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Hydro-oceanography Profile Condition at Tunda Island Serang District Banten Province, Indonesia

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ABSTRACT

Tunda Island has three potential coastal ecosystems, but they would not be sustainable for the organism when the oceanographic condition is under the quality standards. The research aims to study hydro-oceanography as the first profile Marine Conservation Area management plans at Tunda island explains in Zonation Plans on Coastal Areas and Small Island Banten Province. In general, the waters profile condition will describe how it can contribute to the primary productivity of other organisms. Collected the sampling method was in July and November 2020, and the sampling method used purposive sampling on 45 stations across the island. The result of the data analysis from each parameter was the depth of water has ranged from 0.5-52.4±1.14 meters, water transparency from 0.5-13.3±0.25 meters, waters temperature was 29.97-31.16±0.32 °C, DO was 6.63-8.41±0.31 mg/l, pH from 6.83-7.92±0.25, salinity was 31.6-33.8±0.55 ‰, TDS was 13.8-15.8±0.39 mg/l, conductivity was 22.7-24.8±0.36 mS/cm and ORP from 149-186±7.03 mV. Believed the difference in water quality conditions among stations to be due to differences in the typology of water conditions and currents from the Sunda Strait and the flow of particles from mainland Serang. Where northern and western sides are associated with several small islands and lead to the mainland of Serang. Wheres, south and east sides are directly waters related to the Sunda Strait. The hydro-oceanographic can be used as data and information to develop activities like MPAs plans in Tunda Island waters.

Key words : *Conservation, Hydro-oceanography, Purposive, Water-quality, Banten's waters*

Introduction

Tunda Island Area Development Plan, according to Serang Regency Regional Ordinance No. 2/2013 *in* Mujiyanto *et al*. (2020), was being developed as a tourist destination and protected area based on ecological conservation. Tunda Island is located in the north of Java Island, precisely in the northern part of Serang Regency and is close to the Thousand Islands group and included in the waters of Banten Bay (Sasongko *et al*., 2020). The resources potential in Tunda Island's waters are three vital coastal ecosystems: a) mangrove, b) coral reefs, and 3) seagrass. Cannot be released the three essential habitats from the hydro-oceanographic conditions under the quality standards for aquatic biota life.

Hydro-oceanography profiles can be used as instructions for primary products that are the determinant factor of fish resources and other aquatic biota that can be used for community prosperity (Nurdin *et al*., 2018). The primary production affecting the presence of potential fish can be predicted by the company of a front thermal region, as indicated by changes in hydro-oceanographic parameters. It will be impacted by compression particles and water changes around the Sunda Strait for hydro-oceanography around the Tunda Island waters. The oceanographic conditions changes around Tunda Island waters are influenced by the current movement patterns of the Sunda Strait and the Java north coast waters, namely activities of the Seribu Archipelago waters. The massive water flow in the Sunda Strait and the Indian Ocean always comes from the Java Sea (Amri *et al*., 2017). It can be seen in the movement of warmer waters masses to the south. Variability of the water's movement also can become in this waters. The water's movement mass variability will also occur in these waters, especially with seasonal changes. The geographic location and conditions, many factors can influence the oceanographic conditions in the waters of the Sunda Strait (Amri *et al*., 2017), which will indirectly impact changes in the water conditions Tunda Island.

Tunda Island's waters are influenced by mainland activities originating from Banten Bay and Jakarta Bay. In addition, the post-sand dredging activities in the northern region of Tunda Island are also the cause of ecosystem instability on it. The distance from Tunda Island is ± 28 km from the mouth of Banten Bay, while the distance between Tunda Island and Jakarta Bay is ± 70 km (Mujiyanto *et al*., 2021). The influence of development and industrial activities of Jakarta Bay and Banten Bay be affected various underwater ecosystems found in the area of small islands in the surrounding waters. Tunda Island's coral reef ecosystem may be threatened by excessive exploration of coral stone for the residential foundation of construction. In addition, the presence of the population responsible for the disposal of household waste can put pressure on the environment. Both the activity factor of the Tunda Island mainland and natural characteristics such as changes in water mass in the Sunda Strait will have an impact on changes in the hydro-oceanographic conditions. Tisch *et al*. (1992) explained that could know changes in the state of a body of water by looking at the properties of the water condition, such as dissolved oxygen, temperature, salinity, pH, and primary production.

This research aimed to analyse water quality conditions as a profile of the current state of Tunda Island's waters. This research would explain the hydro-oceanographic shape of Tunda Island waters as baseline data and information in the Coastal and Small Islands Zoning (RZWP3K *in* Indonesian) action process in the spatial planning Conservation Area Management Plan for the Banten Province waters.

Materials and Methods

The study area

Research sampling was done at forty-five stations around Tunda Island, Serang Regency, Banten Province (Figure 1). The study was done using the purposive sampling method, and it was the process of determining the sample based on the selected station as the research subject (Yusal *et al*., 2019). Data collection was conducted from July to November 2020 in Tunda Island Serang Regency Banten

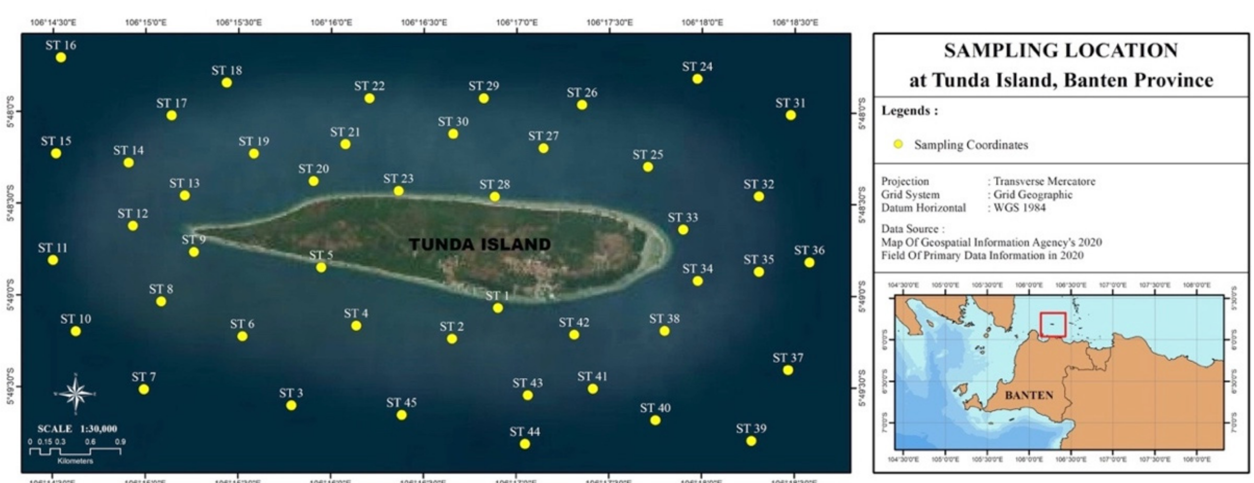

Fig. 1. Map of sampling site at Tunda Island, Serang Regency, Banten Province

Province Republic of Indonesia.

Study method

Water quality samples were measured at the surface layer. Water quality measurements were made in-situ using WQC (Water Quality Checker) merk HORIBA U-52-G and GPS (Global Positioning System) Map sounder Garmin 572xs. Water quality parameters were collected in situ. Bathymetry used a Global Positioning System Map sounder unit, and waters transparency used a Secchi disc. While the temperature of waters, Dissolve Oxygen (DO), pH, salinity, Total Dissolve Solid (TDS), conductivity, and Oxidation-Reduction Potential (ORP) were measured using the Water Quality Checker.

Study analysis

Oceanographic data were collected and compiled in numerical form, including station coordinates (latitude and longitude) and numerical data on parameter values. Numerical data for each parameter is then converted to spatial data using a spline-based interpolation technique (Corner *et al*., 2006). The following process combines spatial data and analyses using boundary conditions based on the overlay method. Boundary conditions are included the range of values bathymetry, water transparency, temperature, DO, pH, salinity, TDS, conductivity, and ORP (Suyarso, 2008). In contrast, community waters of fish resource communities such as shrimp, spiny lobster, sea cucumber, and dolphins are the targets for defining conservation areas around Tunda Island waters that can live and reproduce. The boundary conditions used in the analysis refer to the location selection method required by the decision by the Ministry of Marine Affairs and Fisheries No 31/2020. The boundary output from the analysis process is a hydro-oceanographic parameter distribution map as a profile of the Tunda Island waters conditions in Banten Province as a basis for area zoning plans for the conservation area management plans.

Results

Analyzed the data of hydro-oceanography at forty-five observation stations are shown in Figures 2 and 3. Meanwhile, the range values for each parameter and the water quality standards for biota targets can serve as targets in determining the model of marine protected areas and spatial planning. All the range

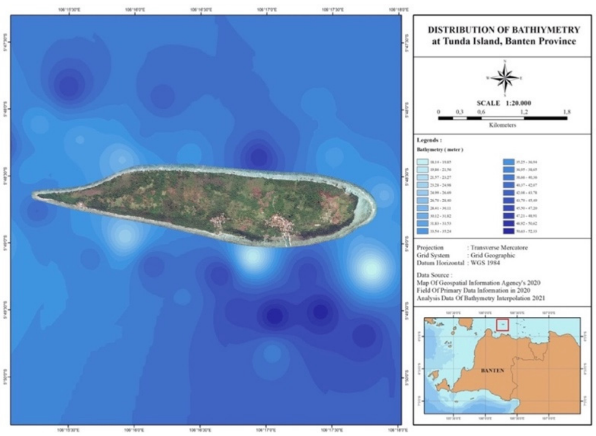

Fig 2. Bathymetry distribution at Tunda Island, Banten Province

Table 1. Results of oceanographic parameters analysis at Tunda Island, Banten Province

No.	Parameter	Ranges	Value of water quality standards for life					
			Coral reef	Mangrove	Seagrass	Spiny Lobster	Sea Cucumber	Dolphins
1.	Depths (m)	0,5 - 52,4 ± 1,14	< 50 [b])	< 2,5 [d])	< 90 m [i])	5-80 [j,k])	0,5-20 [l])	45 [o])
2.	Waters transparency (m)	0,5 - 13,3 ± 0,25	15-20 % [b])	15-20 % [b,e])	< 10 m [i])	15-20 % [b])	> 0,5 [0])	NA
3.	Waters temperature (°C)	29,97 - 31,16 ± 0,32	28-30 [a])	20-30 [g])	28-30 [a])	25-32 [k])	26-30 [l])	24-32 [h])
4.	DO (mg/l)	6,63 - 8,41 ± 0,31	> 5 [a])	NA	> 3 [a])	5-7 [m])	4-9 [l])	6-8,7 [o,h])
5.	pH	6,83 - 7,92 ± 0,25	7,0-8,5 [a])	7,0-8,5 [a])	7-8.5 [a])	7-8 [k])	7,9-8,4 [n])	6,45-28.04 [o])
6.	Salinity (‰)	31,6 - 33,8 ± 0,55	33-34 [a])	1-32 [f])	33-34 [a])	33-34 [a])	15-35 [l])	30,5-34,5 [o])
7.	TDS (mg/l)	13,8 - 15,8 ± 0,39	< 20 [a])	< 80 [a])	< 20 [a])	20 [a])	10-25 [l])	< 45 [o])
8.	Conductivity (mS/cm)	22,7 - 24,8 ± 0,36	NA	NA	NA	NA	NA	NA
9.	ORP (mV)	149 - 186 ± 7,03	< 199 [c])	< 202 e)	NA	NA	NA	NA

Note: DO = Dissolved Oxygen; ORP = Oxidation-Reduction Potential; TDS = Total Dissolved Solid; ORP = Oxidation-Reduction Potential; [a]) = The Minister of Environment Decree No. 51/2004; [b])= b) Nybakken (1992); [c])= APHA (1998); [d]) = Fujimoto and Miyagi (1993); [e]) = Deborde *et al*. (2015); [f]) = Alby *et al*. (2020); [g]) = Kennis *et al*. (1990); [h]) = Mujiyanto *et al*. (2017); [i]) = Duerte (1991); [k]) = Sulardiono *et al*. (2017); [j]) = Goñi *et al*. (2003); [k]) = Jones (2009); [l]) = Supriharyono (2007); [m]) = Seok *et al*. (1995); [n]) = Rasmussen *et al*. (2013); [o]) = Sarma *et al*. (2016).

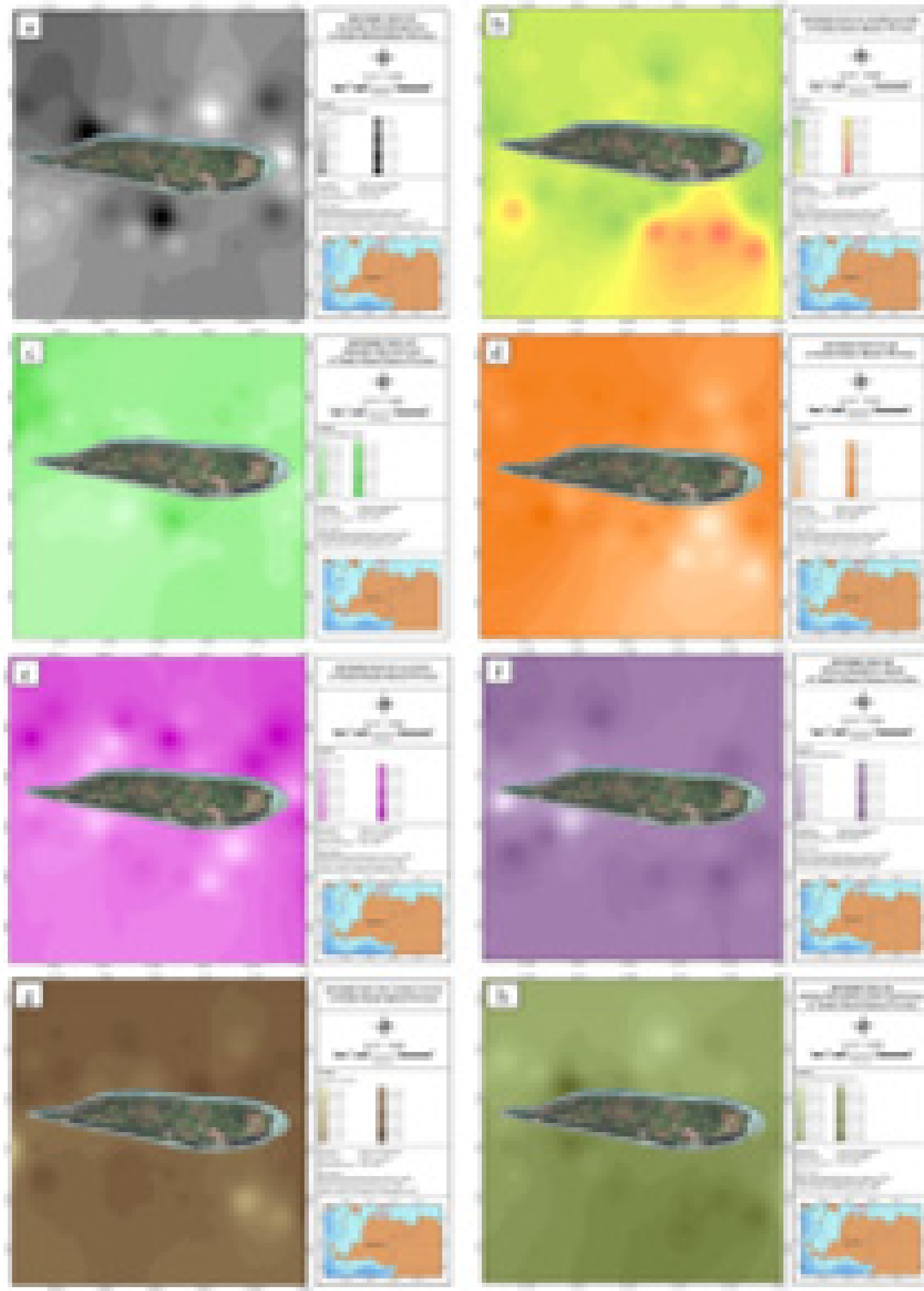

Fig. 3. Map of oceanography paremeters distribution (a= waters transparency, b= waters temperature, c: Dissolved Oxygen, d= pH, e= salinity, f= Total Dissolved Solid, g= Conductifity dan h= Oxidation-Reduction Potential) at Tunda Island, Banten Province Republik of Indonesia.

data values and standard values for biota to lie are shown in Table 1. Based on Table 1, the bathymetry of Tunda Island waters ranges from 0.5 to 52.4 ± 1.14 meters, with the distribution of each depth as described in Figure 2.

The water transparency analysis results range from 0.5 to 13.3 ± 0.25 meters (Figure 3a). During the study, the waters surrounding the seagrass ecosystem had average water transparency values down to the bottom. There were some waters on the south side of the seagrass ecosystem with water transparency between 0.5 to 1.2 meters. Meanwhile, the average water transparency in mangrove waters is ± 0.5 meters (Figure 3a). Water transparency is the degree of intensity of sunlight penetrating water and thus is influenced by turbidity. Based on various sources described in Table 1, the water transparency around the Tunda Island waters is appropriate for aquatic biota survival.

The result of waters temperature analysis around Tunda Island waters is 29.97 to 31.16 ± 0.32 °C. Can explain in Figure 3b the water temperature differences between the south and north sides. On the south side, the station was higher than on the north side. The between values are just around 0.5 to 1.5 °C.

The Dissolved Oxygen (DO) value in Pulau Tunda waters showed no significant difference. The Dissolved Oxygen range is between 6.63 to 8.41 ± 0.31 mg/l (Figure 3c). The results of observations of pH waters ranged from 6.83 to 7.92 ± 0.25 (Figure 3d). The sampling results found no significant differences between the waters approaching the land and towards the sea. The salinity concentration has ranged from 31.6 to 33.8 ± 0.55 ‰ (Figure 3e). Factors of salinity concentration for the survival of shrimp, sea cucumbers, fish and various other marine organisms affect the water's osmoregulation. This process takes place from the egg hatching stage to the larval stage. The results analysis of the TDS concentration ranged from 13.8 to 15.8 ± 0.39 mg/l (Figure 3f). For the aquatic biotas' survival, such as sea cucumbers and shrimp, these concentrations are included in the average values for their survival. The conductivity concentration is the ability of the water to conduct electrical current; the results of conductivity concentration analysis in Tunda Island waters were 22.7 to 24.8 ± 0.36 mS/cm (Figure 3g). Based on some literature, no one has mentioned the norm value of the maximum conductivity concentration limit for the survival of aquatic organisms. The matter of the ORP range of the analysis in Pulau Tunda ranged from 149 to 186 ± 7.03 mV (Figure 3h).

Discussion

The range bathymetry of Tunda Island's waters demonstrates the quality standards appropriate for the survival of coral reefs, mangroves, seagrass, spiny lobsters, sea cucumbers and dolphins. Tunda Island is a small island surrounded by coral reefs (Mujiyanto *et al*., 2020) and seagrass (Sugianti *et al*., 2021), while the presence of mangroves on the south, east, and west sides as well as on the north side (Mujiyanto *et al*., 2021). When referring to the literature described in Table 1, The bathymetry range can be an area for coral reef survival. The depth was more than 70 m, and coral reefs are difficult to find (Levinton, 1982). Coral reefs can also live at depths up to 50 m with good water transparency (As-Syakur and Wiyanto, 2016). It is related to light penetration into the water for the photosynthesis process.

In addition to these three critical habitats, Tunda Island's waters are also a migration route for dolphins. Even though the waters around the island is not like Seribu Archipelago, Kilauan Bay, Savu Sea, and Lovina Bay, the dolphins sighting can see every week (noted: it needs detailed data and information) around this location. Some economically important fish products, such as spiny lobster and sea cucumber, are also places to live because the waters around this site were a dolphin migration route between Kilauan Bay and Seribu Archipelago (Siahainenia and Isnaniah, 2013).

That value of waters temperature distribution is in line with Suryono *et al.* (2021) average waters temperature on the coral reef ecosystem in Panjang Island Central Java was 30.19 °C from 30.03 to 31.52 °C. Added Suryono *et al*. (2021) that water temperature was essential in coral reef distribution. The ideal average water temperature for the living coral reef is around 27 to 29 °C (Siburian and Ningrum, 2019). Supriharyono (2007) also explained the optimum average water temperature for coral reefs between 28 to 29 °C. While for other biotas like marine mammals, the optimum average waters temperature around, according to Mujiyanto *et al*. (2021), in the Savu Sea, the optimum values was approximately 28 to 32 °C. Dolphins that are often found almost every week are the Bottlenose dolphin. In North Amerika, the Bottlenose dolphin is typically found on average water temperature between 10 to 32 °C (Reeves, 2003).

Dissolved Oxygen concentration around Tunda Island waters in line with the study by Simanjuntak (2007) in Klabat waters on Bangka Island, where DO levels on a surface level (0 m) were 5 m and also the near-bottom waters each range from 3.54 to 4.08 mg/l (3.79 ± 0.10 mg/l); 3.22 to 3.58 mg/l (3.47 ± 0.15 mg/l) and 2.97 to 3.30 mg/l (3.06 ± 0.14

mg/l). Yusal *et al*. (2019) found that the range of dissolved oxygen from the north to the south side of Makassar City, South Sulawesi was 3.2 to 5.0 mg/l. This value is considered achievable for meiofauna survival. This conformity is also explained in the standard value in the Environment Ministry's Decree No 51/2004 that the maximum limit of marine biota that can live is > 5 mg/l. Aquatic environmental conditions on juvenile culture media for sea cucumbers (*Holothuria scabra*) and abalone seeds (*Haliotis squamata*) in a polyculture system performed on three different media resulted in a DO concentration range of 5.45 to 5.78 mg/l (Sembiring and Agustriani, 2012) explained in this study that based on the results of the DO content on Tunda Island waters (5.45 to 5.78 mg/l) can support some marine organism to live and grow up.

According to Odum (1993), surface water's acidity (pH) in Indonesian waters is generally between 6.0 to 8.5. The range of pH values is in line with Bachmid *et al*. (2020) that research stated the density of sea cucumbers in the Buntal Island waters found in Kotania Bay West Seram Regency, the pH range between 7.8 to 8.0. According to Rukminasari *et al*. (2014), the acidity distribution of seawater is influenced by fluctuations in O_2 and CO_2, where changes in pH, even slightly, will affect changes and imbalances in CO_2 concentrations and impact the life of organisms in the water. A relatively high concentration of CO_2 also involves changes in water quality parameters, especially in the carbonate system. The pH concentration for sea cucumber survival ranges from 6.5 to 8.5 (Kordi and Gufran, 2010). Another view expressed by Xiyin *et al*. (2005) is that the tolerance of the pH of the water for the life of sand sea cucumbers is 7.9 to 8.4. Water is polluted if the pH concentration is below 4.8 and above 9.2 (Sary, 2006).

Salinity design distribution is similar to water temperature around Tunda Island waters. The salinity concentration for marine organisms' lives was explained by Pratiwi (2008) that shrimp could grow well in salinity concentrations between 15 to 30 ‰. Pratiwi (2008) also explained that if the salt concentration of the water is too high, it will have consequences for reducing the growth rate of shrimp in nature. For the survival of coastal ecosystems such as coral reefs, the salinity concentration for normal coral reef life was 32 to 35 ‰ (Littaqwaa *et al*., 2020). Coral reefs do not live in waters that regularly receive freshwater from large rivers, leading to low salinity (Suryono *et al*., 2021).

In the study by Muskananfola *et al*. (2021) in a marine area in Hansisi Village and Uiasa Village, Semau Island, East Nusa Tenggara, the TDS value was found to range from 0.5-3.0 mg/l. That research also explained that the measurement results showed a difference in the TDS value of the two sites but that this was a common value for the lifespan of sea cucumbers. TDS concentration and turbidity are correlated with TSS levels; increasing TSS will increase turbidity levels in the water column. In nature, the ecological influence of turbidity can reduce sunlight penetration. A weak penetration of the sun will decrease the level of primary productivity of the waters (Ulum, 2020).

Referring to Widada (2007) explained that the nature of seawater has an electrical conductivity of 15.5 to 50.0 mS/cm, or based on this classification, the state of the water is in normal conditions for the conductivity of electrical seawater currents. According to Khairunnas and Gusman (2018), along the coast of Padang City, the total conductivity value ranges from the lowest value of 96.5 S/cm to the highest value of 13075.5 S/cm, meaning that of the above value, there is an anomaly where the conductivity value is very high compared to another measuring point.

Oxidation reactions describe electrons that leave the cell membrane in microorganisms, and this causes the cell to become unstable and damaged so that the cell membrane will die (Sukma *et al*., 2013). Suslow (2004) discovered that ORP is a method that has been developed to control the content of microorganisms in water. The concentration of these values is not much different from the results of research by Sukma *et al*. (2013), explaining that the ORP value of water increased in proportion to the increase in plasma exposure time with the highest value of 187 mV relative to the original state of the sample, namely 142 mV. As the ORP value rises, the oxidation reaction becomes more accessible, and more microorganism cell membranes are damaged and die. Suslow (2004) found that the higher the ORP of the water, the shorter the time it takes to kill *Escherichia coli* and *Salmonella* spp. bacteria contain in water. The ORP concentration for fish lives as described in Putri *et al*. (2017) that in the Ancol coast Jakarta Bay waters in 2015, the massive fish death was the ORP concentration at sampling -200 mV. According to Gerardi (2007) *cit* Putri *et al*. (2017), this range of values influences sulphide formation and methane gas production, which can cause the fish to suffocate and even die.

Conclusion

The hydro-oceanographic condition profile of Tunda Island's waters, based on nine physical parameters, shows that Tunda Island's waters are classified as waters suitable for the survival of marine life. In the future, when the Local Government or Ministry wants to develop a conservation area at Tunda Island waters especially using coral reef, mangrove and seagrass ecosystems or marine organisms like fish, spiny lobster, sea cucumber or dolphins as target conservation that Tunda Islands waters are suitable for their life. However, the study results require further detailed investigation of habitat characteristics and composition of biota species that will be used as targets for protected area management.

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