

Macrozoobentos Diversity Index as a Bioindicator in Krueng Cunda River to Support the Success of the Shrimp Agribusiness at Lhokseumawe City, Aceh

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Submission date: 04-Nov-2021 05:00PM (UTC+0700)

Submission ID: 1692821701

File name: Ekamaida_dan_Adhiana_emeral_cek.pdf (313.33K)

Word count: 2749

Character count: 14843

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Macrozoobentos Diversity Index as Bioindicator

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Abstract

Purpose – The purpose of this research is to examine the diversity of macrozoobentos as well as its relationship with water quality and substrate in the pond culture area.

Design/Methodology/Approach – The method of sampling area is on five observation stations by purposive sampling. The research was done indirectly (ex situ) for macrozoobenthic identification at the Ecology Laboratory, Faculty of Mathematics and Natural Sciences.

Findings – The fairness/uniformity index obtained from the five research stations ranging from 0.483 to 0.923 indicates a high degree of uniformity. This indicates that the macrozoobentos biological index at the study site can be used as an indicator that water quality is in good condition and has the potential to be developed into an aquaculture area as well as supporting the success of the shrimp farming as one of the sub-systems of the shrimp agribusiness.

Research Limitations/Implications – This research can be a source of information for the management and utilization of environment in the research area, so that shrimp harvest can be optimized in the pond farming area.

Originality/Value – This research has found that macrozoobentos included 61 species.

Keywords Macrozoobentos, water quality, bioindicator, shrimp farming

5 All papers within this proceedings volume have been peer reviewed by the scientific committee of the Malikussaleh International Conference on Multidisciplinary Studies (MICoMS 2017).

1. Introduction

Macrozoobentos in water can be used as an indicator of the quality of the aquatic environment as they may reflect changes in environmental factors including the level of environmental pollution over time (Oey, 1978 in Maulana, 2010). Macrozoobentos can be used as biological parameters in determining the condition of ponds or rivers because their life is relatively silent based on ponds or rivers. The purpose of this research is to see the

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Emerald Reach Proceedings Series
Vol. 1
pp. 157–163
Emerald Publishing Limited
25 16-2853
DOI 10.1108/978-1-78756-733-1-00011

diversity of macrozoobenthos and its relationship with water quality and substrate on river area which becomes water source for pond culture. This research area is a river flow mixed with sea water (*estuaria*) and has a feature that this area is a sea area which divides the mainland of Sumatera island to the strait. The flow of water that irrigates the pond area comes from salt water because its position is in the strait area. This area has important roles for the society, such as cultivating groupers, snapper, shrimp, crab, and also oysters.

The management of coastal environments as cultivated land to boost shrimp production sustainability should be done taking into the natural capabilities established by biodiversity. Improvement in environmental quality will artificially cost and high risk, so the concept of natural recovery is the best alternative. Biotic and abiotic components in coastal areas have specific roles, but they are interconnected with each other to maintain the stability and fertility of cultivated land in coastal areas. Macrozoobenthos have sensitivity to some contaminants, low mobility, easily to catch, and long-lived. Therefore, the role of macrozoobenthos is to maintain the balance of aquatic ecosystems including cultivated land can be an indicator of recent ecological conditions in a particular area. The main problem is how to improve the amount of shrimp harvest. This study aims to see the diversity of macrozoobenthos as well as its relationship with water quality and substrate in pond culture area. The results of this study are expected to be an information for the management and utilization of the environment in the coastal areas of research for the utility of pond farming and optimizing the results of shrimp harvest.

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2. Methodology

2.1. Time and location

The research was conducted in May 2017 until June 2017 along the Krueng Cunda River which is the source of water for the Lhokseumawe's aquaculture area. Sampling area is on five observation stations by purposive sampling. The research was done indirectly (*ex situ*) for macrozoobenthic identification at Ecology Laboratory Faculty of Mathematics and Natural Sciences.

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2.2. Tools and materials research

The tools and materials used in this research are the tools for measuring the physical condition and chemistry of the water environment, Global Position System was used to determine the coordinates of the research station, and Identification Book Tropical Pacific Invertebrate used to identify the macrozoobenthos species and sampling tools macrozoobenthos. The other materials are plastics, plastic bags, sample bottles, stopwatch, label paper, markers, and digital camera.

2.3. Sampling method

Determination of observation station is using purposive sampling method at five observation stations based on consideration of ecological condition. Sampling was done by method of transect line plots systematically randomized. Each observation station is divided into three substations in the form of a 100-m transect line which is operated perpendicular to the coastline. For taking macrozoobenthos, each substation is divided into three plots (10 × 10) m². Samples of macrozoobenthos were taken with the surber net by means of dredging the substrate three times. The obtained macrozoobenthos samples were sorted and then inserted in 40% formalin filled sample vessels then identified in the laboratory. Water samples were taken at each station without *in situ* repeats and substrate sampling was performed using a 4 inch diameter paralonic pipe to a depth of 10 cm, then the substrate was stored in plastic and labeled for further analysis in the laboratory.

2.4. Statistical analysis

2.2.1. *Macrozoobenthos community structure* Macrozoobenthos Community Structure comprising: total number of taxa (N), number of species (S), diversity (H'), uniformity (E), and dominance (D) with Shannon–Wiener Diversity/Diversity Index (H') (Krebs, 1989) follows:

$$H' = -\sum p_i \ln p_i \text{ where } p_i = \frac{n_i}{N} \quad (1)$$

H' = diversity index

n_i = the number of individual taxa i

N = total number of individuals

P_i = proportion of species i

Uniformity/Evenness Index Type/Evenness Index (E) (Fachrul, 2007):

$$E = \frac{H'}{H_{maks}} \quad (2)$$

with:

E = uniformity index

H' = diversity index

H_{maks} = maximum diversity index

Index dominance (Odum, 1994):

$$D = \sum p_i^2 \quad (3)$$

with:

D = index of dominance

N_i = the number of individual taxa i

N = total number of individuals

$P_i = n_i/N$ = proportion of species i

3. Results and discussion

3.1. Geographical condition of research sites

The research location is located at Kota Lhokseumawe in 04°54' to 05°18' North Latitude and 96° 20' to 97°21' East Longitude, staple by the Malacca Strait. The research location is the area of the river that irrigates aquaculture. Map of research area illustrated in Figure 1.

3.2. Density and composition type of macrozoobenthos

The results of the analysis consist of macrozoobenthos community structure (number of individuals and macrozoobenthos type composition, diversity index, uniformity index, and dominance).

(1) *Density of macrozoobenthos:*

The total number of individual macrozoobenthos obtained during the sequential study of the highest was 293 individuals/m³ at station I, 194 individuals/m³ at station II, 109 individuals/m³ at station III, 51 individuals/m³ at station IV, and 31 individuals/m³ at station 5.

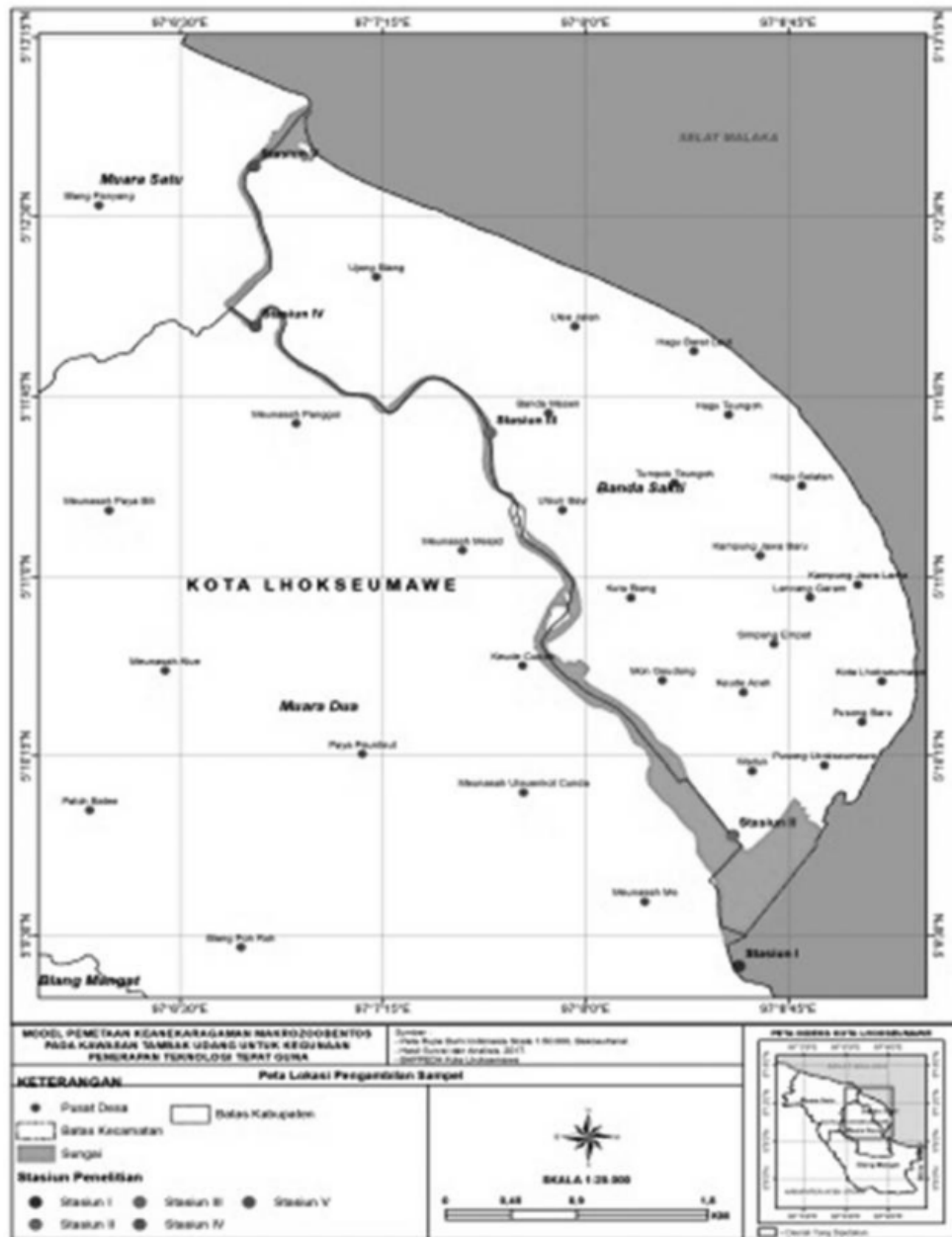


Figure 1.
City of Lhokseumawe

- (2) *The composition of macrozoobenthos:*
The macrozoobenthos composition at the study sites consisted of 19% Annelida, 37% Bivalves, 2% Crustaceans, 40% Gastropods, 0.4% Holothuroidea, 0.1% Insecta, 1.3% Malacostraca, and 0.1% Oligochaeta. The five sampling stations

that have been conducted are dominated by species from the Gastropoda class and bivalves.

(3) *Diversity index, uniformity index, and dominance index:*

Overall the results of the analysis can be seen in comprising the index of macrozoobenthos diversity in the five research stations ranging from 1.056 to 2.500. The fairness/uniformity index obtained from the five research stations ranged from 0.483 to 0.923. The dominant index of the five research stations ranged from 0.099 to 0.520.

The research location is located at Krueng Cunda River is the source of water for the cultivation of Lhokseumawe municipal pond. It is the expanse of fishery aquaculture pond development which is dominated by the maintenance of shrimp commodity, milkfish, and also keramba floating. Cultivation production obtained by farmers community still fluctuate because the cultivation method applied is still different, that is, traditional and semi-intensive and intensive

The results showed that the number of individual macrozoobenthos found in observation stations in the Krueng cunda River were 61 species consisting of eight classes, Annelida, Bivalvia, Crustacea, Gastropoda, Holothuroidea, Insecta, Malacostraca, and Oligochaeta. Bivalves and Gastropoda are the ever-present classes at every station. The number of classes of Gastropoda and Bivalvia allegedly related to the substrate contained in each station, namely in the form of mud, sandy mud, dusty soil to clay. The type of Gastropoda and Bivalvia can grow and develop on muddy substrate types because it has a special physiology of long siphon (Nybakken, 1988). *Cerithidea cingulata* dominates the species against other species in all research stations. According to Marpaung (2013), *Cerithidea cingulata* is one of the benthos whose habitat is on a muddy substrate like a substrate in a pond. The presence of dominance due to the highly favorable environmental conditions in favor of the growth of certain species.

The macrozoobenthos composition at the study site consisted of 19% Annelida, 37% Bivalves, 2% Crustaceans, 40% Gastropods, 0.4% Holothuroidea, 0.1% Insecta, 1.3% Malacostraca, 0.1% Oligochaeta (Figure 2). The five sampling stations that have been conducted are dominated by species from the Gastropoda and Bivalvia class. The number of classes of Gastropoda and Bivalvia allegedly related to the substrate contained in each station, namely in the form of mud, sandy mud, dusty soil to clay. According to Nybakken (1988), the type of Gastropoda and Bivalvia can grow and develop on muddy substrate types because it has a special physiology of long siphon.

Cerithidea cingulata is a species found in the five research station sites, it is suspected that the adaptation of this species is high. According to Syamsurisal (2011), this type of *Cerithidea cingulata* has a thick and strong shell, columella usually rolled up and has a short canal. Body structure like this causes the organism is not easily preyed by predators, so its existence is always abundant.

Differences in macrozoobenthos composition in each station show that macrozoobenthos communities have specific adaptations to the environmental and ecological conditions to be viable, to grow, and to breed (Pong and Andi, 2006). The macrozoobenthos diversity index in the five research stations is moderate from 1.056 to 2.500. Moderate (moderate) community conditions are a volatile community condition only with relatively small environmental influences. The value of $H' < 1$ then the biota community is categorized as unstable, and if the value of H' ranges from 1 to 3, then the stability of the biota community is moderate, and if the value of $H' > 3$ then the community of biota is categorized in good condition (Pong and Andi, 2006).

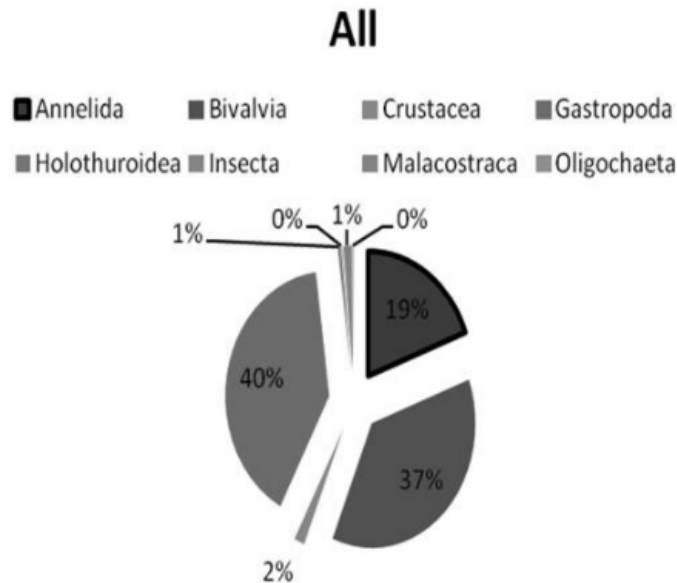


Figure 2.
Composition of
Macrozoobentos
throughout the
Station

The diversity index at station 5 is higher than the other four stations, presumably because this station is located in the estuary area close to the fishing dock. The value of low diversity index is found in stations 1, 2, 3, and 4, it is suspected that this station is close to the residential area of residents. The existence of environmental zone differences causes the diversity of the intolerant organisms to decline, otherwise the tolerant organisms will be high. Suwondo *et al.* (2004) mentions that there is a close relationship between diversity and environmental quality.

The fairness/uniformity index obtained from the five research stations ranging from 0.483 to 0.923 indicates a high degree of uniformity. The highest uniformity indexes at stations 4 and 5 are 0.838 and 0.923, and low at stations 1, 2, and 3 are 0.594, 0.543, and 0.483, respectively. The number of species obtained is small and no dominant species, whereas the 4 and 5 indexes indicate high value. This is thought to be due to environmental factors that are less supportive for the life of macrozoobentos. The value of *E* close to 0 means uniformity of organism types in an unbalanced waters due to competition both place and food (Rosyadi and Thamrin, 2009). If the value of *E* approaches 1 indicates the uniformity of the type of organism in the waters in a state of balance because there is no competition either to place or food.

The dominant index shows the values obtained from the five research stations ranging from 0.099 to 0.520, indicating moderate dominance. If $0 < D < 0.5$, then the dominance is low; if $0.5 < D < 0.75$, then the dominance is moderate; and if $0.75 < D < 1.00$, then the dominance is high (Susiana, 2011). The highest dominant index in the embankment is at station 3 and the lowest dominant index is at station 5. This is expected to affect the substrate type. Substrate type is the main factor that controls the distribution of macrozoobentos. This is due to the smaller number of species and the presence of some larger individuals dominating the area (Setiawan, 2010).

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