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DIVERSITY OF MAKROZOOBENTHOS IN THE FISH-SHRIMP POND AREAS IN ULEE MATENG VILLAGE

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ABSTRACT

Makrozoobenthos plays a crucial role in ecosystems as producers, primary consumers, and decomposers or detritus that can degrade organic compounds into inorganic ones. As primary consumers, the role of makrozoobenthos is vital for the survival of wildlife, especially various species of shorebirds commonly found in coastal areas and fish-shrimp pond areas. The aims of this research is determining the abundance of makrozoobenthos (ind/m^3) and ecological index at the pond in Ulee Matang Village. The diversity of macrozoobenthos species in the area consists of 12 species of three phylum and six classes. The abundance of macrozoobenthos on two type of pond (fish and shrimp) are ranging from 892 ind/m3 to 1400 ind/m3. The Arthropoda phylum, abundant in the research area, notably featured the Water Flea *Daphnia* sp. that serving as a primary food source for fish and shrimp prior to the introduction of fish and shrimp seeds. This suggests a significant role of arthropods in the food chain, supporting not only fish and shrimp but also macrozoobenthos and shorebirds.

Introduction

Ulee Matang is one of the villages in the Seunuddon District, North Aceh Regency, Aceh Province, Indonesia. This village area is located close to the sea, thus providing potential in the management of the fisheries sector, especially in pond management. The community in this village generally manages ponds by cultivating high-value and fast-producing species, such as shrimp, milkfish, gourami, and even tilapia. On the other hand, the community's activities in pond management passively contribute positively to the presence of macrozoobenthos species that live and adapt well in the pond area. Various types of macrozoobenthos from the groups of Annelida, Crustacea, and Mollusca greatly benefit from aquaculture activities.

Makrozoobenthos plays a crucial role in ecosystems as producers, primary consumers, and decomposers or detritus that can degrade organic compounds into inorganic ones. As primary consumers, the role of makrozoobenthos is vital for the

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survival of wildlife, especially various species of shorebirds commonly found in coastal areas. Makrozoobenthos serves as the primary food source for various types of shorebirds that regularly visit the aquaculture areas in this village. This is particularly unique because of its proximity to the northern coast of Aceh, where many shorebirds make the aquaculture locations in Ulee Matang Village their primary destination for food and stopovers during migration.

During the migration season of 2018, Putra and his team successfully detected satellites attached to Spoon-billed Sandpipers *(Calidris pygmaea)* in the pond areas of this village. This species has garnered special attention from bird researchers in Russia, where special breeding grounds have been established to help increase its population (Putra *et al,* 2019). According to the IUCN Red List, this species is classified as Critically Endangered (CR), with only less than 500 individuals remaining worldwide. Therefore, it's important to understand the role of makrozoobenthos in the pond areas of this village by assessing the abundance and diversity of macrozoobenthos species and analyzing their ecological indices. Additionally, it's crucial to understand the physical environmental factors and characteristics of the substrate in the pond areas as supporting data for the important habitats for shorebirds.

Materials and Methods

Tools and materials

The tools used are Surber nets, a cool box, Global Positioning System (GPS), a digital camera, 10 kg plastic bags, 5 ml syringes, alcohol bottles, laminated graph paper, permanent markers, tweezers, a work board, and writing tools. The materials used are 70% alcohol, Lugol's solution, label paper, and rolled tissues.

Research methods

The sampling locations were determined using purposive sampling based on the distribution of the largest/most abundant bird populations and divided into three locations: (i) fish pond I, (ii) fish pond II and (iii) shrimp pond. Sampling was conducted at three points in each location, repeated three times.

Research procedure

Sampling Techniques

Research team: two persons for sample collection, two persons for sorting and preparing samples, one person for documentation.

1. The bottom substrate is scraped to a depth of ± 10cm (according to the size of the Surber net: 30x30x30cm) using a modified Surber net, with three repetitions.
2. The captured macrozoobenthos are sorted using tweezers and documented on laminated paper.
3. The documented samples are then placed into sample bottles based on their taxa (different Phyla/Classes).
4. Each sample is preserved in 70% alcohol and stained with Lugol.
5. Subsequently, they are placed in a cool box filled with ice for identification in the laboratory.
6. In the laboratory, the obtained samples are then identified and specifically documented to obtain taxonomic species or genus levels.
7. Identified samples are then preserved as specimens using formalin for further identification references.

Data Analysis

The data analysis conducted includes population abundance, species richness index (R), Shannon-Wiener

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Diversity Index (H'), Species Evenness Index, and Dominance Index.

a. Abundance of macrozoobenthos
Population abundance describes the number of individuals occupying a certain area, calculated using the formula:

$$K = \frac{\text{The number of individuals of a species.}}{\text{Total area of Surber net}}$$

b. Indeks of Species Richness
Species richness index can describe the species richness at a research location. This index is calculated based on the formula:

$$R = \frac{S-1}{ln\ N}$$

R: Indeks of species richness
S: Total species
N: The total number of individuals of all species.

Description R:
R < 3,0 Low species richness
3,0 – 5 Moderate species richness
R >5 High species richness

c. Indeks of Diversity Shannon – Wiener (H')
The Shannon-Wiener Diversity Index analysis can depict the diversity level of a species within the overall species present, thereby revealing dominant species in the study.

$$H' = -\sum pi \ln pi$$

H':indeks diversitas Shannon – Wiener
Pi : the proporsion of spesies
Ln : logaritma Nature

The diversity and abundance of macrozoobenthos species at the research site

The diversity of macrozoobenthos species in the three ponds consists of three Phyla, six Classes, and 12 species of macrozoobenthos. The number of species and individuals in the three ponds can be seen in Table 1.

pi : $\sum ni / N$ (The calculation of the total number of individuals of all species)

Description H':
$0 < H' < 1$ = Low diversity
$1 < H' < 3$ = Moderate diversity
$H' > 3$ = High diversity

d. Indeks of Eveness (E)
The Evenness Index can describe the evenness of a species within the overall observation area, calculated using the formula:

$$E = \frac{H'}{ln\ S}$$

E : Indeks of eveness
H' : Indeks of diversity
S : Total of species

Description value E:
$0 \leq E \leq 0,4$: Low eveness
$0,4 \leq E \leq 0,6$: Moderate eveness
$E \geq 0,6$: High eveness

e. Indeks of Dominance
The Dominance Index describes the dominance of a species over all species in the observation location, calculated using the formula:

$$D = \sum(\frac{ni}{N})^2$$

D = Indeks of Dominance
ni = The total number of individuals of a species
N = The total number of individuals of all species.

Description D:
D<0,5 No species dominate
D>0,8 Species dominance exist

Results and Discussion

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Tabel 1. Diversity and Abundance of Macrozoobenthos in Fish Pond I, Fish Pond II, and Shrimp Pond at Ulee Matang Village

Phylum	Class	Species	Total		
			Fish Pond I	Fish Pond II	Shrimp Pond
Annelida	*Oligochaeta*	*Oligochaeta sp.*	9	55	-
	Branchiopoda	*Daphnia sp.*	165	155	210
Arthropoda	*Insecta*	*Gryllotalpa sp*	13	-	-
	Malacostraca	*Amphipoda sp*	-	-	23
Molusca	*Bivalvia*	*Callista lilacina*	-	1	-
	Gastropoda	*Cerithidea quoyii*	11	15	-
	Gastropoda	*Nassaridae sp*	16	21	-
	Gastropoda	*Pirinella sp*	27	8	22
	Gastropoda	*Nassarisius margaritifer*	-	78	47
	Gastropoda	*Littoria sp.*	-	7	38
	Gastropoda	*Nassarius sp*	-	15	-
	Gastropoda	*Peringea sp*	-	23	-
Total			241	378	340
Abundance (ind/m^3)			**892.59**	**1400.00**	**1259.26**

Based on Table 1, it can be seen that the highest species diversity is found in fish pond II with ten species, fish pond I with six species, and shrimp pond with five species. The highest individual abundance is found in fish pond II with 1400 ind/m3, shrimp pond with 1259 ind/m3, and fish pond I with 892 ind/m3. *Daphnia* sp. has the highest abundance in each pond because this species is the primary food source for fish and shrimp intentionally cultured before stocking fish or shrimp fry into the pond. The presence of Daphnia sp also benefits the diversity of macrozoobenthos species as insects and malacostraca can thrive well. Overall, the three ponds in Ulee Matang Village play a crucial role in the survival of coastal birds by providing a diverse and abundant macrozoobenthos species as their natural food source.

Macrozoobenthos in the mangrove forest of Lubuk Kertang Village, North Sumatra showed that eight species and classified into three classes of Gastropods, Bivalvia, and Malacostraca (Basyuni *et al*, 2018).

Macrozoobenthos in the coastal waters of Padang and Pariaman consists of Bivalvia, Gastropods, and Malacostraca. The analysis of the sediment organic matter showed weak position relationships with macrozoobenthos abundance (Fauzan *et al,* 2023). Benthos of the Shallabugh wetland was represented by Arthopoda, Annelida and Mollusca, and was studied in relation to abiotic and biotic factors for one year. The abundance of some specific pollution indicator species, especially Annelids such as Limnodrilus sp, Tubifex tubifex and Branchiura sowerbyii, is depictive of transition in trophic status of the wetland from meso- to eutrophy (Siraj *et al*, 2020).

The diversity of macrozoobenthos in Sei Barombang mangrove ecosystem showed gastropod and bivalvia as dominant species. *Barbatia amygdalumtosum* and *Glauconome virens* were the most species often found in all station (Dimenta *et al*, 2020). The abundance macrozoobenthos in Intertidal Zone of Sambungo Village Pesisir Selatan, West Sumatera obtained ranged from 3.33 - 5.11 ind/m2 (Anggara *et al,* 2021).

Indeks of Ecology

Indeks of Species Richness

The highest macrozoobenthos species richness index is found in fish pond II with a value of 1.516, fish pond I with 0.912, and shrimp pond with 0.686.

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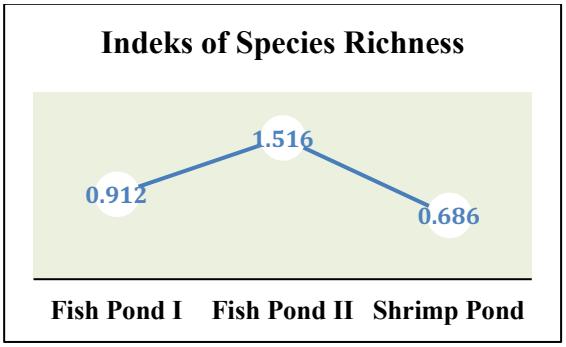
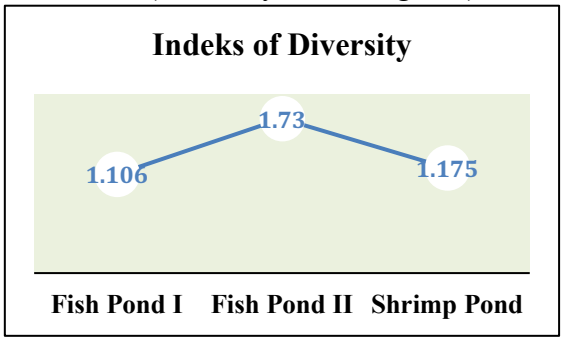


Figure 1. Indeks of Species Richness Makrozoobenthos in Fish Pond and Shrimp Pond at Ulee Matang Village

Based on the species richness index values, both fish pond and shrimp pond in Ulee Matang Village are classified as low. The low values of this index suggest that only specific species of coastal birds may prey on macrozoobenthos in this area. Based on the species data, it can be assumed that birds feeding on *Daphnia* sp. dominate in these three ponds, hence the correlation of this index value tends towards several species of coastal birds that prey on small insects or larvae. A low index value does not directly indicate that an area is not important; on the contrary, for some species of coastal birds that may be indicated as critically endangered, the presence of macrozoobenthos in Ulee Matang Village plays a crucial role in their survival.

Indeks of Diversity

The highest Shannon-Wiener diversity index is found in fish pond II with a value of 1.73, followed by the shrimp pond with a value of 1.175, and fish pond I with a value of 1.106. The index value represents the comparison between the number of species and the number of individuals in a particular observation area. Fish pond II area has the highest index because it has the highest number of species and individuals among the ponds. Based on the diversity index values, all three ponds fall into the category of low diversity. The low index values in this area contrast with its important ecological function. Putra (2019) reported that several bird species classified as CR (Critically Endangered) and



Vulnerable have been recorded in this area. Thus, despite the low diversity, this area has the potential to be designated as a conservation area, particularly for shore bird.

Figure 2. Indeks of Diversity Makrozoobenthos in Fish Pond and Shrimp Pond at Ulee Matang Village

Macrozoobenthos in the Coastal Waters of Marsegu Island, Maluku showed the diversity index about 2.07 – 3.56 and classified moderated until high diversity (Yunita *et al,* 2018). In other study, the diversity index of macrozoobenthos in reclamation land of PT. Semen Indonesia Tbk showed in the moderate category (Nurtjahyani, 2022). Other study in the Ogan River around Baturaja City showed diversity index value in ranged from 1.117 to 2.22 with a moderate category (Nurainah *et al*, 2022).

Indeks of Eveness

The highest evenness index of macrozoobenthos is found in fish pond II with a value of 0.787, followed by the shrimp pond with 0.656, and fish pond I with 0.617. Based on the evenness index, all three pond locations exhibit high evenness between the number of species and the number of individuals. This index

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value indicates that each species has a high distribution of individuals in each pond. This could be due to the even distribution of food sources such as *Daphnia* sp. and other insect larvae, resulting in a uniform distribution of macrozoobenthos in this area. This is related to the distribution of coastal birds spread across the pond area. Despite the low level of diversity, the evenness of various macrozoobenthos species as food for coastal birds is available in sufficiently high quantities.

Figure 3. Indeks of Eveness Makrozoobenthos in Fish Pond and Shrimp Pond at Ulee Matang Village

The diversity and evenness index, in the sea of Gorontalo water was in the medium category with no dominant species in the marine area. Biota communities in the lower reach station tend to be more like estuary biota than marine biota (Kadim *et al,* 2022).

Indeks of Dominance

The highest dominance index is found in fish pond II with 0.418, followed by the shrimp pond with 0.288, and fish pond I with 0.22. Based on the dominance index values, none of the three locations have species that dominate. This occurs because the number of macrozoobenthos species in each species is balanced. Despite the intentional breeding and introduction of Daphnia sp. into the ponds, the supportive environment and substrate allow other macrozoobenthos species to also have high populations.

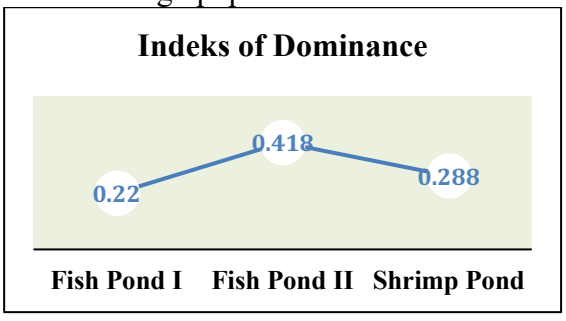
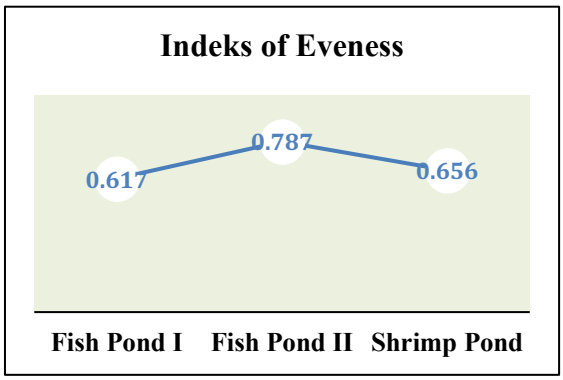


Figure 4. Indeks of Species Richness Makrozoobenthos in Fish Pond and Shrimp Pond at Ulee Matang Village



The community structure of macrozoobenthos in the estuary of Donan River, Cilacap, Central Java showed the macrozoobenthos density, diversity index, evennes index, and dominance index classified to be moderately ecological polluted (Hakiki *et al,* 2017).

Conclusions

The diversity of macrozoobenthos at fish pond and shrimp pond consists of three phyla, six classes, and 12 species. The abundance of macrozoobenthos at fish pond I 892.59 ind/m3, at fish pond II is 1400 ind/m3, and at shrimp pond is 12159.26 ind/m3. The species richness index and diversity index at all pond into low category, evenness index into high category, while in the dominance index, none of pond have dominating species.

Future Study and Recommendation

The research should be more focused on each species regarding their characteristics and specific roles. Additionally, it is also necessary to conduct DNA analysis to identify species more accurately and validate their accuracy. It is also important to identify the types of species that exist on the seabed substrate through DNA analysis based on their habitats. The diversity and abundance of macrozoobenthos on the three beaches are classified as low category based on the number of species, the number of individuals of each species, no species dominate based on dominance index and

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high category based on evenness index. However, all pond is vital role in the survival of shore birds and are globally significant for maintaining the balance of ecosystems in the Ulee Matang Village. Given the importance of these roles, it is necessary for these three areas to receive special attention in their management to protect the diversity and abundance of biodiversity they possess. Furthermore, it is hoped that these areas can also serve as benchmarks for important sites in the context of biodiversity and conservation.

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