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Impact of Oceanographic Factors on Productivity Biofouling Waste of Pearl Oysters (Pincada maxima L)

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Abstract. – This study aims to determine the characteristics of the physical and chemical parameters of Nuruwe waters on the productivity of pearl oyster bifouling and to determine the level of suitability of the location of Nuruwe waters in supporting the management of pearl oyster (*Pinctada maxima* L.) cultivation. Data collection for this study was carried out in August 2023 at PT. Globalindo Mutiara, Hatusua Village. The oceanographic data used in this study were the results of a survey in the Nuruwe Waters of West Seram, which was conducted during the East Season. The results of the study indicate that Nuruwe waters have fairly good physical-chemical parameter values for pearl oyster biofouling productivity. Thus, the condition of Nuruwe Waters is suitable for pearl oyster (Pinctada maxima L.) cultivation.

Keyword – ***Pearl Oyster, Biofouling, Oceanographic.***

I. Introduction

Background

Indonesia has a very large marine potential in cultivation efforts. This potential is supported by the availability of sufficient raw materials, good environmental requirements, and favorable seasonal conditions for various types of marine commodities to be cultivated. One of the abundant marine biological resource potentials (megadiversity) from non-fish that can be cultivated is the pearl oyster (Pinctada maxima) which will essentially produce pearls.

Pearl oyster cultivation of the Pinctada maxima species is increasingly in demand in Indonesia. This type of oyster lives and is concentrated in waters that have coral reef ecosystems and sandy coral fragments and are spread at depths of between 20-60 m. This oyster cultivation is very promising considering that the pearls produced have high selling value [1]. Even so, pearl oyster cultivation efforts do not always run smoothly. There is a possibility that pearl oysters will experience disease or even death [2].

Another major concern about biofouling is the potential competition for food caused by the settlement of filter-feeding epibionts [3] [4]. In addition, fouling by algae or by hardening of species on nets or trays can impede water flow, further reducing the amount of food for bivalves [5]. Such disturbances can result in slow growth and in extreme cases in mortality of bivalves [5], thus compromising aquaculture production.

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In addition, pollution of organisms (phytoplankton or zooplankton) attached to the shell or net that has an impact on the quality of pearls or oyster productivity [6]. Physical damage will occur if fouling organisms such as fungi or porifera interfere with the growth of Pinctada maxima shells, so that nacre or pearl production will decrease and even die. Barnacles also interfere with mechanical functions such as opening and closing the valves of P.maxima by settling on their mouths or hinges. Other fouling organisms also have a negative impact by becoming competitors for food sources (phytoplankton) (Southgate & Lucas, 2011); [8].

PT. Globalindo Mutiara, Hatusua Village, West Seram Regency is a company engaged in pearl cultivation. In this location, some cultivation areas are close to river mouths, some others are close to coral reefs.

The Nuruwe waters of West Seram Regency are part of the Piru Bay waters, which are oceanic waters and have quite abundant fisheries potential. In addition to having tourism potential, the Nuruwe waters are used as a pearl cultivation location. The character of the Nuruwe water mass is influenced by the Banda Sea water mass that enters through the Haruku Strait and the waters between Ambon Island and Tanjung Sial as well as the fresh water mass from rivers that flow into the Piru Bay waters. Thus, changes in the dynamics of the Banda Sea waters and the supply of fresh water mass that varies seasonally will affect the water mass of the Nuruwe Waters.

In pearl oyster farming, biofouling can cause serious problems. Excessive growth of biofouling on equipment or cultured organisms can reduce the quality of production and increase maintenance costs. Understanding the oceanographic characteristics that support biofouling growth helps farmers take more appropriate preventive and treatment measures. Biofouling can also affect local ecosystems, either by competing with native organisms or introducing invasive species. Understanding the relationship between biofouling and oceanographic characteristics helps predict potential ecological impacts and helps protect biodiversity.

Research on the relationship between biofouling and oceanography provides important data for developing effective and environmentally friendly anti-biofouling technologies, such as the use of organic ameliorants.

Problem Formulation

How to know the characteristics of physical and chemical parameters of Nuruwe waters on the productivity of pearl oyster biofouling? (Pinctada maxima L)?

Hypothesis

There is an influence of temperature, salinity and turbidity on the biofouling productivity of pearl oysters (Pinctada maxima L).

II. Literature Review

Pearl oysters are included in the shellfish group from the phylum mollusk. The main characteristic of this class is to have 2 shells, soft body with small feet, Byssal glands and paired gills. Pearl oyster can be found in the tropics and grow in clear water. Bi-Valves is an ideal marine organism to be cultivated. ([9]; [10]; [11]; [12].

One of the increasing cultivation businesses in Indonesia is pearl oyster cultivation of Pinctada Maxima. Pearl oyster cultivation of Pinctada Maxima is increasingly in demand in Indonesia. This type of oyster lives and is concentrated in waters that have coral reef ecosystems and sandy coral fragments and are spread at depths between 20-60 m. This oyster cultivation is very promising considering the resulting pearl has a high selling value [1]. Even so, pearl oyster cultivation efforts do not always run smoothly. There is a possibility that pearl oysters have disease and even death [2].

One of the causes of death of pearl oysters in cultivation activities is the presence of biofouling (attachment organisms) attached to the basket and the oyster shell that is exposed (Hamzah et al., 2008). The presence of biofouling in the oyster shell will cause damage to the shell and reduce the rate of growth [13].

Another major concern about biofouling is a potential competition for food caused by the completion of epibionts filter-feeder [3], [4]. In addition, dangers by algae or by hardening species in the net or tray can inhibit the flow of water, further reducing the amount of food in Bivalvia [5]. Such disorders can result in slow growth and in extreme cases in the death of Bivalvia [5] there by interfering with the production of fisheries aquaculture.

Judging from its habitat, pearl oysters prefer life in high salinity. Pearl oyster can live in 24 ppt salinity and 50 ppt for a short period of time, which is 2-3 days. Location selection should be in waters that have salinity between 32-35 ppt. This condition is good for the growth and survival of pearl oysters. Changes in temperature play an important role in the activity of oyster biophysiology in water. A good temperature for the survival of pearl oysters is around 25-30 ^{0}C. Water temperature in the range of 27-31 ^{0}C is also considered feasible for pearl oysters. Water brightness will affect the function and structure of invertebrates in water. The duration of irradiation will affect the opening and closing process of shells. Oyster shells will open slightly if there is light and wide open when dark. According to Sutaman (2000), for maintenance of pearl oysters, the water brightness should be between 4.5-6.5 meters. If the range exceeds the limit, the maintenance process will be difficult. For convenience, oyster mothers must be maintained at depths exceeding the existing brightness level [14].

Conceptual Framework

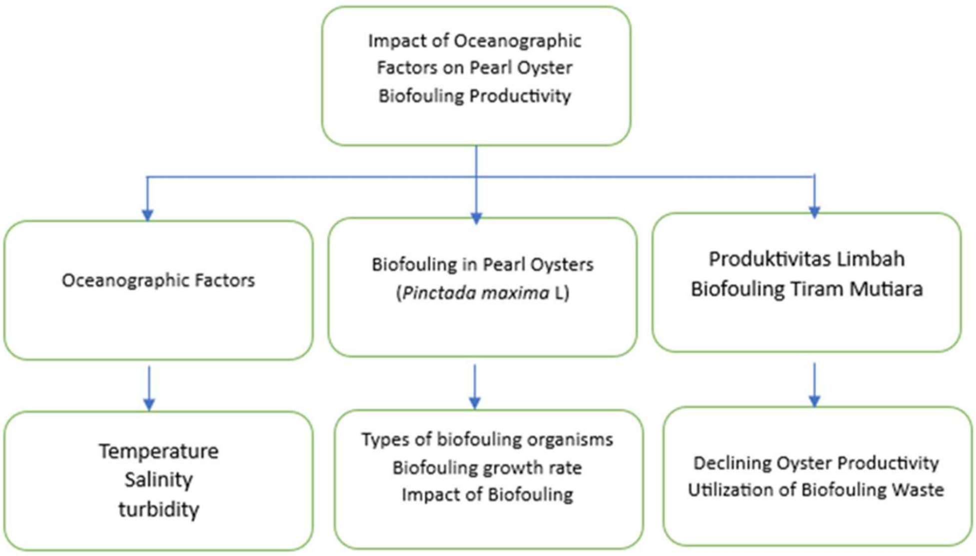


Figure 1. Impact of Oceanographic Factors on Pearl Biofouling Productivity

III. METHODOLOGY

Research Design

This research was conducted in Nuruwe Waters, West Seram Regency which took place in August 2023 (Figure 2). This activity includes several stages, namely location surveys, taking or collecting field data and compiling a database. Determination of sampling points for environmental quality parameters of waters was carried out using a systematic random sampling technique. Data collection techniques by measuring temperature, turbidity, and salinity. Measurements were made using CTD (Conductivity Temperature Depth) Guildline-6000. This tool is commonly called the Guildline Numeric CTD Probe which has three sensors to measure pressure, temperature, and electrical conductivity.

The measurement method is done by lowering the CTD from the surface of 1 m, 10 m to a depth of 20 meters using a "winch" with a 50-meter cable. This "winch" tool, in addition to functioning as a towing cable, also functions as a data transmission media from the CTD probe to a control unit. Furthermore, from this control unit, pressure, temperature and conductivity ratio data are sent to an Acer computer or tape recorder to be processed and recorded on a diskette/cassette. Data recording is done when the CTD starts to be lowered (surface) and then recorded at every 1 meter interval to a depth of 50 meters. Calculation of salinity and sigma-t is done using a formula according to the Salinity Scale (Practical Salinity Scale/PSS). Data recording is done based on changes in water mass pressure on the sensor installed on the measuring device. The environmental parameters obtained consist of temperature, salinity, turbidity, sigma-T and chlorophyll a. The measurement results are recorded in digital form and recorded in the form (.HEX). CTD data processing is done with SBE Data Processing software. The first step in data processing begins with converting the .HEX format file to a .CNV text file. Then a low-pass filter is performed to remove noise and smooth the data. After align, cell thermal, and loop edit, the CTD data processing step is to average the data (bin average), with an average setting of every 1 meter. CTD data analysis and visualization are performed using Ocean Data View (ODV) software, covering vertical profiles and cross-sections of CTD data along the survey path between surface depths and 50 meters.

Data analysis

CTD data analysis and visualization were performed using Ocean Data View (ODV) software, including statistical description of data, parameter calculations (temperature, salinity, conductivity, density and speed of sound), which were analyzed based on several levels of depth, starting from the surface, 1, 10 and 20 m spread over 11 observation station points. Furthermore, descriptive analysis was carried out to determine the oceanographic phenomena of the waters. CTD data recording was also carried out in real time, controlled by the deck unit and operator, where the data was automatically stored in the computer for use in further analysis. The interval of oceanographic data recorded by CTD was 1/1 meter.

IV. Results and Discussion

General condition of the location

The survey location during the East Season is located at a latitude of between 3o 32’24.96” S and longitude between 128o 19’37.25” E with 11 observation stations (Figure 2).

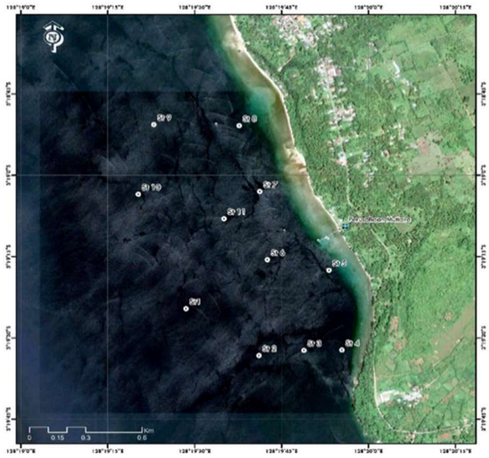


Figure 2. Sampling Location at PT Globalindo Mutiara

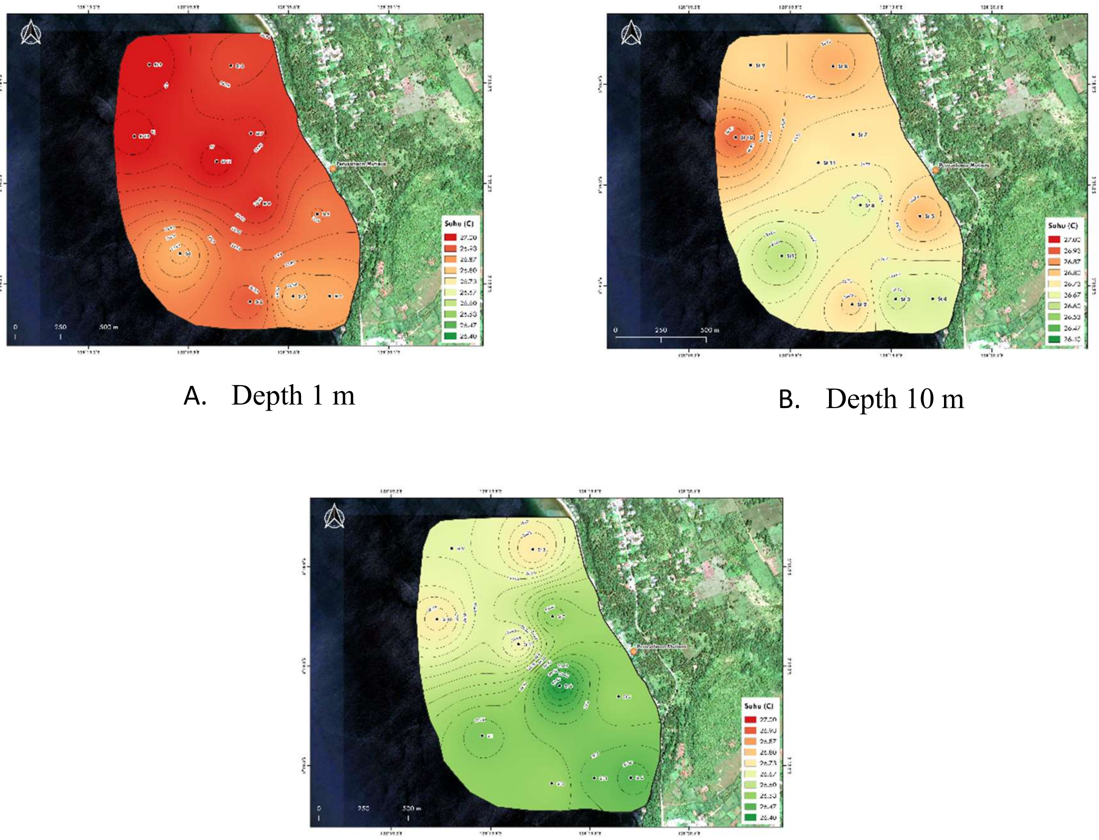
Note: Personal Document

Temperature

The Nuruwe waters of West Seram Regency are part of the waters of Piru Bay. The character of the Nuruwe water mass is influenced by the water mass of the Banda Sea that enters through the waters of the Haruku Strait and the waters between Ambon Island and Tanjung Sial as well as the fresh water mass from rivers that flow into the waters of Piru Bay. Thus, changes in the dynamics of the Banda Sea waters and the supply of fresh water mass that varies seasonally will affect the water mass of the Nuruwe Waters.

Nuruwe waters and its surroundings are the location for seaweed cultivation [15]. A suitable environment that supports cultivation activities also has an impact on the development of organisms attached to the surface of the substrate, both the surface of the cultivated organisms (the surface of the pearl oyster shell) and cultivation facilities including floating net cages, ropes. [16], The presence of attached organisms (biofouling) in floating net cage activities can inhibit production results. [1] found 36 types of biofouling on pearl cultivation baskets and shells. It is also said that the growth and diversity of biofouling are highly determined by environmental factors including temperature, salinity, turbidity, and brightness.

The surface temperature (1m depth) of Nuruwe Waters in August ranged from 26.02-27.02 ºC with an average of 26.94±0.07 ºC. At a depth of 10m, the horizontal distribution of temperature ranged from 26.59-26.92 ºC with an average of 26.74±0.10 ºC while at a depth of 20 m, the temperature ranged from 26.41-26.74 ºC with an average of 26.57±0.11 ºC. The horizontal temperature distribution pattern at depths of 1m, 10m and 20m showed higher temperatures in the northern part of the waters than in the southern part of the waters (Figure 3). The temperature distribution image also shows the influence of cold water mass input moving into the Nuruwe waters from the southern direction of the waters. The cold water mass is the upwelling water mass of the Banda Sea that enters the Nuruwe waters through the Haruku Strait. The influence of the Banda Sea water mass can also be seen through the cold surface temperature of the waters to a depth of 20 m which is in the range of 26.41-27.02 ºC. The upwelling phenomenon in the Banda Sea occurs when the landmark monsoon winds blow ([17]; [18] and [19]). Upwelling is indicated by the surface layer water mass with low temperature characteristics, salinity and high nutrient concentrations. [20] said that the peak of upwelling in the Banda Sea occurs from June to September.



A. Depth 1 m

B. Depth 10 m

C. Depth 20 m

Figure 3. Horizontal distribution of temperature (oC) of Nuruwe Waters. A. Depth 1m; B. Depth 10 m; and C. Depth 20 m.

Nuruwe waters which are the location of pearl oyster cultivation based on research results show that the water temperature conditions are lower than the temperature conditions suitable for pearl oyster cultivation. This condition is different from the results of research in February to March which found that the average temperature conditions in the Nuruwe Waters cultivation environment were around 30 ºC [15]. Thus, Nuruwe waters are suitable for pearl oyster cultivation.

The condition of Nuruwe waters is also suitable for the growth of biofouling. Utami et al. (2023) found that the range of water temperatures for pearl oyster maintenance ranged from 28.2-29.9 ºC. [1] found that the range of water temperatures suitable for pearl oyster cultivation ranged from 28-29 ºC and [21]said that the water temperature for pearl oyster cultivation ranged from 28-30ºC. The results of the study of the biofouling water environment in floating net cages by [16] found that the water temperature conditions ranged from 29-31 ºC while [22] and [23] said that the quality of water temperature suitable for biofouling ranged from 20-30 ºC. Based on this, biofouling can grow and develop in temperature conditions with a wide range. Thus, the temperature of Nuruwe Waters is in a suitable condition for the growth of biofouling-attaching organisms.

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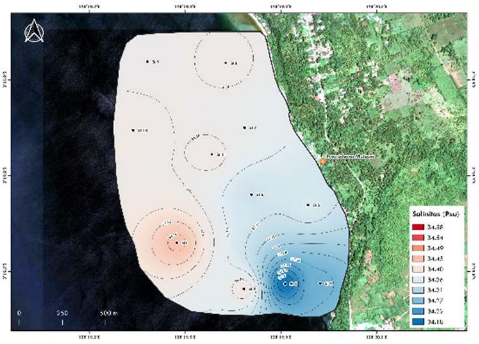
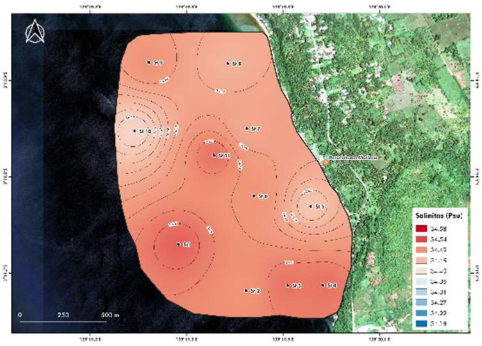
Salinity

The salinity on the surface of Nuruwe Waters during the study ranged from 34.18-34.44 PSU with an average of 34.35±0.07 PSU. The salinity distribution pattern on the water surface shows slightly lower salinity in the southern coastal part of the waters. This is likely influenced by the input of fresh water mass from rivers that flow around the coast. At a depth of 10 m, the horizontal distribution of salinity ranged from 34.42-34.48 PSU with an average of 34.48±0.03 PSU and at a depth of 20 m, salinity ranged from 34.48-34.58 PSU with an average of 34.54±0.03 PSU. The salinity distribution pattern at depths of 10 m and 20 m shows that salinity is higher in the southern part of the waters compared to the northern part of the waters. The high salinity in the southern part of the waters is due to the influence of the Banda Sea water mass. Overall, from the water surface to a depth of 20 m, the salinity of the Nuruwe Waters is quite high and oceanic (Figure 4).

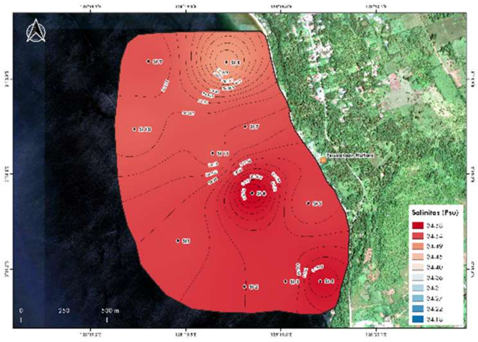
The salinity conditions of Nuruwe Waters are quite good for pearl oyster cultivation. Sutaman (1993) said that good salinity for pearl growth ranges between 32-35 PSU. Thus, the conditions of Nuruwe Waters are suitable for pearl oyster cultivation. These conditions are also suitable for biofouling growth. [24] and [25]said that the salinity conditions of waters suitable for biofouling range between 34-35 PSU.



A. Depth 1 m



B. Depth 10 m

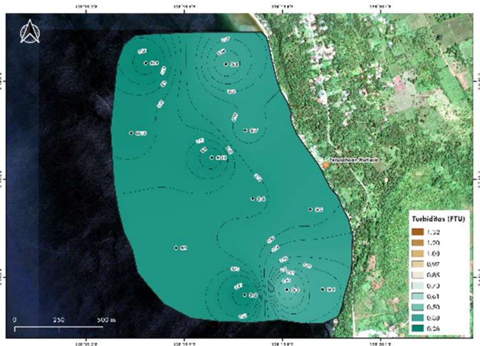


C. Depth 20 m

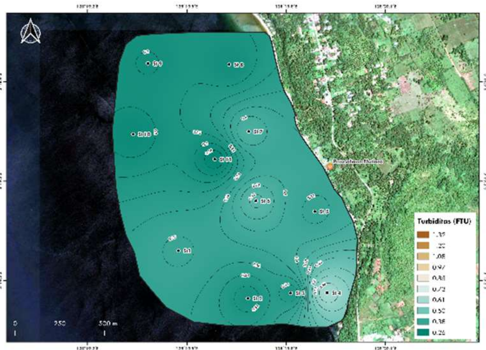
Figure 4. Horizontal distribution of salinity (PSU) of Nuruwe Waters. A. Depth 1m; B. Depth 10 m; and C. Depth 20 m.

Turbidity

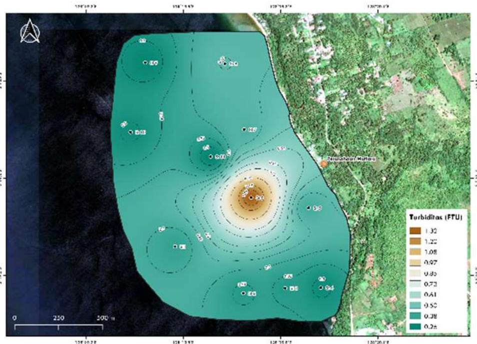
The turbidity of a body of water provides an overview of the level of turbidity of a body of water. [26] stated that the turbidity of a body of water is influenced by the content of suspended material, both organic and inorganic, in a water column. Turbidity can affect the decrease in water clarity. The results of measurements during the study using CTD found that on the surface of the water, turbidity ranged from 0.28-0.44 FTU with an average of 0.34±0.05 FTU. At a depth of 10 m, turbidity ranged from 0.27-0.61 FTU with an average of 0.37±0.10 FTU, while at a depth of 20 m it ranged from 0.27-1.32 FTU with an average of 0.43±0.30 FTU. The value indicates that Nuruwe Waters are quite clear except at Station 6 at a depth of 20 m (Figure 5). The high turbidity at Station 6 at a depth of 20 m is likely caused by the density of phytoplankton. Baka (1996) said that turbidity as a parameter of water quality that is suitable for pearl oyster cultivation must be <5 FTU. Comparing with the results obtained in the study, the turbidity of Nuruwe Waters is suitable for pearl oyster cultivation activities. Thus, the turbidity condition of the waters is also suitable for the growth of biofouling. Current speed is related to the distribution of oxygen and natural food such as phytoplankton in the water body, as well as the attachment of biofouling and damage to the pearl oyster cultivation installation. The results of in situ measurements show that the current speed is relatively weak, but the distribution of dissolved oxygen is even. With weak current conditions, the cultivation media has the potential to experience biofouling attachment.



A. Depth 1 m



B. Depth 10 m



C. Depth 20 m

Figure 5. Horizontal distribution of turbidity (FTU) of Nuruwe Waters. A. Depth 1m; B. Depth 10 m; and C. Depth 20 m.

V. CONCLUSION

There are three oceanographic factors that influence the productivity of Pearl Oyster (Pincada maxima L) biofouling waste, namely temperature, salinity and turbidity.

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