Characteristics of environment and habitat of sea cucumbers in Pane Island, Tapanuli Tengah Regency

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Abstract. Pane Island is one of the tourist destinations in Tapanuli Tengah Regency, visually Pane Island has some of marine ecosystems such as seagrass, mangrove, seaweed, and dead coral ecosystems. Sea cucumbers are invertebrates, it’s have high commercial value and has ecological functions. In this study, sea cucumbers identification, abundance and seagrass cover was investigated in Pane Island. The results showed that 1 sea cucumber species were found, Holothuria leucospilota. Sea cucumber abundance ranged from 0 to 1.2 ind/m². Based on Principal Components Analysis (PCA), sea cucumber abundance is positively related to temperature, current, pH, salinity, total nitrogen, phosphate, and C-organic content. Furthermore, sea cucumber abundance is negatively related to the parameters of water depth, water transparency, DO and percentage of seagrass cover.

1. Introduction
Pane Island is one of the tourist destinations in Sosor Gadong District, Tapanuli Tengah Regency, North Sumatera Province, Indonesia. Visually, this island has some of marine ecosystems such as seagrass, mangrove, seaweed species (especially Sargassum sp.) and dead coral (located at the end of the island and dealing directly to the open-sea). Based on visual observations and information from local community, on this island, we can also found some animals such as sponges, fish, snails, hermit crabs, crabs, shrimp, and sea cucumbers.

Sea cucumbers are any Echinoderms (spiny-skinned animals) with cylindrical-shape body. Sea cucumbers are generally depositary feeder and suspension feeder in the food chain [1]. Sea cucumber behaviour "stirs" the bottom of the water to get its feed, helps fertilize the surrounding substrate [2]. Furthermore, [2] mentioned that the sea cucumbers have a role as a food contributor in the
form of eggs, larvae, and sea cucumber juvenile, for other marine organisms such as crustaceans, molluscs, and fish. The main habitat of sea cucumbers is in seagrasses and corals ecosystem [3] and some of them were found in boulders areas (1). Sea cucumbers also have a very high economic value so it was widely traded both in local and international markets. The price of dried sea cucumbers ranges between 400,000 – 6,000,000 IDR depending on the species, contents per kilogram and markets (local or international markets). The higher economic value in the international market is mainly due to the nutrient content and bioactive compounds contained in sea cucumbers body [4]. The higher economic value and nutrient content of sea cucumbers have increased the exploitation and hunting of these animals.

Based on population information about the existence of sea cucumbers on Pane Island and considering the role of sea cucumbers both ecologically and economically, the research is needed to identification, estimate the abundance and determine the environmental characteristics of sea cucumbers on this island. At present, there is no written information regarding the sea cucumbers species on Pane Island. The result of this study can be useful for sustainable management of sea cucumbers on the island Pane.

2. Material and methods

2.1. Study Area
This research was conducted from June to July 2019 in Pane Island, Sibolga, Tapanuli Tengah Regency. Four study site were selected to describe the condition of Pane Island, Station 1 (98° 49'51.16''E and 01° 93'82.35''N), station 2 (98°49'43.36'E and 01° 93'70.62''N), station 3 (98°49'42.73''E and 01° 93'52.73''N) and station 4 (98°49'99.10''E and 01° 93'80.38''N).

2.2. Procedures
This research is based on primary data, consisting the sea cucumber data, seagrass cover, and water physical-chemical parameters. The samples of sea cucumber and seagrass cover were collected using quadrant transects (50 x 50 cm) along a transect line. There are at least 3 transect lines in 1 station that drawn perpendicular to the coastline. The distance between transect lines was 50 m and the distance between quadrant transects was 10 m. Sea cucumber samples and seagrass cover are taken at low tide to make it easier. The reference guides to Sea cucumber species identification included books [5] and seagrasses were identified using books [6].

The water physical-chemical parameters were also determined in this research using in situ and ex situ analysis. The parameters such as temperature, salinity, pH, DO, current, brightness and depth of water are measured by in situ analysis. Total nitrogen and phosphate are measured in ex situ method by bringing water samples to the laboratory. The samples of substrate were taken to the analysis of substrate texture and C-organic content. Analysis of substrate texture, C-organic content, total nitrogen, and phosphate was conducted at the Laboratory of the Palm Oil Research Centre (PPKS) Medan, North Sumatera.

2.3. Data analysis

2.3.1. Abundance. The abundance of sea cucumber was calculated following the formula (eq. 1), where X is the abundance of species (Ind/m²), ΣXi is the number of total individual of species (ind) and n is wide of the area sampled (m²) [7].

\[ X = \frac{\Sigma X_i}{n} \]
2.3.2. Seagrass cover. The average of seagrass cover at each station was calculated using the formula (eq. 2) [6], which are:

\[
\text{Average of seagrass cover} = \frac{\text{the amount of seagrass cover throughout the transect}}{\text{amount of quadrants throughout transects}}
\]  

(2)

2.3.3. Principal components analysis (PCA). Principal components analysis is multivariable statistical analysis to determine the relation between seagrass cover, water physical-chemical parameters and the abundance of sea cucumbers. This analysis was analysed using software of XL stat.

3. Results and discussion

3.1. Species of sea cucumber

This research only reported one species of sea cucumber, there is \textit{Holothuria leucospilota} belonged to Family Stichopodidae of Order Aspidochirotida. This species is hiding behind dead coral during the daytime. It is usually black in the water but if we lifted to the surface its colour looks more clear, black on the dorsal and black brown on the ventral surface. The cylindrical body shape can be very elongated.

The mouth is at ventral and surrounded by black peltate type tentacles. Peltate or sucker tentacles are usually found on deposit-feeding sea cucumbers that are eating anything contained in the bottom of the water. The ventral mouth has a function to facilitate sea cucumbers filter their food from the substrate. Based on [8] The Aspidochirotida have peltate tentacles that are used for deposit feeding on the sea floor. The anterior is narrower than posterior. [9] stated that \textit{H. leucospilota} has a round cross-section with an anterior narrower than the posterior. The anus is at the back of his body. Misidentification often occurs when identifying \textit{H. leucospilota} and \textit{Holothuria atra} caused by the similarity of body shape and skin colour. The characteristic of \textit{H. leucospilota} is podia and papillae randomly distributed on the dorsal surface.

3.2. The abundance of sea cucumbers

Sea cucumbers abundance in Pane Island ranged from 0 to 1.2 Ind/m². Station 3 has highest abundance with 1.2 Ind/m². Station 2 has an abundance value of 0.6 Ind/m². The stations 1 and 4 have the lowest abundance with 0 Ind/m², its means there are no sea cucumber at that station. This relates to the characteristics of their habitat at each station of this research. The first station was on the north while station 4 was on the southeast side of the island. There is seagrass ecosystem at stations 1 and station 4 were only dominated by one seagrass species, \textit{Enhalus acoroides}. In our study, sea cucumber was not found in the seagrass ecosystem. Based on visual observation, seagrass on this island was associated with seaweed species namely \textit{Sargassum} sp, \textit{Turbinaria} sp, \textit{Padina} sp and several types of sponge.

Station 2 is characterized by the presence of dead coral substrate with a few seagrass beds and some mangrove species of \textit{Rhizophora} sp. while station 3 is characterized by presence of dead coral, there is more mangrove than station 2 and directly face to the open sea. \textit{H. leucospilota} was found on Pandaratan Beach, Tapanuli Tengah Regency in the seagrass ecosystems dominated by \textit{Cymodocea rotundata} [10].

During the study, all the sea cucumber species of \textit{H. leucospilota} was found behind the dead coral fragments that still contained a little stagnant water. This is in line with [11] that more \textit{H. leucospilota} species were found within corals, seaweeds, and boulders infested areas and less in areas where these are scarce or absent. This sea cucumber species has a low economic value, unlike \textit{Holothuria scabra} which has high economic value, therefore, this species is not much hunted by local communities. According to [12], based on commercial value, sea cucumbers can be divided into 3 categories, namely main, medium and low categories. \textit{H. leucospilota} is classified to the low categories of economic value.
3.3. Seagrass percentage cover
The percentage cover of seagrass in Pane Island was ranged from 0 to 23.96%. Station 4 has the highest percentage cover of seagrass (23.96%) followed by station 1 with 14.4%. Station 3 has the lowest percentage cover of seagrass with 0%. This is because station 3 is characterized by presence of dead coral and directly face the open sea so that this area is not suitable for seagrass growing well. Station 2 is characterized by dead coral and a little sand so there was found a small-seagrass-biomass. The percentage of coverage in this station is 2.46%.

The results show that one species of seagrasses, Enhalus acoroides were found around the Island. There are no other seagrass species that live on this island. This is because the waters on Pane Island has higher turbidity even though the brightness values were 100% in all stations. The brightness of the water was 100% because it is measured at low tide. The higher turbidity caused by location of Pane Island which is adjacent to the mainland of Sumatera Island, tourism activities and estuary formation at stations 1 and station 4. E. acoroides are generally growing well on mud substrates in turbid waters [13, 14]. [15] stated that this seagrass species can form single vegetation (mono-species vegetation) or mixed vegetation (multispecies vegetation).

3.4. Physical-chemical parameters
The results of the measurement of the physical-chemical parameters of water, the texture of the substrate and the content of organic matter at the study site indicate that these parameters are still supportive for the life of sea cucumbers.

Table 1. Physical-chemical parameters measurement results

| Parameters                  | 1     | 2     | 3     | 4     |
|-----------------------------|-------|-------|-------|-------|
| Temperature (°C)            | 31.2  | 33.2  | 34.3  | 31.6  |
| Water transparency (%)      | 100   | 100   | 100   | 100   |
| Depth of water (m)          | 0.57  | 0.23  | 0.1   | 0.5   |
| Current (m/s)               | 0.06  | 0.058 | 0.063 | 0.061 |
| Salinity (ppt)              | 29    | 30    | 30    | 29    |
| pH                          | 7.8   | 8.1   | 8.1   | 7.9   |
| DO (mg/l)                   | 7.0   | 6.5   | 6.2   | 7.2   |
| Total of nitrogen (mg/l)    | 1.14  | .84   | 1.33  | 1.17  |
| Phosphate (mg/l)            | 0.002 | 0.003 | 0.007 | 0.003 |
| C- Organic (%)              | 0.04  | 0.54  | 0.71  | 0.05  |
| Substrate texture           | Sand  | Loamy Sand | Loamy Sand | Sand   |

3.5 Principal components analysis (PCA)
PCA analysis showed that the abundance of sea cucumbers was positively correlated to the parameters of temperature, current, pH, salinity, total nitrogen, phosphate, and C-organic content. The correlation value between sea cucumber abundance and water parameters is 0.569; 0.324; 0.803; 0.367; 0.208; 0.936 and 0.846, respectively. Sea cucumber abundance is negatively correlated to the water depth, water transparency, DO and percentage of seagrass cover with a correlation value of 0.869; 0.389; 0.727 and 0.676, respectively (Figure 1).

The observation and sampling of Sea cucumber, seagrass, substrates, and other water parameters was conducted during low tide to make it easier. During this research, low tide on Pane Island was in the afternoon about 01:00 pm to 05.00 pm that’s why the temperature and salinity were positively correlated to
sea cucumber abundance. In Pane Island, *H. leucospilota* found mostly at stations with rocky and dead coral substrate and direct sun exposure to the substrate at low tide.

Station 2 and station 3 is characterized by the presence of rocky and dead corals, causing the temperature and salinity to be higher than other stations which are characterized by seagrass beds. The depths at stations 1 and station 4 was higher than other stations. The low water depths at stations 2 and 3 causes an increase in salinity and water temperature. High water temperature can increase salinity by increasing the rate of evaporation [10, 16]. High temperatures at stations 2 and station 3 also affected the decline of oxygen content. Temperature affects dissolved oxygen concentration as it is negatively correlated with dissolved oxygen [17].

![Principle components analysis results](image)

**Figure 1.** Principle components analysis results

Water pH on Pane Island was classified in bases level. The relationship between pH and sea cucumber abundance is also positive. Sea cucumber abundance increased at stations with higher pH. Stations 2 and station 3 has a higher pH because this stations directly faced the open sea. Open sea tended to higher pH compared to closed waters, the pH of small islands has a high pH (alkaline) and large islands with a lot of river flow have a low pH (acidic) [18].

There is a positive correlation between sea cucumber abundance with total nitrogen, phosphate and organic matter content. Organic matter is a supplier of aquatic nutrients such as nitrates and phosphates. The content of organic matter is related to the texture of the substrate. Sea cucumbers are generally depositary feeder that can eat detritus from the substrate. Deposit feeders are among the most important consumers of detritus on the ocean floor [19]. The substrate texture at stations 2 and 3 was loamy sand which is finer than the sand texture at stations 1 and station 4. A finer substrate texture is easier to bind the organic matter because it has a larger surface area. According to [20] the detritus (non-living matter) constituted 60-80% of the organic matter in the sediment.

The percentage of seagrass cover was negatively correlated with sea cucumber abundance. Sea cucumbers are not found to be associated with seagrasses on Pane Island. This relates to the seagrass species founded on the island, which is only one species, *Enhalus acoroides*. Some species of sea cucumbers such as *Holothuria scabra*, *Holothuria atra*, and *Holothuria leucospilota* was found in seagrass ecosystems at Pandaratan Beach, Tapanuli Tengah Regency [10]. Seagrass species at this location consist of *Enhalus*
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acoroides and Cymodocea rotundata [21]. [22] also reported that cucumber species, Actinopyga milliaris, Actinopyga aechinites, Holothuria scabra were found in seagrass ecosystems on Ungegh Island, Tapanuli Tengah Regency. Seagrass species that found on this island are Enhalus acoroides, Cymodocea serulata and Halodule pinifolia [23].

4. Conclusions

One species of sea cucumber, Holothuria leucosipilota was found at Pane Island. Sea cucumbers abundance at stations 1 and 4 is 0 Ind/m². Stations 2 and 3 have an abundance of 0.6 and 1.2 Ind/m². This study shows that the sea cucumber abundance is positively related to the temperature, current, pH, salinity, total nitrogen, phosphate, and C-organic content and negatively related to the water depth, water transparency, DO parameters and seagrass cover percentage.

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