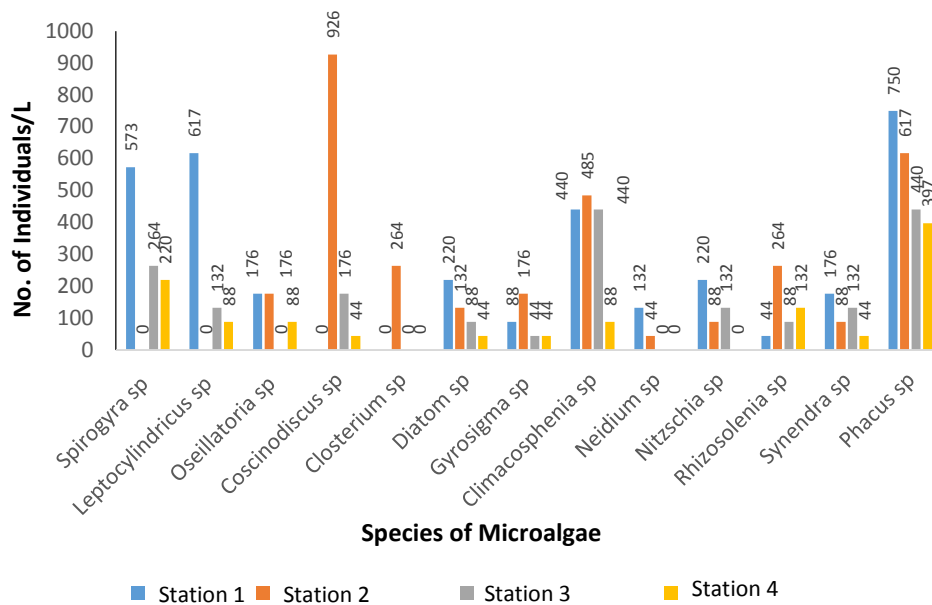


Fig. 1. Density of microalage at sampling stations

The Bacillariophyceae group has a high composition (in particular *Coscinodiscus* sp and *Climacosphenia* sp) compared to other classes. This is due to its ability to grow rapidly even in low nutrient and low light conditions and due to it having greater regeneration and reproductive capacity.

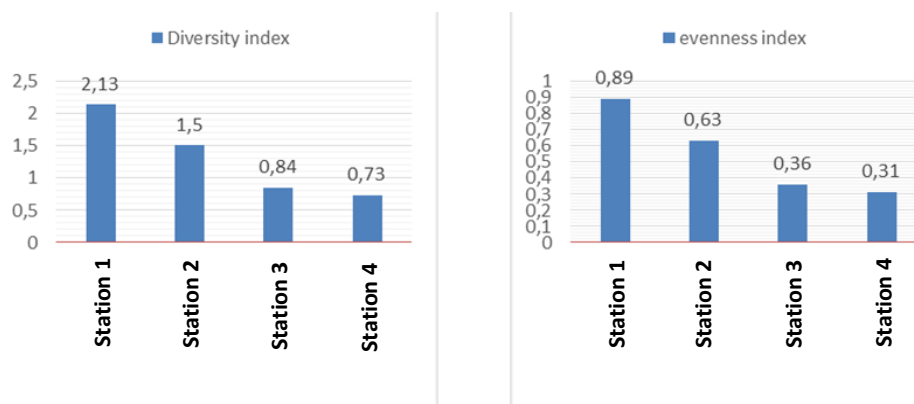


Fig. 2. Comparison of Plankton Index at sampling stations

The species of *Coscinodiscus* sp and *Climacosphenia* sp are the Chrysophyta or Bacillariophyta groups commonly found in aquatic ecosystems. This is due to aforementioned high growth and regeneration capabilities. The existence of the Bacillariophyceae class that dominates the common waters occurs in marine waters as proposed by Ref[6] that the composition of phytoplankton in waters is dominated by the Bacillariophyceae group.

The value of diversity index accounted averaged between 1-3 during the study period. According to Ref[7], if the average value of diversity reaches more than 1 and less than 3, then the relationship between the diversity index and the community microalgae's stability is moderate. Meanwhile, according to Ref[8], the low value of the diversity index (H') was less than one and H' values between 1-3 is moderate community stability. H' values higher than 3 indicate high phytoplankton diversity. The highest H' index value observed was at the reference station and reached 2.13. The lowest observed H' value was 0.73 at Station 4. One of the factors causing low phytoplankton diversity is the low Dissolved Oxygen (DO) content. The effect of dissolved oxygen on

the physiological organisms in water occurs primarily during the process of respiration. Unlike the temperature factor that has a uniform effect on the physiology of all aquatic organisms, the concentration of oxygen dissolved in water only significantly affects the aquatic organisms that absolutely require dissolved oxygen for its respiration [9]. Phytoplanktons are aquatic organisms that are aquatic oxygen producers due to photosynthesis. The low diversity of phytoplankton affects dissolved oxygen levels in water [3].

The Evenness Index Microalgae is an index showing the spread of phytoplankton present in water. The result of the Evenness (e) Index at the fish farming location has a value ranging between 0.310-0.63, which is considerably low. It indicates that the pattern and individual distribution owned by each species is very much different and uneven. An index value less than 0.5 indicates that the individual spread of each species is relatively uneven, while an index value of more than 0.5 indicates that the individual spread of each species within the community is relatively evenly distributed. Meanwhile, the saprobic system is used to view dominant groups of organisms and is widely used to determine pollution levels by the Dresscher and Van Der Mark equations. Based on the saprobic index [6], the waters of Setoko Island belong to the category of light disturbance because it has an index value of 1.92 and is included in the Oligosaprobik / β -mesosaprobic water phase.

Table 1. The average water quality measurement of at all sampling stations

Environmental Parameters	Station 1	Station 2	Station 3	Station 4
Disolved Oxygen (Ppm)	6	5	5,4	5,5
Temperatur (°C)	29,5	26,5	27,4	29,5
Ph	7,3	7,5	7,4	7,4
Salinity (Ppt)	32	31	31,5	32
Turbidity (NTU)	17	32	37	34
Light Intensity (M)	1,45	1,40	1,40	1,45
Conductivity	72,3	74,8	74	73,7

Results from the water quality measurements showed that dissolved oxygen was sufficient for the life of aquatic organisms, especially for fish farming that reaches levels of more than 5 ppm.

Temperature is a physical factor that greatly affects the overall viability of aquatic organisms and the absorption of organisms. Temperatures at the study site were 26.5 ° C - 29.5 ° C. Water temperature conditions are relatively homogeneous and are still in the tolerable range for phytoplankton. This is in accordance with Ref[7] Nybakken (1992), which states that good temperatures for microalgae life generally range from 20-30 ° C. The average pH value measured is 7.3 - 7.5. The pH values in all stations are normal because they have a range of values between 7-8. The pH value describes the balance between acid and base in the water. Salinity and turbidity had a normal value range for marine waters of 31 ppt - 32 ppt. Turbidity recorded at all sites ranged from 17 to 37 NTU, showing a normal range. The lowest turbidity was 17 measured at the reference site (Station 1). Turbidity can be composed of organic and/or inorganic constituents. Turbidity due to a large volume of suspended sediment will reduce light penetration, thereby suppressing photosynthetic activity of phytoplankton, algae, and macrophytes, especially those farther from the surface. Excess turbidity leads to fewer photosynthetic organisms available to serve as food source for many water invertebrate organisms. Consequently, overall numbers may decline, which may then lead to a fish population decline and thus disturb food chain in a water ecosystem.

4. Conclusion

Thirteen genus microalgae (bawal fish farming), 9 genus (fish farming kakap) and 11 genus of microalgae (kerapu fish farming) consisting of *Chlorophyta*, *Chyanophyta* *Chrysophyta* and

Dinophyta were recorded. The value of H' index at the farming area ranged from 0.73 to 1.5. Microalgae abundance was dominated by *Phacus* sp, *Coscinodiscus* sp, *Climacosphenia* sp and *Spirogyra* sp. Based on the saprobic index, the farm area has an index value of 1.92, thus it can be referred to as the oligo/ β -meso-saprobic phase, indicating light disturbance by organic enrichment.

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