Diversity and abundance of sea cucumber (Holothuroidea) in seagrass ecosystem at Suli Village, Maluku, Indonesia

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Abstract. Sea cucumber (Holothuroidea) is one of the marine resources that play an important ecology and economy roles. Sea cucumber has been reported to have high abundance in the seagrass ecosystem at Suli Village, however, its population has been reported to decline quite recently. It is speculated that this problem caused by environmental pressure due to human activity in form of marine tourism and also the change of physical properties of the coast due to abrasion. The aims of this study were to analyze the diversity and abundance of sea cucumber in the seagrass ecosystem of Suli Village. The study was conducted from September to October 2017. A sample of sea cucumber was collected through linear transect quadrate and identified down to species level through microscopic analysis of sea cucumber spicula shape. The number of species found then used to calculate some population ecology parameters. Our result showed that there are 14 species of sea cucumber found in the seagrass ecosystem of Suli Village that belong to 5 genera and 3 families. *Holothuria scabra* being the species with the highest density (0.0347 ind m$^{-2}$) whereas *Stichopus chloronotus* has the lowest density (0.0004 ind m$^{-2}$). Species with the highest abundance is *Holothuria scabra* (4,164 individuals) while the lowest abundance belongs to *Stichopus chloronotus* (53 individuals). In conclusion, the diversity of sea cucumber in Suli Village was considered high but its level of dominance was considered low.

1. Introduction

Sea cucumber (Holothuroidea), known as holothurian, is one of the marine resources that play an important ecology and economy role. Holothurian belongs to the phylum Echinodermata or spiny skin organism. Holothurians are an organism with leathery skin and an elongated body, classified as deposit feeder in which possesses an ability to transform the substrate of their habitat to be a food source, and ecologically functioned as substrate taker as well as prey for other organisms surrounding in form of their eggs and larvae [1].

Holothurians have become a superior aquaculture commodity with high economic value nowadays, due to the high nutritional content. Sea cucumber contains 82% of protein, 1,7% of lipid, 8,9% of water, and 4,8% of fiber (in dry weight) [2].

Some studies related with community structure, sustainability and management of sea cucumber has been conducted at some parts in Maluku i.e. at Morella Village [3,4], Porto and Warialau Village [5], Suli, Morela, Pelauw, and Ihamahu Village [6], at Central Maluku and Southeast Maluku Regency [7] and in Baguala Bay of Central Maluku [8]. Selanno et al (2014) [6] reported 8 species
were found in Suli waters, with low diversity and density compared to others villages in their research. Uneputty et al (2017) [8] also report the same result (8 species) in which 4 among those species were the same species reported by Selanno et al (2014) [6]. The studies have not been comprising the potency reports yet, particularly with reference to sea cucumber that possesses high economic value.

Suli Village was purposively selected as research location based on the reason of the number of substrate types in seagrass ecosystem which varied from silt to coral fracture. This substrate is still in good condition and it suited generally as sea cucumber habitat preference. Based on the background and studies described above, the aim of this study was to analyze the diversity and abundance of sea cucumber in the seagrass ecosystem at Suli Village.

2. Materials and Method

2.1 Study site

The study was conducted in the seagrass ecosystem at Suli water, from September to October 2017. The sampling sites were composed of 15 stations which determined purposively to represent the seagrass ecosystem in this area (Figure 1).

2.2 Sampling procedure

The tools and materials used in the study were i.e. plastic sample, small vials, dissecting set, pipette, sedgwick rafter, light microscope, sediment corer, sediment shaker, rope, meter roll, GPS, alcohol, NaOCl, and aquades. The data collection and procedure were divided into 3 processes, i.e.: 1) field sampling, 2) samples preservation, and 3) sample identification.

The line transect method was used for sea cucumber data collection following [9] with the quadrat size of 5x5 m. The sampling was conducted at night time during low tide. A Slovin formula [10] was used to determine the number of sampling point. This method was used to determine the minimum sample size required according to the condition of the population recognized, with the following formula:
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\[ n = \frac{N}{1 + N d^2} \]

where:
- \( n \) : number of sample
- \( N \) : population
- \( d \) : deviation standard (0,1)

The specimens of sea cucumber collected were preserved in 90% alcohol, which will then be used to identify sea cucumber species. The identification of sea cucumber species was based on ossicles shape following sea cucumber identification guides [11, 12, 13].

Some ecology indices used in this analysis covers density, abundance, species diversity, and species dominance following the equations according to [14]. The formula for species density as follow:

\[
\text{Density (ind m}^{-2}\text{)} = \frac{\text{total number of species}}{\text{total number of quadrat}}
\]

Formula for species abundance was calculated using the following formulas:

\[
\text{Abundance (ind m}^{-2}\text{)} = \frac{\text{number of i species}}{\text{total number of quadrat where i species found}}
\]

Species dominance and species diversity index were analyzed using Simpson Diversity Index and the Simpson Dominance Index following the formulas as follows [9]:

Species Dominance (D) Index.
\[
D = \sum \frac{n_i(n_i - 1)}{N(N - 1)}
\]

where:
- \( D \) : Simpson Dominance Index
- \( n_i \) : Total number of species (i)
- \( N \) : Total number of individual of species

Species Diversity Index.
\[
D' = 1 - D
\]

3. Result and Discussion

3.1 Species composition
There are 14 species of sea cucumber found in this study which belong to 2 order, 3 families, and 5 genera. Table 1 shows sea cucumber species composition recorded during the study.

The number of species found in this study is higher than the previous study conducted by Selanno et al (2014) [6] and Uneputty et al (2017) [7] at the same site who found only 8 species. Of 8 species found by Uneputty et al [7], 4 species was similar to Selanno et al [6]. The difference in species composition might be caused by the variation of the sampling area, quadrant size as well as the sampling period. Study on species composition in Arreceffi Island, Palawan, Philippines [15] found 15 species, of which 11 species from Holothuridae, 3 species from Stichopodidae and 1 species from Synaptidae. On the other hand, a study on species composition on the reef of Mayotte of Western Indian Ocean found 14 species using mantatow survey method and 8 other species outside mantatow area [16]. A study conducted at Singapore waters found 33 species [17]. Some studies conducted at
several different sites in Indonesia shows different species composition as well. Two species were found at the south of Bali coast [18], 7 species were found at North Likupang Minahasa Coast [19], 4 species at Bira Besar Island [20] and 24 species found at Biak [21].

Table 1. Sea cucumber species composition found at sea grass ecosystem at Suli Village

| Class           | Ordo      | Famili    | Genus      | Species               |
|-----------------|-----------|-----------|------------|-----------------------|
| Holothuroidea   | Aspidochirotida | Holothuriida | Actinopyga | A. ehinites            |
|                 |           |           |            | A. lecanora           |
|                 |           |           |            | A. miliaris           |
|                 |           |           |            | Bohadschia            |
|                 |           |           |            | B. marmorata          |
|                 |           |           |            | B. vitiensis          |
|                 |           |           |            | Holothuria            |
|                 |           |           |            | H. arenicola          |
|                 |           |           |            | H. atra               |
|                 |           |           |            | H. coluber            |
|                 |           |           |            | H. hilla              |
|                 |           |           |            | H. lessoni            |
|                 |           |           |            | H. scabra             |
| Stichopodida    | Stichopus |           |            | S. chloronotus        |
|                 |           |           |            | S. horrens            |
| Apodida         | 2         | Synaptida | 3          | Opheodesoma           |
| Total           | 14        |           | 5          | O. grisea             |

All the studies show variation in species composition both at the same site and at a different site. Some species tend to occur in aggregations, and their distribution may be influenced by biotic relationships or sediment characteristics like: grain size, organic content [15] whilst some can also be influenced by other habitat variables such as shelter [21, 22, 23, 24]. Many species also seems to utilize different habitats across the stages of their life-history [15].

3.2 Density and abundance of sea cucumber

This study shows that the highest density of all 14 species found in Suli waters belonged to the species of *H. scabra* (0.0347 ind m$^{-2}$), while the lowest density was at *S. chloronotus* (0.0004 ind m$^{-2}$). Compared to other species, *H. scabra* occupies wider type of substrate preference which varies from silt substrate, sand, coral fracture, and extended to nearby mangrove ecosystem which is dominated by a silty substrate. Figure 2 shows the graphic of sea cucumber density in the seagrass ecosystem at Suli Village.

![Figure 2. The density of sea cucumber in seagrass ecosystem at Suli Village](image-url)
The similar result was also found in species abundance where *H. scabra* has the highest species abundance (4,164 individual) and *S. chloronotus* has the lowest abundance (53 individual). Figure 3 displays the graphic of sea cucumber abundance in the seagrass ecosystem at Suli Village. The number of abundances was strongly related to the density. The number of abundance was explicitly explaining the potency as well. However, the numbers of density and abundance of sea cucumber in the seagrass ecosystem at Suli Village were considered lower compared to some locations [6, 8, 18].

Study on sea cucumber density, abundance, and distribution in Belize found 18 species, with *H. mexicana* being most abundant species (60 ind ha\(^{-1}\) at sparse seagrass bed, 110 ind ha\(^{-1}\) at dense seagrass bed, and 333 ind ha\(^{-1}\) at coral rubble). Variation in density and abundance between the species with *Isosthycopus badionatus* is the lowest one [25]. Study on density and biomass of commercial sea cucumber at the Aegean Sea. Seven species of sea cucumber was found in this study with different density among species with an average number per square meter was 1.91. The three most abundant species was *H. tubulosa*, *H. polii*, and *H. mammata* [26].

Some studies on sea cucumber density and abundance have also been done in several parts in Indonesia, include Maluku. Uneputty et al [8] in their study on density and diversity of echinoderms in seagrass bed in Baguala Bay, Ambons Island, found the density of *Synapta maculata* to be 15.47 ind m\(^{-2}\) which was the highest one, *H. atra* with the density of 1.5 ind m\(^{-2}\), and *H. scabra* with the density of 0.66 ind m\(^{-2}\) which was lowest one. Another study on the density and abundance of sea cucumber in Central Maluku found the density of *Opheodosoma grisea* to be 0.4516 ind m\(^{-2}\) [6]. In Bali coast, the density of sea cucumber was 0.75 – 5.75 ind m\(^{-2}\) [18] while in Bira Besar Island the density was 0.65 - 0.96 ind m\(^{-2}\) at seagrass ecosystem and 0.52 – 0.59 ind m\(^{-2}\) at coral reef ecosystem [20]. Another study in Pulau Panjang, Jepara, found the density of *H. atra* at seagrass bed and coral ecosystem were 1.07 ind m\(^{-2}\) and 0.05 ind m\(^{-2}\) respectively, *H. nobilis* at seagrass bed and coral ecosystem were 0.08 and 0.59 ind m\(^{-2}\), respectively [27].

All the mentioned studies have shown that there is a variation in density and abundance across the different site, time, species, and different substrates or ecosystem. These differences could be due to several factors such as sampling technic, time of sampling, substrate, fishing intensity [24, 27, 28]. In the case of Suli Village, it is assumed that fishing intensity and human activities in the near coast have been the major factors contribute to low density. This fishery has been conducted for many years with almost no fishery management practice.

### 3.3 Species diversity and dominance

Species dominance index of sea cucumber in seagrass ecosystem at Suli Village was 0.111 which considered low but species diversity index was considered high with the value of 0.889. This finding indicates that none of the species found in Suli Village dominate the ecosystem. This present result however different from the previous study at the same site which shows a contrasting value which showed low diversity value and dominance [6]. Study on bioecology of sea cucumber in Porto Village [29] found 7 species with low dominance (0.42) which is higher than the present study. Differences in density and diversity were also found at Arrecife Island, Palawan, Philippine where the density was associated with a high diversity of seagrass and vise versa as well as sampling time. During the day, *Synapta maculata* was found with high density (14.0±0.5) ind. m\(^{-2}\), while during the night *Bohadschia marmorata* was found with high density (19.0±2.6) ind m\(^{-2}\) [15]. The variation on diversity and dominance of sea cucumber was also found in the Jaffna Peninsula of Sri Lanka [30].

Many factors contribute to the difference in species diversity and dominance of sea cucumber. Habitat in term of substrate structure (for example, coral fracture, rubbles, silt, sandy), seagrass composition, food availability, time (day and night), fishing intensity, and sampling technic [13, 24, 27, 29, 30].
Substrate types at study area were varied from silt, silty sand, sandy gravel, and coral fracture. Fishing practice for this sea cucumber has been conducted for a quite long time with no regulation on fishery management. The number of population in this area also increases with the consequence of high pollution risk as well as an increase in tourism activity in the coastal area of Suli Village. All these factors inevitable will cause a change in the variation of sea cucumber status in this area.

4. Conclusion
Species composition of sea cucumber found in seagrass ecosystem at Suli Village consisted of 2 order, 3 families, 5 genera, and 14 species. The highest density and abundance were found on H. scabra, while the lowest was on S. chloronotus. The diversity of sea cucumber in the seagrass ecosystem at Suli Village was considered high with a low level of dominance.

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Figure 3. The abundance of sea cucumber in seagrass ecosystem at Suli Village
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