Community Structure of Sea Cucumber (Holothuroidea) In Pombo Island Conservation Area, Central Maluku

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Abstract. Sea cucumbers (Holothuroidea) are marine animals that is highly nutritious for human consumption, commercially important, and serve a useful role in the marine ecosystem. Less optimal monitoring in Pombo Island Conservation Area and the activity of catching sea cucumbers by the surrounding community, then the aim of this research is to find out community structure of sea cucumber in Pombo Island Conservation Area, Central Maluku. It is a descriptive quantitative research. The research was conducted from October 28, to November 28, 2018 by using linear quadratic transect method. Based on the result of the research, it can be concluded that there were 208 individuals which consists of 1 family (Holothuroidea) and 3 species (Holothuria atra, Holothuria leucospilota, Holothuria nobilis). The most observed species is Holothuria atra with a total of 111 individuals whereas the least observed species is Holothuria nobilis with a total of 42 individuals. Furthermore, Holothuria atra was the species with highest density, abundance, frequency of occurrence, and important value index while the lowest is Holothuria nobilis. The diversity index value is in medium category at 1.0086, while the dominance index value is close to 0 (0.3385) or no species dominates.

1. Introduction

Sea cucumbers are sea invertebrates that have soft, fleshy body and elongated cylindrical shape like cucumbers [1]. Sea cucumbers are the most common group of marine animals. Many of these animals are found on coral reefs and on rocky or muddy beaches. Sea cucumbers can be found in almost all coastal waters, ranging from shallow tidal areas to deep waters [2]. Sea cucumbers have benefits both in economic and ecological terms. The behavior of sea cucumbers that stirs the bottom of the water in how to get their food, allows the oxygenation of the top layer of sediment and helps fertilize the surrounding substrate [3].

In the waters of Maluku, sea cucumbers can be found in almost all coastal waters starting from a depth of one meter to a depth of 40 meters spread almost on every island, including Pombo Island. Pombo Island is one of the Islands in Maluku Province which is located between Ambon Island and Haruku Island, and is administratively located in the Salahutu District area, Central Maluku Regency. Since 1973, Pombo Island has been designated as a natural resource conservation area in the category of Nature Reserve, with the status of a Nature Reserve or Marine Park by the Government of Indonesia. Then in its development, in 1996, the coral reef ecosystem area of Pombo Island was designated as a Nature Conservation Area, with the status of Marine Nature Park. However, management for this conservation area is not optimal or not working properly and seems to be
neglected. In addition, the lack of supervision allows the community to be able to do activities freely in the Nature Reserve of Pombo Island [4,5]. The local community near Pombo Island (Wainuru village) states that most of the sea cucumbers that inhabiting Pombo Island are the black sea cucumber species and this species is sometimes used for food [5].

Sea cucumber resources are those that can be recovered (renewable resources) but continuous capture without restrictions and are not environmentally sound can result in the depletion of these resources [6]. The existence of uncontrolled collection of sea cucumber species can affect the diversity of species and community structure. A community has a high diversity if arranged by many species with a high species abundance and if the community is composed by a low number of species and there are few dominant species, the species diversity is low [3]. Thus, research is needed with the aim of assessing ecological aspects especially the structure of the sea cucumbers (Holothuroidea) community in the Pombo Island Conservation Area, Central Maluku, which includes density, frequency of species presence, abundance, ecological index and environmental parameters. Community structure can be used to determine the stability of the aquatic environment, so that through this research it is hoped that it can provide information about the ecological aspects of sea cucumbers and can be scientific information for further research and input for sustainable management efforts.

2. Experimental

2.1 Methods

This research is a quantitative descriptive research and linear quadratic transect technique is used to collect data. The collected data is explained in the form of tables and images. The research was conducted on October 28, 2018 until data collection is completed. The research was conducted in the conservation area of Pombo Island, Central Maluku. Pombo Island is geographically located between Ambon Island and Haruku Island with coordinates 128°22'09″East and 3°31'35'South (Fig. 1). The types of the intertidal zone of Pombo Island at station 1 are dominated by sandy substrate, station 2 are dominated by flat dead coral fragments and covered with seagrass vegetation, while at station 3 are dominated by sandy substrate, flat dead coral fragments and without seagrass vegetation (Fig. 2).
The types of the intertidal zone of Pombo Island: (a) Station 1; (b) Station 2; (c) Station 3

The instruments used in this research were digital cameras, rulers, pencils, meters, scissors, knives, pH meters, thermometers, refractometers, buckets, gloves, plastic bags and sea cucumber identification books based on [7,8]. The materials used in this research were label paper, duct tape, distilled water, sea water and alcohol 75%. The initial survey was conducted to examine the location to determine the best area for the research to get the maximum result. Sampling was carried out at low tide using the linear quadratic transect technique. Based on Pombo beach area which is ± 1,200 m² in length, the sampling area divided into 3 stations, the distance between stations is 200 m.

At stations I and II, 3 transects were placed while 6 transects were placed at station III perpendicular to the coastline from the highest to the lowest tide. At station I, where the tide is low, 3 transects were placed and the transect length is 50 m, and then 10 observation plots were placed. The distance between transects is 10 m and the distance between plots is 5 m. At stations II and III where the tide is high, 3 transect were placed at station II while 6 transect were placed at station III. The transect length was 240 m and 24 observation plots were placed at transects in stations II and III, the distance between transects was 10 m and the distance between plots was 5 m. At station I, II and III the transect was placed in a plot in a size of 1x1 m². Sea cucumber samples found in each plot were calculated and then put into plastic bag with alcohol 75% for further identification in the Ecology Laboratory, Faculty of Mathematics and Science, Pattimura University. Besides, environment parameter is also measured which includes temperature, salinity, and pH. Data on the number of species and individuals per species of sea cucumber (Holothuroidea) then analyzed as follow:

2.2 Density (Ind/m²) and Relative Density (%)

The Density and Relative Density of sea cucumber were calculated by using the following formula, according to Odum, 1971 in [9,10]:

\[
\text{Density} = \frac{\text{Total Number of Individuals Species (ni)}}{\text{Area surveyed in transect (A)}} \quad (1)
\]

\[
\text{Relative Density} = \frac{\text{Total Number of Individuals Found (ni)}}{\text{Total Number of Individuals Species Found (} \sum n \text{) x 100%}} \quad (2)
\]

2.3 Frequency of Occurance (Ind/m²) and Relative Frequency (%)

The frequency of Occurance (\(F_i\)) and relative frequency (\(RF_i\)) of sea cucumber were calculated by using the following formula, according to Odum, (1971) in [9,10]:

\[
F_i = \frac{\text{Number of Individuals Found in Plot Transect-}i (pi)}{\text{Total Number of Plot Transect (} \sum P \text{)}} \quad (3)
\]

\[
RF_i = \frac{\text{Frequency of Species (Fi)}}{\text{Total Number Frequency of Species (} \sum \text{Fi) x 100%}} \quad (4)
\]
2.4 Abundance (Ind/m²) and Relative Abundance (%)
The abundance and relative abundance of sea cucumber were calculated by using the following formula, according to Krebs, (1997) in [9-11]:

\[
\text{Abundance} = \frac{\text{Number of Individuals Species}}{\text{Total Number of Species in Plot Transect}}
\]

\[
\text{Relative Abundance} = \frac{\text{Total Number Abundance of Species}}{\text{Total Number Abundance of All Species} \times 100%}
\]

2.5 Important Value Index (%)
The important value index of sea cucumber were calculated by using the following formula, according to Brower et al., (1989) in [9,10]:

\[
\text{Important Value Index} = \frac{\text{Relative Density} + \text{Relative Frequency} + \text{Relative Abundance}}{3}
\]

2.6 Diversity Index of Shannon-Wiener (H’)
The diversity index of species were calculated by using the following formula, according to Shannon-Winner, (1963) in [10,12]:

\[
H’ = \sum_{i=1}^{n} \frac{\text{Pi \times Ln Pi}}{\text{Pi}} = \frac{\text{Number of Individuals Species (ni)}}{\text{Total Number of Individuals Species (N)}}
\]

Note: \( H’ < 1 = \) Low Diversity; \( 1 \leq H’ \leq 3 = \) Medium Diversity; \( H’ > 3 = \) High Diversity

2.7 Dominance Index of Simpson (D)
The dominance index of species were calculated by using the following formula, according to Brower, (1989) in [10, 13]:

\[
D = \sum (\text{Pi})^2
\]

Note:
\( D = \) Dominance Index
\( \text{Pi} = \) Number of individuals Species Proportion to Total Number (ni/N)

The dominance index value ranges from 0-1. The dominance category is based on the Simpson Dominance Index value (D):

- 0,00 - 0,50 = No Dominance Species
- 0,51 - 1,00 = Dominance Species

3. Result and Discussion
3.1 Composition of Sea Cucumbers.
The findings of the research found that the composition of sea cucumbers species in of Central Maluku Pombo Island found three species of sea cucumbers from one family namely Holothuriidae (Holothuria atra, Holothuria leucospilota and Holothuria nobilis) with a total number of individuals found, namely 208 individuals. These results are presented in Table 1.
Table 1. Composition of Sea Cucumbers in the Pombo Island Conservation Area, Central Maluku

| Family         | Species              | Number of Individuals |
|----------------|----------------------|-----------------------|
| **Holothuroidea** | **Holothuria atra** | 111                   |
|                | **Holothuria leucospilota** | 55               |
|                | **Holothuria nobilis** | 42                   |
|                | **Total**            | 208                   |

Based on Table 1, shows that the most sea cucumbers species found in Pombo are *Holothuria atra* with a total of 111 individuals, *Holothuria leucospilota* 55 individuals, and the least *Holothuria nobilis* species at only 42 individuals. *Holothuria atra* can be found at each observation station. Then for *Holothuria leucospilota* only found at stations 1 and 3. While *Holothuria nobilis* just be found at stations 2 and 3. Those three species are presented in Fig. 3.

![Sea Cucumbers](image)

**Figure 3.** Sea Cucumbers Found in Pombo Island Conservation Area
(a). *Holothuria atra*; (b). *Holothuria leucospilota*; (c). *Holothuria nobilis*

3.2 Density, Frequency of occurrence, and abundance value of sea cucumber species

The calculation on the density, frequency of occurrence and abundance value of sea cucumbers species in Pombo Island Conservation Area, Central Maluku are presented in Table 2.

Table 2. Density, frequency of occurrence and abundance value of sea cucumbers species in Pombo Island Conservation Area, Central Maluku

| No. | Species             | ∑ Individu | Di (Ind/m²) | RDi (%) | A (Ind/m²) | RA (%) | Fi (Ind/m²) | RFi (%) |
|-----|---------------------|------------|-------------|---------|------------|--------|-------------|---------|
| 1   | *Holothuria atra*   | 111        | 0,451       | 53,31   | 1,306      | 35,85  | 0,346       | 50,66   |
| 2   | *Holothuria leucospilota* | 55        | 0,224       | 26,48   | 1,170      | 32,12  | 0,191       | 27,96   |
| 3   | *Holothuria nobilis* | 42         | 0,171       | 20,21   | 1,167      | 32,03  | 0,146       | 21,36   |
|     | **Total**           | 208        | 0,846       | 100     | 3,643      | 100    | 0,683       | 100     |

Note: Di = Density; RDi = Relative Density; A = Abundance; RA = Relative Abundance; Fi = Frequency of Occurrence; RFi = Relative Frequency
Based on the statistics in Table 2, it can clearly be seen that the density, frequency of occurrence and abundance value of sea cucumbers species in Pombo Island Conservation Area, Central Maluku, is the highest for *Holothuria atra* while the lowest is *Holothuria nobilis*.

### 3.3 Important Value Index.

The calculation for important value index for each sea cucumber species found in Pombo Island Conservation Area presented in Table 3.

**Table 3.** Important value index of sea cucumbers in pombo island conservation area, Central Maluku

| No. | Species              | RDi  (%) | RA  (%) | RFi  (%) | INP  (%) |
|-----|----------------------|----------|---------|----------|---------|
| 1   | *Holothuria atra*    | 53.31    | 35.85   | 50.66    | 139.82  |
| 2   | *Holothuria leucospilota* | 26.48    | 32.12   | 27.96    | 86.56   |
| 3   | *Holothuria nobilis*  | 20.21    | 32.03   | 21.38    | 73.62   |

Note: RDi = Relative Density; RA = Relative Abundance; RFi = Relative Frequency INP = Important Value Index

Based on the results in Table 3, it can be seen that the species with the highest important value index is *Holothuria atra* and the lowest important value index is *Holothuria nobilis*.

### 3.4 Diversity and Dominance Index Value of Sea Cucumbers.

High and low species diversity is determined by the number of species and the total number of individuals. Dominance value is used to determine the concentration and distribution of dominant species. If the dominance is more concentrated in one species, the dominance index value will increase and conversely if several species dominate then the dominance index value will be low. The result and calculation of diversity and the dominance index value are presented in Table 4.

**Table 4.** Diversity and dominance index value of sea cucumbers in pombo island conservation area, Central Maluku

| Diversity Category | Dominance | Category |
|-------------------|-----------|----------|
| 1.0086 Medium     | 0.3385 No Dominance |  |

Based on the data in Table 3, the diversity value is 1.0086 which is classified as medium category and the dominance index value is 0.3885 which means that there is no particular dominant species.

### 3.5 Physical and Chemical Aquatic Factors Measurement.

The measurements of physical and chemical factors in coastal waters of Pombo Island Conservation Area, Central Maluku Regency can be seen in Table 5.
The results in Table 5 show that the temperatures in Pombo Island Conservation Area range from 26-29 (°C); salinity ranges from 27-30 (%); and pH ranges from 7.6 to 7.9. Based on the Table 1-5 can be concluded that there were only 3 sea cucumber species found only from 1 family. *Holothuria atra* is the most observed species with a total of 111 individuals, and the least observed species is *Holothuria nobilis* at only 42 individuals. The calculation of the density, abundance and frequency of occurrence value when compared with other species of sea cucumbers, *Holothuria atra* is also the species that has the highest value, as can be seen in Table 2.

The high number of individuals, density, abundance and frequency of occurrence value for *Holothuria atra* species in this research is probably due to high survival mechanism against interference or threat. *Holothuria atra* will emit a red liquid which is thought to be a Holothurim compound when getting disturbances or threats. *Holothuria atra* also has thick and soft body wall that is a very good way of adaptation compared to the other species of sea cucumbers. Another adaptation possessed by *Holothuria atra* is to coat itself with fine sand, where the sand attached to the body of *Holothuria atra* will reflect light and make its body temperature lower at extreme temperature changes. Not only by coating itself with sand, this sea cucumbers is also hiding under rocks or between rocks. These adaptations are done by the species to protect itself from sunlight, high temperatures, and predator attack [15]. In addition, the high density, abundance and frequency of occurrence of the *Holothuria atra* are thought to be related about their ability to reproduce asexually (fissiparous). *Holothuria atra* have a potential to reproduce by separation body part, without being affected by certain months [16]. Thus, *Holothuria atra* is often found in waters with high density, abundance and frequency of occurrence in waters due to the high level survival skill and better adaptation from this species of sea cucumber [15,17].

The species with the lowest number of individuals, density, abundance and frequency of occurrence is *Holothuria nobilis*. It is allegedly due to the ability to compete in occupying habitats, because of the high or low density of biota can also be caused by lack of competitiveness in occupying habitats [18]. *Holothuria nobilis* is more suitable to live in habitats with rocky substrate that is rocky and coexist with a lot of seaweed. Likewise with [19, 20], this species is less suitable to survive in muddy and sandy substrate. *Holothuria nobilis* is very suitable to grow in areas containing organic matter, superficial areas, and with coral reefs. This is consistent with Sutaman, (1993) in [15], basic substrate is one of the main ecological factors that affect the structure of macrobenthos community.

*Holothuria atra* also occupies the highest Important Value Index and the same goes to the lowest which is *Holothuria nobilis*. Important value index are generally used to indicate species composition and community structure. The higher the importance index value of a component, is the more important role of these species in the community [10]. From these results it can be seen that the most influential type of sea cucumber in a sea cucumber community structure in the coastal waters of Pombo Island, is *Holothuria atra*. They plays an important role for the sea cucumber community. *Holothuria atra* has an important role in the conservation of the marine environment. *Holothuria atra* is omnivorous, filtering sediment with its tentacles and eating detritus and other organic matter. It digests sand at the same time and digests biofilms in grains of sand before removing them through its anus. Through the sea cucumber’s behavior which stirs the bottom of the water in a way to get its feed,

**Table 5. Results of Measurement of Chemical Physical Factors in the Pombo Island Conservation Area, Central Maluku**

| Parameter | Estimation | Sea Water Standardised Quality [9] |
|-----------|------------|-----------------------------------|
| Temperature (°C) | 26 – 29 | 28 – 32 |
| Salinity (%) | 27 – 30 | 33 – 34 |
| pH | 7.6 – 7.9 | 7 - 8.5 |
allows the oxygenation of the upper layers of sediment and helps fertilize the surrounding substrate [21]. So that, if there is a decline in population against *Holothuria atra* at the ecological level, it will illustrate the decline in population for all species of sea cucumbers that live in the coastal waters of Pombo Island.

Then, from the results of the calculation of the diversity index and the dominance of sea cucumbers in this research, it indicates that the diversity index value is in medium category at 1.0086, while the dominance index value is close to 0 (0.3385) or no species dominates. A community has a high diversity if arranged by many species with a high species abundance and if the community is composed by a low number of species and there are few dominant species, the species diversity is low [3]. Furthermore, the high and low species diversity index is closely related with a good habitat conditions. With good habitat conditions, the habitat can function as a shelter, find food and breeding. So, the result of the diversity index and the dominance this research shows that in coastal waters of Pombo Island, community stability and sufficient food availability and supporting environmental conditions means sufficient productivity, fairly balanced ecosystem conditions. This is supported by the chemical and physical factors in coastal waters of Pombo Island which show all parameters to remain in the optimal range of sea water quality standard [14] for sea cucumber lives. The physical-chemical parameters of the waters measured are environmental factors that affect the growth of sea cucumbers, namely temperature, pH, and salinity. From the measurement results (Table 5) it can be seen that the environmental parameters of the coastal waters of Pombo Island are suitable for sea cucumber growth because they meet the criteria of sea water quality standards for marine biota and sea cucumber cultivation requirements. This is evident where all three types of sea cucumbers are still able to survive in the coastal waters of Pombo Island.

In a previous study by [5] in the coastal waters of Pombo Island also found 2 species of sea cucumbers namely *Holothuria atra* and *Holothuria leucospilota* where *Holothuria atra* has the highest number of individuals but no dominant species were found. While research by [3] in the Porto Village, Saparua Island, Central Maluku Regency, shows that the value of the diversity index is low. This is due to the presence of certain species that are found in greater numbers when compared with other species.

**4 Conclusions**

The research of community structure of sea cucumbers in Pombo Island Conservation Area, Central Maluku, shows that in this area was found three species of sea cucumbers (*Holothuria atra, Holothuria leucospilota* and *Holothuria nobilis*) from one family, Holothuroidea. Species with the highest density, frequency of occurrence, abundance and important value index is *Holothuria atra* species while the lowest density, frequency of occurrence, abundance and important value index is *Holothuria nobilis*. The value of the diversity index, i.e. 1.0086 is classified as medium category and no species dominates (D = 0.3385). Based on the results of this research, it can be concluded that the coastal waters of Pombo Island are still relatively stable and supporting to sea cucumber lives.

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