Benthos population in seagrass ecosystem at Bira Island
Kepulauan Seribu, Jakarta Indonesia

R Komala*, M Miarsyah and R D Wulaningsih
Department of Biology, Faculty of Mathematics and Natural Science, Universitas
Negeri Jakarta, Jakarta, Indonesia

*rkomala@unj.ac.id

Abstract. One group of organisms that can be used as bio indicators of water quality is benthos, these organisms are spread over several habitats and also in coastal areas, one of which is in the seagrass ecosystem on Bira Island, located in the Kepulauan Seribu Jakarta. The aim of this study was to determine the dynamics of benthic population as an illustration of the environmental conditions on Bira Island for 6 months of observation. The method used in this study was descriptive with survey design. Data collecting by purposive sampling with the transect method at 3 observation stations. The data were analyzed descriptively through the calculation of abundance, diversity and dominance. The results of the study identified 23 species of benthos included in the 3 phylum with the largest to lowest composition represented by molluscs, arthropods and echinoderms phylum. The benthic population fluctuates and shows a pattern of decreasing trends every month during observation. The abundance of the highest species of each phylum is represented by Turicula javana (Mollusc), Portunus sp (Arthropods) and Holothuria atra (Echinoderms). The Species Abundance based on the observation station shows that the highest abundance is at station 1, followed by station 2 and the lowest is station 3. Benthos diversity at each station is in the moderate category, and there is no species dominates.

1. Introduction
Bira Besar Island is one of the tourist islands in the North Thousand Islands Jakarta [1]. This area has several important ecosystems including mangrove ecosystems, seagrasses and coral reefs, and there are many biota in the ecosystem. Sea which has important ecological and economical value one of the groups of marine life is benthos, which are animals that live in the bottom of the waters and their lives are very dependent on the substrate as their habitat [2].

Benthos play an important role as processing sediments in substrate at sea and food providers in food webs. Benthos can also be used as an indicator of aquatic environmental pollution so that it requires a healthy environment as a place of life [3]. Several types of benthos, especially zoo benthos, are animals that are negative phototactic, so they tend to stay away from sunlight [4]. These organisms are spread over several habitats and also in coastal areas, one of which is in the seagrass ecosystem on Bira Island, located in Kepulauan Seribu Jakarta.

Seagrasses are flowering and high-level plants that live in shallow waters and can adapt to salty waters, can form stretches of seagrass so-called seagrass beds [5]. Ecologically seagrass ecosystems serve as a food source for marine biota, spawning places and living quarters of marine life, supporting food chains and playing an important role in the process of nutrient cycles as well as protecting the coast from sea water abrasion [6].

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Many tourism and the community’s activities around the Island can affect several important ecosystems, one of which is seagrass ecosystems that directly affect the organisms that exist in the ecosystem. One of them is benthos as forming benthic communities. The purpose of this study was to determine the dynamics of benthic population as an illustration of the environmental conditions of the waters in Bira Island for 6 months of observation,

2. Research methods
The research was carried out in Seagrass Ecosystem, Bira Island, Kepulauan Seribu, Jakarta, in December 2017 to May 2018. The research method used descriptive with survey design and direct observation. Observation location was divided into 3 observation stations based on seagrass vegetation conditions and determination of observation station coordinates using GPS. Sampling was done purposively by transect method.

On the muddy substrate benthos was taken using Eckman tools and benthos on the surface of the substrate were taken directly by hand. Then data were recorded, photographed, calculated, then identified using the identification books [5,7]. The parameters measured includes: temperature, pH, salinity, dissolved oxygen, BOD, turbidity, depth, Nitrate, Nitrite and Orthophosphate. Data were analyzed descriptively through calculation of abundance, diversity index and dominance index [8,9]. The Abundance was measured using the following formula:

\[
D_i = \frac{n_i}{A}
\]

\(D_i\) = i abundance of individual species
\(n_i\) = number of individuals from the i-species
\(A\) = the area of the sampling plots

2.1. The diversity index
To find out the diversity index of the benthos, the Simpson formula was used, namely:

\[
C' = \sum_{i=1}^{n} \left( \frac{n_i}{N} \right)^2
\]

\(n_i\) = value of the importance of each type (number of individual species i)
\(C\) = diversity index
\(N\) = total value of interest (total number of all individual)

Diversity index criteria:
\(H \leq 1.0\): hence the diversity is small, productivity is very low, and there is an indication of heavy pressure and an unstable ecosystem.
\(1.0 \leq H \leq 3.322\): then the diversity is moderate, productivity is sufficient, the condition of the ecosystem is quite balanced and the ecological pressure is moderate.
\(H \geq 3.322\): then there is high diversity, the ecosystem is stable, and there is high productivity and resistance to ecological pressure.

2.2. Dominance index
The dominance index was calculated using Simpson's Dominance Index, namely:

\[
D = \sum_{i=1}^{5} \frac{n_i (n_i - 1)}{N(N-1)}
\]
D = dominance index
\( n_i = \) number of individuals from the i-species
N = total number of individuals
S = number of types (number of genera)

3. Result and discussion

3.1. Abundance and composition of benthos

Identified as many as 23 species of benthos included in the 3 phylum, with the largest to lowest composition represented by Molluscs, Arthropods and Echinoderms. The high abundance of each phylum is represented by *Turicula javana* and *Natica tigrina*, (Mollusc), *Portunus* sp (Arthropods), *Holothuria atra* and *Synapta maculata* (Echinoderms) (Table 1).

| No | Phylum/species | Di   | %   | No | Phylum/species | D     | %   |
|----|----------------|------|-----|----|----------------|-------|-----|
| 1  | *Polymesoda* sp | 51.46| 1.52| 14 | *Penaeus* sp   | 285.52| 8.45|
| 2  | *Nerita articulata* | 44.82| 1.33| 15 | *Squilla* sp   | 56.44 | 1.67|
| 3  | *Littoraria* sp | 29.88| 0.88| 16 | *Portunus* sp | 393.42| 11.64|
| 4  | *Pitar citrine* | 24.9 | 0.74| 17 | *Libnia* sp    | 29.88 | 1.08|
| 5  | *Scaparca pilula* | 48.14| 1.42| 18 | *Doripe granulata* | 29.88 | 0.88|
| 6  | *Anadara* sp | 39.84| 8.57| 19 | *Ophiarachnella* | 56.44 | 1.67|
| 7  | *Placuna pacenta* | 69.72| 5.04| 20 | *ECHINODRMS*  |       |     |
| 8  | *Turicula javana* | 496.34| 14.69| 20 | *Holothuria leucospilota* | 61.42 | 1.81|
| 9  | *Natica tigrina* | 310.42| 9.18| 21 | *Holothuria atra* | 685.58| 20.29|
| 10 | *Nasarius livescens* | 24.9| 0.73| 22 | *Synapta maculata* | 376.82| 11.15|
| 11 | *Policines didima* | 56.44| 1.67| 23 | *Diadema setosum* | 64.74 | 1.92|
| 12 | *Cypraea* sp | 71.38| 2.11| 24 |       |       |     |
| 13 | *Nerita articulata* | 63.08| 1.86| 25 |       |       |     |

The benthos population showed a pattern of decreasing trends every month during observation (Figure 1).

Figure 1. Fluctuation of benthos population.
3.2. The diversity and dominance index

The diversity index and dominance index ranged for each month is shown in table 2 below:

|        | Month and year |        |
|--------|----------------|--------|
|        | Dec | Jan | Feb | March | April | May |
| Diversity (C’) | 1.09 | 1.04 | 1.08 | 1.06 | 1.07 | 1.07 |
| Dominance (D)   | 0.34 | 0.34 | 0.35 | 0.35 | 0.34 | 0.36 |

3.3. Environmental parameters of the waters of Bira Island

The physical and chemical environment parameters of the water showed fluctuating values and varied between stations. The Range of Temperature (27.88 – 30.12°C), pH (62 – 72), Salinity (20.48 – 27.22 ppt), DO (4.89 – 6.91 mg/l), BOD (1.12 – 2.23 mg/l), Substrate (dusty sand), Turbidity (15.02 – 18.03 NTU), Depth (50 – 67 cm), Nitrate (0.02-0.08 mg/l), Nitrite (< 0.02-0.03 mg/l), Otrhofosfat (< 0.005 – 0.018 mg/l).

The Mollusc Phylum is highest composition among the other phylum. This is because Mollusc can adapt well and consist of animals that are very successful in adjusting to life in several places and weather and has the most members among members of other aquatic organisms [10,11]. *Turricula javana* has the highest density and composition this is because most commonly found in various habitats [12]. *Turricula javana* is a gastropods species that has adapted well to environmental conditions. Gastropods are the most successful class of living in various habitats such as the seabed, pelagic, freshwater waters and parts of the land [12]. Phylum of Arthropods is a relatively low density and composition among other phylum. The presence of Arthropods was pushed by Mollusc which had a good adaptation to local habitat Echinodermta Phylum is also a relatively low composition. The presence of the phylum Echinodermata includes only 4 types of sea cucumbers, namely *Holothuria atra* (Blood Sea Cucumber), *Holothuria leucospilota* (Sea Cucumber sap), *Holothuria fuscocinerea* (Lakling chocolate) and *Synapta maculata* (King Belt Sea Cucumber) of 2 families namely *Holothuriidae* and *Synaptidae*.

*H. atra* and *H. leucospilota* is a type of sea cucumber which belongs to the fissiparous group, which is a group of sea cucumbers that have the potential to reproduce by splitting themselves *Synapta maculata* has morphological characteristics namely cylindrical and long body, black-brown stripes, and body very weak when lifted from water. This type often secretes tentacles [3]. *Holothuria fuscocinerea* belongs to the Holothuriidae family. The morphology of this type of sea cucumber is predominantly white throughout the body, cylindrical shape, and the bottom and back of this sea cucumber is brown.

Sea cucumbers found in seagrass ecosystems and coral reef ecosystems are mostly included in the order of Aspidochirotides that commonly found in tropical waters order Aspidochirotida are deposit feeders, these groups of biota are often found in calm, protected, and rich in accumulation of organic matter, so that the suspected location of seagrass ecosystems and coral reef ecosystems is a suitable habitat for the development of sea cucumbers from the order [13].

Tropical waters have various kinds of ecosystems that can break down currents such as seagrass ecosystems and coral reef ecosystems so that some marine biota such as sea cucumbers in the ecosystem will be protected from strong currents and the marine biota will get accumulated organic matter from the movement of ocean currents [6].

*H. atra* and *H. leucospilota* are types of sea cucumbers which belong to the fissiparous group, namely the group of sea cucumbers which have the potential to reproduce by splitting themselves [3,14]. *H. atra, H. leucospilota, Synapta maculate and H. fuscocinerea* are some of the sea cucumbers found on Bira Island [13]. Sand substrate is the dominant substrate of Bira Island. Supports the life of sea cucumbers because rich in organic matter [15].

Diversity index includes in medium criteria, the rainy season and conditions that are less conducive namely high turbidity levels and result in inhibited benthos growth and even cause death due to disruption of the respiratory process [1]. Diversity indicate that the distribution of individual species is
moderate and the stability of the community is moderate [2,16]. This dominance value shows the dominance of a species in a community. The value of dominance index closer to 1, it means that there is dominance of one or more types of zoo benthos. Environmental parameters in general are still in the normal range for benthic life in seagrass ecosystems. The ideal temperature for marine organisms to live is 20-30 °C, so these results are still ideal to support benthos life [17] and normal waters have an optimum temperature of 28–31 °C [6,18].

Dissolved oxygen (DO) that supports the life of marine biota is > 5 mg/l. Dissolved oxygen is very important for macro zoo benthos and other aquatic organisms [16]. The normal pH range of waters that can sustain the life of aquatic organisms is 6.50 - 8.50 [19]. Most aquatic biota are sensitive to changes in pH and like a pH value of about 7 - 8.5 [20]. The substrate on all three stations is a type of dusty sand, which could have influence in the ecosystem composition and distribution. Substrate is a basic factor that influences the composition and distribution of benthic organisms. Besides being a place of life, the basic substrate is also used as a food source for most benthos [2,21].

4. Conclusion
As many as 23 species of benthos, belonging to 3 phylum's, namely, mollusks, arthropods and Echinoderms were identified on Bira Island, with the highest phylum represented by molluscs and the lowest by Echinoderms. The species with the highest abundance represented by Turicula javana (Mollusc), Portunus sp (Arthropods) and Holothuria atra (Echinoderms) and the lowest. Represented by Pitar citrine (Mollusc), Doripe granulata (Arthropods) dan Holothuria leucospilota (Echinoderms). The diversity of benthos is moderate criteria and no species dominance exists, while the environmental parameters in general are still in the normal range for zoo benthos life. The decline in the population of the zoo benthos over time is due to a greater extent to habitat degradation.

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