Ranching of sea cucumber in Indonesia: A study case of *Holothuria atra*

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**Abstract.** Sea ranching is one of the promising sustainable ways to restore depleted stocks and increase production of sea cucumber. Before, only high price species were exploited but now the demand is extended to many other low-value species, such as Teripang Hitam, *H. atra*. The present work were aimed to observed the growth and survival of *H. atra* ranching using pen system. Sea pens system size of 5meter x 5meter x 1.8meter was set up in Teluk Awur Waters, Jepara, Indonesia. They were designed as mesocosms that mimic sea ranching location. Wild young *H. atra* (average weight of 100 g) from Panjang Island, located adjacent to Teluk Awur waters were stocked at 3 individu.m⁻² and reared for five months without food addition. Sea cucumber was weighed and counted monthly to determine their growth and survival rate. The results of present experiment revealed that sea cucumber increased their weight with the time of rearing, the average weight gain and survival rates were 212 g and 83% respectively. It showed that their adaptation to the new environment was went well. The sea cucumber got intake of food that naturally grew in the sea pens or transported by the sea current from surrounding area. This result showed promising application on sea ranching for marine natural conservation.

1. **Introduction**

Sea cucumber or teripang is one of many increasingly harvested in Indonesia. Strong market demand, uncontrolled exploitation and inadequate fisheries management have led to many sea cucumber species stocks becoming heavily overfished [1]. Before, only high price species have strong demand from the markets but now trend also go to more lower price species. One good effort suggested to overcome rapid depleting stock is sea ranching. Sea ranching is defined as releasing cultured or wild juveniles into an area of natural habitat and harvested when they reach a commercially optimal size [2][3]. There are several advantage of sea ranching [4], such as apply low technology, lower inputs as no need for food addition and water management, but it is able to produce marketable size of sea cucumber.

Sea ranching has been conducted in many countries in the world, such as for *Apostichopus japonicas* in China [5], *H. scabra* in Fiji [6], Philippines [7], Mardives, New Caledonia, Saudi Arabia [1], Australia [8]; for *Holothuria. lessoni* in Australia [1][8] and *H. arguinensis* in Portugal [9] and in Europe [10]. But in Indonesia, very little has been done and studies on releasing of sea cucumber (restocking) for conservation purposes was mainly for *H. scabra* [11] and [12].
Black sea cucumber *H. atra* is one promising species that gain increasing demand for sea cucumber market. It provides good protein sources for human food [13] especially for coastal community, produce high potency bioactive molecules for marine pharmaceutical [14], and they are ecologically important as their ability for sediment bioturbation and remineralization which enrich environment [15]. Therefore, this paper were aimed to evaluate the sea ranching trial for *H. atra* and look for its possibility to apply for other species.

2. Materials and Method
For experiment purposes, 225 individuals of *H. atra* with average size of 102.52 gram were taken from Panjang Island Waters, Jepara. The locations for the sea ranching was Teluk Awur Waters, Jepara, Central of Java, Indonesia that had muddy sand substrate with seagrasses and seaweed which was suitable for the habitat of sea cucumber [16]. Three unit of 5 meter x 5 meter x 1.8 meter of sea pens were set up based on design of [17]. According to [1] sea pens are mostly advantageous as experimental tools to help the researcher better estimate the survival and growth of released sea cucumbers. Moreover sea pen retained sea cucumbers in a defined area while allowing tidal, or current-driven, seawater exchange and access to naturally occurring sediments, seagrass, and organic detritus. As these mesocosms mimic sea ranching location, it was no food addition for the rearing of sea cucumber.

Sea cucumber were reared for five months, and weighed monthly to determine their performance and the number of sea cucumbers alive were counted to determine their survival rate. The weight (growth) and survival rate were plotted as a bar graph and analyses descriptively. As supporting data, the water quality (salinity, temperature, pH, and dissolved oxygen) were measured every day and the biomass of microphytobenthic was analyzed as their pigment photosynthesis i.e. Chlorophyll-a.

3. Result and Discussion
As common shallow-water species, *H. atra* was mostly found on inner and outer reefs flats and back reefs or shallow coastal lagoons. It was abundant on sandy-muddy grounds with rubble or coral patches and in seagrass beds. Inshore shallow-water populations are denser, composed of smaller individuals, while in deeper or outer reef populations the individuals were more scattered with larger individuals [18][19].

During the rearing of *H. atra* the water quality such as temperature, salinity, pH, dissolved oxygen was in the range of suitable for *H. atra* life (Table 1). Water temperature is one of the most important environmental factors that affect growth and physiological performance in aquatic animals such as sea cucumber *H. atra*, it influenced growth [20], immune response [21], the rhythm of activity [22] and feeding process and movement [23]. Salinity in the Teluk Awur waters were in the range of 27.8-32.2‰ which was still suitable for the life of sea cucumbers.

| Table 1. Water quality parameter in the sea pens |
|-------------------------------------------------|
| No. | Parameter (°C) | SP1 | SP2 | SP3 | Control | Reference |
| 1   | Temperature | 28.2-31.3 | 29.6-32.2 | 28.5-32.2 | 28.7-32.9 | 27-30 [23] |
| 2   | Salinity (%) | 29.3-30.3 | 27.8-32.2 | 28.4-30.8 | 28.2-31.2 | 27-35 [23] |
| 3   | pH | 6.81-7.82 | 6.52-7.91 | 6.42-7.65 | 7.25-7.7 | 6-8 [24] |
| 4   | Dissolved oxygen (ppm) | 5.32-7.54 | 5.45-7.68 | 5.65-7.93 | 6.75-7.6 | >5 [25] |
| 5   | Depth (m) | 0.35-1.75 | 0.35-1.77 | 0.28-1.87 | 0.17-1.88 | - |
| 6   | Light transparency (m) | 0.35-1.75 | 0.35-1.77 | 0.28-1.87 | 0.17-1.88 | - |

Besides temperature and salinity, acidity of the water (pH) affect the life of *H. atra*, and the value of pH was 6.42-7.91. The change of environment, especially for water pH, will activate epidermal layer as defense barrier in sea cucumber [24]. The dissolved oxygen in the sea pens water were 5.32-7.93
ppm (Table 1) which is still good for *H. atra*. Sea cucumber respires with all the tentacles, skin and respiration trees by consuming lots of water and absorbing dissolved oxygen inside [25].

*H. atra* is a deposit feeder [15], these sea cucumbers digest organic materials from sediments which continue to decrease during maintenance. Sea cucumbers mainly eat microphytobenthic (algal periphyton) [26] and bacteria [27]; and in the presence of sunlight that reaches the bottom of the waters (brightness) as in this experiment (Table 1) will support rapid growth in sea cucumbers [28].

Microphytobenthic biomasses which are feeding sources of sea cucumber *H. atra* are measured in the form of chlorophyll-a and presented in Figure 1 and showed fluctuation during *H. atra* ranching. Compare to the control area, the concentration of chlorophyll-a in the sediment of sea pen is higher. [29] found that *H. atra* fed on sediment underneath their body and they took advantage of high abundance of microphytobenthic organisms (presented as chlorophyll-a) in their natural microhabitats. Chlorophyll-a in sediment could be representative of microphytobenthos (MPB), i.e. microalgae, cyanobacteria and other photosynthetic bacteria [30] which were important and crucial in coastal food webs because of their high accessibility to consumers, such as sea cucumber [15] especially *H. atra* [31].

![Figure 1. Concentration of Chlorophyll-a in the sediment of sea pens](image)

Sea cucumber ranching trial using bottom cages has been carried out by [17] and [32] for *H. scabra* as well as using sea pens for *H. scabra* [11] and [12] and *H. atra* [29]. Although according to [33] the maintenance of sea cucumbers with feeding greatly affects growth performance, i.e. sea cucumbers grow faster when given additional feed but in the process of sea cucumber rearing in this study, *H. atra* was not given additional feed, it was expected that the sediment/substrate is a good habitat to grow feed for sea cucumbers because, in the concept of sea ranching activity, there is no feed addition. In sea cucumber maintenance with the aim of sea ranching, no input is given so that the life of sea cucumbers is left to/depend on the availability of natural feed [3].

Growth is a change in the length or weight of an organism in a given period of time. According to the works of [34], growth of sea cucumbers depend on food availability. The monthly average weight of *H. atra* during rearing in sea pens were increased with time (Figure 2), in the end of experiment (5th month) the average weight was 314, 35 ± 5,72 gram. The weight gain was in the range of 207-217 gram with an average of 212 gram (Figure 3). This results were higher than in previous experiment (Hartati, 2020, unpublished data) as well as the survival rate from three sea pens rearing which was 83%. (Figure 4) According to [35] sea cucumber commonly the growth of weight was more significant than length growth.
Figure 2. Average weight of *H. atra* reared in sea pens

Figure 3. Average weight gained by *H. atra* in the end of experiment

Figure 4. Survival rate of *H. atra* in the end of experiment

The result of sea ranching with sea pen system trial for *H. atra* in present work gave good weight gain and survival rate. It was confirmed the benefit of this simple process for sea cucumber conservation and production. Sea ranching had different objectives than restocking or stock enhancement [1][4]. The released animals in sea ranching are not expected to contribute to the spawning population like in restocking [36] or to augment the natural supply of juveniles and optimize harvests by overcoming recruitment limitation in case of stock enhancement [37]. Moreover, application of sea pens in this ranching experiment confer ownership of released stock and limit
predation in natural habitats for fisher. But the costs of materials, maintenance, and surveillance against poaching can diminish its profitability. Therefore sea ranching will be the best way to apply with the coordination with coastal community, it will not only for sea cucumber conservation but also give alternative livelihood and additional income for fishers or groups of fisher.

4. Conclusion
The result of sea ranching with sea pen system trial for H. atra in present work gave good weight gain (212 gram in five months) and survival rate (83%). This attempt has very good potency to be implemented for other species and locations.

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