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Possibility of Fish Cultivation Based on Study of Water Quality around Dutungan Island, Barru Regency, Indonesia

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ABSTRACT: The study aims to determine the possibility of fish cultivation based on aspects of water quality around Dutungan Island, Barru Regency, Indonesia. There are 4 study locations, namely Location 1 is located around Dutungan Island, Location 2 is located in the fish hatchery industry and Location 3 is located around residential areas of Mallusetasi Beach, Barru Regency. Water quality parameters measured include current, brightness, temperature, pH, dissolved oxygen, and salinity. Data were analyzed by descriptive analysis. Based on the results of water quality analysis, it shows that the waters of Dutungan Island, Barru Regency still qualify the requirements for the development of fish and seaweed cultivation. The highest speed of water currents is obtained at location 1, which is an average of 0.52 m/s, the highest average water brightness was obtained at location 2 of 3.43 m, the highest average water temperature was obtained at location 1 of 28.97°C, the highest average water pH was obtained at location 1 of 8.03., the highest average dissolved oxygen water was obtained at location 3 of 5.25 ppm, and the highest average water salinity was obtained at location 2 of 33.5 ppt. However, the most suitable location for fish and seaweed cultivation of all locations is location 1, namely the location around Dutungan Island.

KEYWORDS: Possibility, Water quality, Cultivation, Dutungan, Barru

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INTRODUCTION

Coastal areas are important areas from various planning and management perspectives, and the consequences of pressure on the coast are management problems that arise due to utilization conflicts resulting from various interests in the region (Hamuna *et al*., 2018), because other than biological resources, coastal areas are also rich in non-biological resources, artificial resources, and environmental services (Haerudin & Putra, 2019). Dutungan Island is one of the coastal areas located in Barru Regency, Indonesia which is suspected of having the potential for the development of fish cultivation. One important aspect in coastal areas is the existence of coral reefs because they can affect water quality. According to Bahri *et al*. (2015), an area with good environmental activities and supported by good management will improve the health and productivity of the coral reef ecosystem in that environment. However, current field observations show that coral care is still relatively low, which causes anemones and coral reefs taken from nature to die and damage marine ecosystems (Sitinjak & Sinaga 2021).

Mariculture is one of the efforts to make the most of coastal waters through the cultivation of fish, seaweed, shellfish or other marine biota that have important economic value (Paruntu, 2015). Meanwhile, fish cultivation is an effort to overcome the decline in fish production (Ervany *et al*., 2013). The carrying capacity of waters is the amount of fish biomass that can be produced by fish cultivation activities, including floating net cages without increasing water fertility (Purnomo, 2013). Water quality is one of the environmental parameters that greatly supports the success of fish cultivation in floating net cages (Soemarjati *et al*., 2021). Water quality is expressed by several parameters such as physical parameters (temperature, brightness, current speed, etc), chemical parameters (pH, dissolved oxygen, salinity, water pH, etc), and biological parameters (presence of plankton, bacteria, etc.) (Effendi, 2003), and water quality is an important factor for the growth of both cultivated fish and fish in nature (Astuti *et al*., 2018).

In coastal areas there are several types of fish that are often found and can be cultivated. According to Selanno et al. (2016), the types of pelagic fish that are commonly found in these waters are fish belonging to the group of small pelagic fish resources such as white anchovy (Stolephorus indicus), red anchovy (Stolephorus heterolobus), sardine (Sardinella spp.), lompa fish (Thrisina baelama), buarao fish (Selaroides sp.) and lema/tatari fish (Rastrelliger kanagurta). Grouper and rabbitfish are marine fish that are abundant in Indonesian coastal waters, which have been successfully cultivated and are quite popular and have high market prices (Philip 1986 & Paruntu 1989). Grouper fish have beneficial properties for mariculture businesses, because it grows fast and can be mass-produced to serve market demand for grouper fish in a live condition (Paruntu, 2015). Grouper fish in nature are often found sheltering among coral reefs or sinking thing and ambushing their prey from hiding positions (Teng and Chua 1979; Paruntu 1989).

There are several aquaculture activities that can be carried out in coastal areas such as fish cultivation using floating net cages or seaweed cultivation. However, according to Simarmata *et al*. (2008), the aquaculture system in floating net cages can be one of the causes of degradation of the aquatic environment. Mud grouper in floating net cages reared using the polyculture system has a stocking density of 4 individuals/m^3, whereas with the monoculture system it is 8 individuals/m^3 (Paruntu 2015). Mud grouper in polyculture floating net cages has a feed conversion value of 6.1 with a stocking density of 4 fish/m^3, and this value is lower than the mud grouper cultured in monoculture floating net cages, which is 6.4 with a stocking density of 8 fish/m^3. Furthermore, samadar baronang fish in polyculture floating net cages in this study showed a feed conversion value of 3.8 with a stocking density of 4 individuals/m^3. Siganus spp. (Baronang fish) known as "rabbit fish" is one of the potential marine fish commodities that can be cultivated (Paruntu, 2015). Baronang fish can rearing in limited places with high stocking densities, because they have gather characteristics (Lam 1974; Merta 1982). Another type of fish that can be developed is the mouse grouper, and the mouse grouper belongs to the Serranidae family (Heemstra and Randall 1993). For the purposes of fish cultivation, monitoring and management of water quality is very necessary in fish cultivation (Ervany *et al*. 2013). Tavares *et al*. (2016) stated that floating net cage systems are deeper and more open than conventional floating net cages, there tends to be a fairly high flow of water and dispersion of leftover feed and fish feces, so that some of the remaining feed and fish feces decompose and settle elsewhere.

Apart from fish cultivation, another commodity that can be developed in coastal areas is seaweed. But according to Lee (1997), the development of seaweed cultivation must be supported by appropriate environmental parameters (physics and water chemistry) so that the cultivation business is successful. However, accurate data and information regarding the level of land suitability and the size of the area suitable for planting are not yet known (Parenrengi *et al*., 2011). The carrying capacity of seaweed depends on the location, method and time of planting seaweed (Winarno *et al*., 1996). Furthermore, Arjuni *et al*. (2015) stated that a good temperature for cultivating K. alvarezii seaweed ranged from 20-28°C. Based on the problems in coastal areas for the development of fish cultivation, a study has been carried out on aspects of water quality in coastal areas to obtain information on the possibility of developing fish cultivation. Based on this description, study was carried out around Dutungan Island, Barru Regency to analyze the possibility of fish and seaweed cultivation.

RESEARCH METHODS

The study design developed is explanatory research which designs research to obtain information about the condition of the waters around the coast of Mallusetasi District, Barru Regency, seen from the aspect of water quality for the development of aquaculture, and the quality of the water studied is related to physical and chemical aspects. This research was carried out for 3 months, from June to August 2020 by conducting 4 (four) sampling times. Determination of study locations based on differences in environmental characteristics at each study location. Location 1 is located around Dutungan Island, Barru Regency, Location 2 is located in the fish hatchery industry and Location 3 is located around the residential area of Mallusetasi Beach, Barru Regency. Parameters observed included current, brightness, temperature, pH, dissolved oxygen, and salinity. Measurement of the physico-chemical parameters of water was carried out in situ. The materials used in this study are seawater samples. The tools and methods used to measure or retrieve water quality data needed in this study include current velocity, brightness, temperature, dissolved oxygen, pH and salinity. Collecting data in this study was carried out through observation, namely data collection techniques by direct observation of the object under study. The data collected in this study are primary data and secondary data. After the data is collected and processed, the next process is to perform data analysis using descriptive analysis methods.

RESULTS AND DISCUSSION

Current Speed (m/s)

Current is the flowing movement of a mass of water which can be caused by wind blowing, or due to differences in the density of sea water or it can also be caused by long wavy movements, namely currents caused by tides (Nontji, 1987). Currents play an important role in the movement of nutrients in the waters which are useful for the growth of aquatic organisms such as plankton (Yulius *et al*., 2018). Nontji (1993) states current is the flowing motion of a mass of water caused by several factors, namely, by wind, changes in seawater density, long wave movement, and can also be caused by tides. Susilowati *et al*. (2012) stated that currents very affect seaweed in taking nutrients and carrying food elements. Nursidi *et al*. (2017) added that strong currents would disturb and harm the seaweed as it could broken, tear and detach from the substrate.

The results of this study indicate that the current velocity at the highest study location is at location 1, which is an average of 0.52 m/s, followed by location 3 with an average of 0.41 m/s and the lowest at location 2 with an average of 0.19 m/s (Fig. 1).

The results of this study are lower than the results of study conducted by Haerudin and Putra (2019) who conducted study on Labuhan Haji Beach showing that locations 1 and 5 have a current speed of ≥ 2 m/s. But the results of this study are still higher than the results of a study conducted by Buamona *et al*. (2021), current speed measurements were obtained during the study of 0.11-0.18 m/s. Hamzah (2003) states that optimal growth of grouper fish will be obtained if it is supported by suitable water conditions.

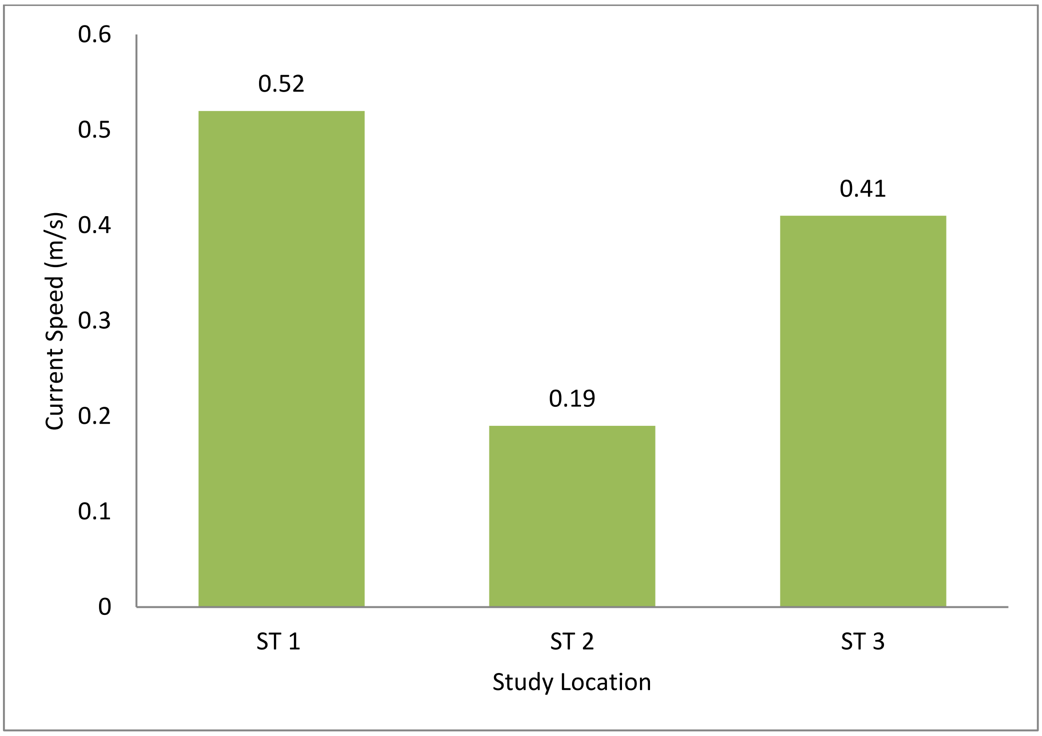

Figure 1. Average Current Velocity (m/s) During the Study

According to Mudeng *et al*. (2015) that a good current speed for seaweed growth is 0.2-0.4 m/s. Current speed has an important role in the growth of seaweed, where in general seaweed growth is better in moving or flowing water (Yulius *et al*., 2019). The optimum range for seaweed growth ranges from 0.2-0.4 m/s (Indriani & Sumiarsih, 1991). Meanwhile, Yulianto (2012) states that for grouper enlargement, current speed required is 20-50 m/s. Meanwhile, Beveridge (2004) states that the current speed requirements are much smaller, namely no more than 1 m/s. Current velocity always decreases with increasing depth (Sverdrup *et al*., 1970).

Brightness (m)

Brightness is the level of water transparency that can be observed visually using a secchi disk. By knowing the brightness of a body of water, we can find out to what extent there is still the possibility of an assimilation process in the water, which layers are not murky, and which are the most murky (Hamuna *et al*., 2018). Brightness refers to the transparency of water and depends on color and turbidity. Brightness values are strongly influenced by weather conditions, time of measurement, turbidity and suspended solids (Yulius *et al*., 2018). Suspended solids have a negative correlation with brightness and vice versa have a positive correlation with turbidity (Chapman, 1996; Effendi, 2003). The low brightness value is also influenced by the depth which is also low, making it easier for water to carry particles on the seabed when turbulence occurs (Haerudin and Putra. 2019). Brightness is related to the ability of light to enter into the water and is an important parameter needed for the process of photosynthesis in plants (Yulius *et al*., 2019).

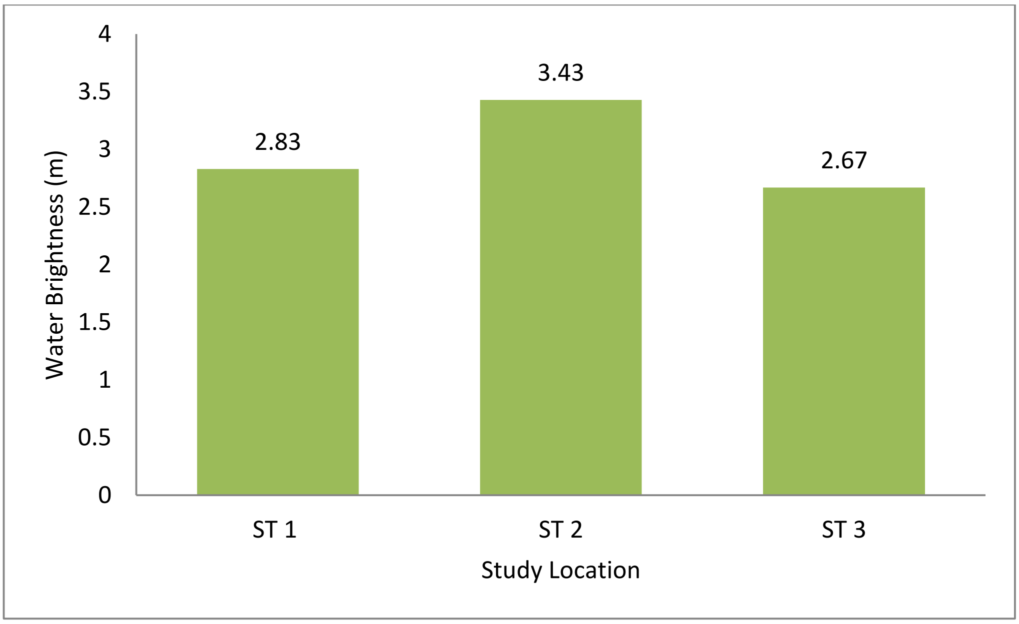

Figure 2. Average Water Brightness (m) During the Study

The results of study conducted around the coast of Dutungan Island show that the brightness of the waters is in the range of 2.67-3.43 m with the highest brightness at Station 2 with an average of 3.43 m, followed by Station 1 of 2.83 m and the lowest at Station 3 of 2.67 m (Fig. 2). The results of this study have similarities with the results of a study conducted by Hamuna *et al*. (2018) who conducted study in Depapre sea waters with seawater brightness levels ranging from 2-13 m. The low level of brightness in this study is because the measurement area is only around the sea coast of Dutungan Island. The level of brightness and turbidity of seawater very influences the growth of marine biota and very determines the rate of photosynthesis of biota in marine waters (Hamuna *et al*., 2018). Menurut Hayashi *et al*. (2007) bahwa kecerahan perairan pada lokasi yang cocok untuk budidaya rumput laut adalah > 2 m. Buamona *et al*. (2021), states that the brighter the waters mean the fewer mud particles that are likely to be in the water column.

Temperature (^{0}C)

Waters temperature is a very important factor for the life of organisms in the waters. Temperature is one of the easiest external factors to study and determine. Metabolic activity and distribution of aquatic organisms are very influenced by water temperature (Nontji, 2005). Temperature is an important factor in the metabolism of fish and the aquatic environment such as an increase in temperature can result in a decrease in oxygen solubility (Effendi, 2003). Fish can grow well in the temperature range of 25-32°C, but sudden temperature changes can cause stress for fish (Pujiastuti *et al*., 2013). Temperature is a physical parameter that plays a role in controlling the ecological conditions of the waters (Selanno *et al*., 2016). The representation of the temperature value of a water is important to study as information on environmental quality research data (Selanno, 2009). Effendi (2003) states that the intensity of sunlight that enters the waters will experience absorption and change into heat energy so that it affects temperature.

The highest water temperature at the study location was at Station (ST) 1 which was 28.97^{o}C, followed by station (ST) 3 which was 28.61^{o}C and the lowest temperature was at Station (ST) 2 which was 28.51^{o}C, but the difference in temperature at each study location did not show a significant difference (Fig. 3). The water temperature in this study was lower than that of Hamuna *et al*. (2018), Haerudin and Putra (2019); Chapman (1996), but relatively the same as the result research of Yulius *et al*. (2019). The results of sea surface temperature measurements in Depapre waters carried out by Hamunal *et al*. (2018) ranges from 29.2-29.7°C. The results of study conducted by Haerudin and Putra (2019) found sea water temperatures ranged from 30-32 ^{o}C. Thus, the research location still meets the requirements for fish and seaweed cultivation. Surface temperature is influenced by the geographical position of a body of water, season, time of observation, air circulation, cloud cover and water depth (Chapman, 1996). The optimum temperature for seaweed cultivation is around 25-31^{o}C (Yulius *et al*., 2019). While Doty (1987); Ask & Azanza (2002) states that a good temperature for seaweed cultivation ranges from 27-30^{o}C. The temperature of the Saleh Bay waters is in the range of 30.8-32.3°C (Yulius *et al*., 2018). Changes in temperature are influenced by meteorological conditions such as rainfall, evaporation, air humidity, wind speed, and sunlight intensity. Changes in temperature affect the chemical, physical, biological processes of water bodies. Temperature also plays a very important role in controlling aquatic ecosystems (Joppy *et al*., 2015). Temperature causes an increase in the speed of metabolism and respiration of aquatic organisms, which in turn will increase oxygen consumption (Effendi, 2003).

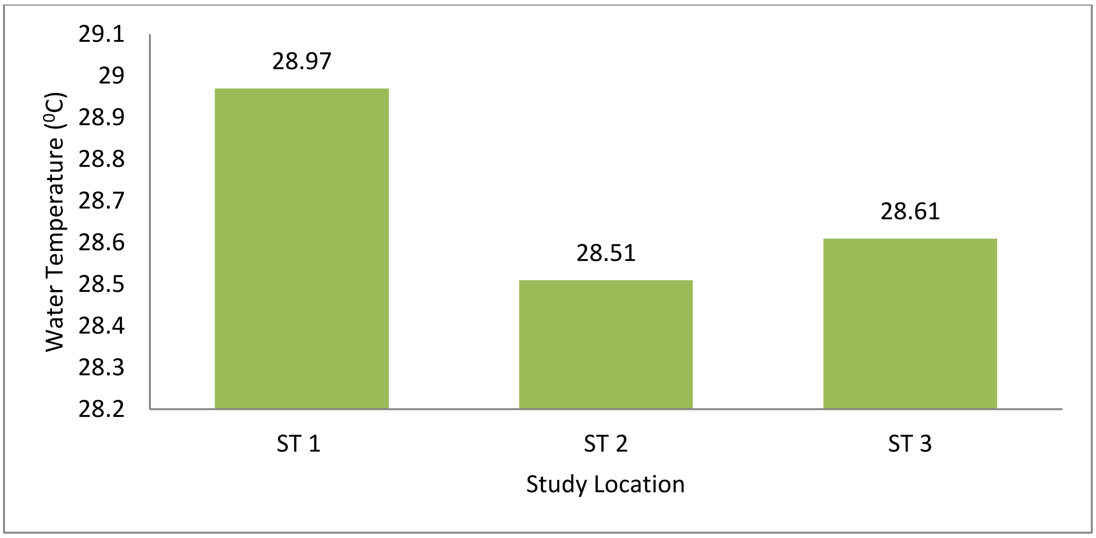

Figure 3. Average Water Temperature (^{0}C) During the Study

Temperature also very influences the life and growth of aquatic biota. Temperature in water bodies is influenced by season, latitude, time of day, air circulation, cloud cover and water flow and depth. Water temperature plays a role in controlling the condition of aquatic ecosystems. Increasing temperature causes an increase in the decomposition of organic matter by microbes (Effendi, 2003). Temperature fluctuations at a depth of 0-1.8 m in this measurement are relatively dynamic due to the depth which is classified as a mixed layer (Yulius *et al*., 2018). Variation of temperature changes can affect the life of coral reefs (Tambunan *et al*., 2013). Increasing temperature can also cause a decrease in the solubility of gases in water, such as O_2, CO_2, N_2 etc (Haslam, 1995). Sea water temperature very affects the survival and growth of marine fish, where changes in sea water temperature very affect the speed of body metabolism and are related to dissolved oxygen concentrations (Lestari and Dewantoro, 2018). The temperature difference that occurs can be caused by biochemical processes, through microorganisms that can produce heat (Patty, 2013). This condition must be seriously considered if the fish cultivation production cycle is to be stable, and physiologically, the fish body will be very sensitive in adapting to changes in water temperature (Sihombing *et al*., 2022).

pH of Water

The sea is waters that has a relatively more stable pH with a range between 7.7-8 (Nybakken, 1992). pH is also an important parameter in aquatic bio-chemical processes (Effendi, 2003; Simanjuntak, 2012). pH is a picture of the concentration of hydrogen ions in waters where between the two is inversely proportional (Tebbut, 1992). The pH of a waters is one of the chemical parameters which is quite important in monitoring the stability of the waters (Simanjuntak, 2009). because the degree of acidity of sea water can affect the hearing of fish which will make it difficult for fish to get food so that it can affect the growth of groupers (Sudjiharno and Winanto 1998). On the results of pH observations carried out by Supii *et al*. (2020), which ranges from 7.5-8.5.

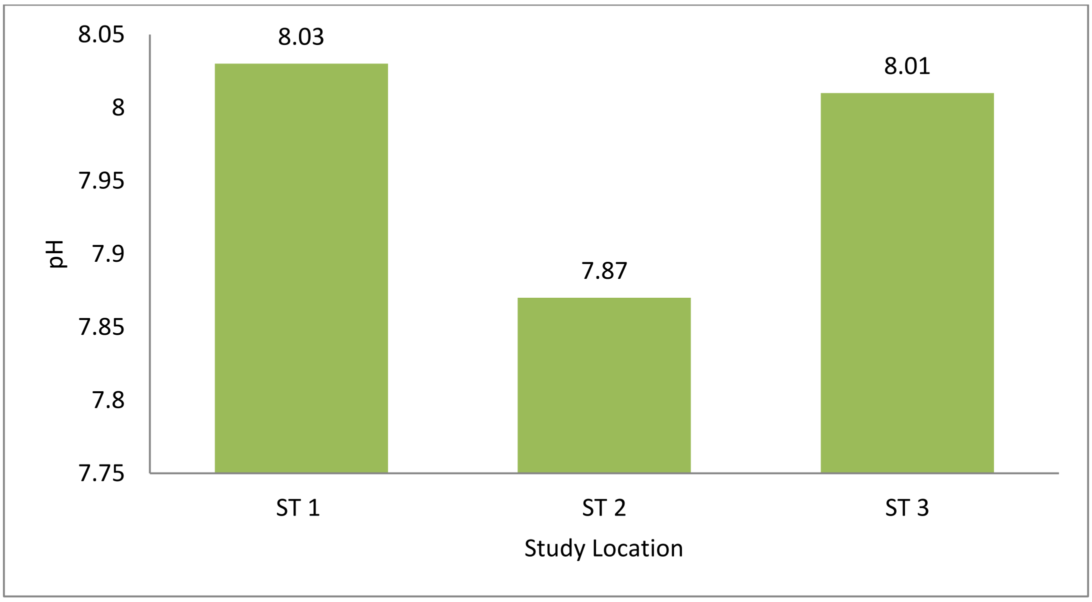

Figure 4. Average Water pH During the Study

Based on the results of measuring the pH of the water at the research location, the average pH value of the waters was in the range of 7.87-8.03, with the highest pH value at location 1 of 8.03, followed by location 3 of 8.01 and the lowest at location 2 of 7.87 (Fig. 4). The pH value of the water in this study was still higher than the results of study conducted by Haerudin and Putra (2019) who conducted study on Labuhan Haji Beach with a pH range obtained of 7.6-7.9. Neutral-alkaline pH conditions (7-10) accelerate the release of ammonium into water (Sukadi, 2010), and carbonic acid is wasted when phytoplankton photosynthesize (Yulius *et al*., 2018). In addition, the high pH value very determines the dominance of phytoplankton which affects the level of primary productivity of a waters where the presence of phytoplankton is supported by the availability of nutrients in marine waters (Megawati *et al*., 2014). Waters conditions that are very alkaline or very acidic will endanger the survival of organisms because it will interfere with metabolic and respiration processes. The low pH of the measurement results can occur because the pH in a waters is influenced by several factors including photosynthetic activity of marine biota, temperature and water salinity (Hamuna *et al*., 2018). High pH or alkaline conditions causing non-ionization of ammonium compounds so that it becomes toxic and easily absorbed into the bodies of aquatic organisms (Tebbut, 1992). The pH value of 4.5-6.5 even causes a decrease in plankton and benthic diversity as well as the total abundance and biomass of zooplankton and benthic (Baker *et al*., 1990 in Novotny & Olem 1994).

The pH value of the water in this study has similarities with the research conducted by Yulius *et al*. (2018) with the pH value at the research location, it shows that locations close to the mainland tend to be low when compared to the observation locations in the middle of the bay, which respectively ranged from 7.89-8.21 and 8.03-8.20, the opposite occurs in alkaline conditions. In general, the pH of seawater is between 7.6-8.7, while, normal fish growth is at a pH of 6.5-9.0 (Kordi, 2011). In relation to cultivated organisms, according to Buamona *et al*. (2021) with a water pH ranging from 7.31-7.82 which is categorized as still within the range that can be tolerated by seaweed, Likewise the results of study by Atmanisa *et al*. (2020) who stated a pH value of 7.6-7.7 showed that the utilization zone for seaweed cultivation was within the range that supports seaweed cultivation.

Dissolved Oxygen (ppm)

Dissolved Oxygen is the total amount of oxygen present (dissolved) in water. DO is needed by all living organisms for respiration, metabolic processes or exchange of substances which then produce energy for growth and reproduction. Generally oxygen is found in the surface layer because oxygen from the air nearby can directly dissolve and diffuse into seawater (Hutabarat and Evans 1985 in Hamuna *et al*., 2018). Dissolved oxygen is needed by all living organisms for respiration, metabolic processes or exchange of substances which then produce energy for growth, as well as for the oxidation of organic and inorganic materials in aerobic processes (Yulius *et al*., 2019). The main source of oxygen in waters comes from a diffusion process from free air and the results of photosynthesis of organisms that live in these waters (Salmin, 2000). The growth conditions of Kappaphycus alvarezii seaweed species can live in an amount of dissolved oxygen in the waters of 2-4 ppm, however, the conditions for growth are better if the dissolved oxygen is above 4 ppm (Indriani & Sumiarsih, 1992).

Based on the results of this study, it was obtained that the average dissolved oxygen value was in the range of 4.94-5.25 ppm, with the highest average oxygen value obtained at Station 3 of 5.25 ppm, followed at Station 2 of 5.05 ppm and the lowest was at Station 1 of 4.94 ppm (Fig. 5). Meanwhile, based on the results of research conducted by Hamuna *et al*. (2018) showed that the results of dissolved oxygen measurements at observation stations were quite varied, ranging from 5.1-5.6 ppm. Furthermore, based on the results of research conducted by Haerudin and Putra (2019) who conducted research on Labuhan Haji Beach, it was shown that all stations obtained a yield range of 6 ppm. Dissolved oxygen has an important role in fish growth because dissolved oxygen is needed by fish to breathe, the process of metabolism or exchange of substances which then produces energy, this energy is used for the growth and reproduction of fish (Salmin, 2005). DO in these waters is below the seawater quality standard for biota and is still classified as natural waters because DO concentrations do not exceed 10 ppm (McNeely *et al*., 1979). Aquatic biota need oxygen to burn their fuel (food) to produce activities, such as swimming, growth, reproduction etc (Joppy *et al*., 2015). The optimum content for the growth of aquatic biota ranges from 5-6 ppm (Kordi 2011). The variable in fish living media is water quality which affects the survival and growth of fish, because water is a means of transporting metabolic products and oxygen (Boyd, 2000).

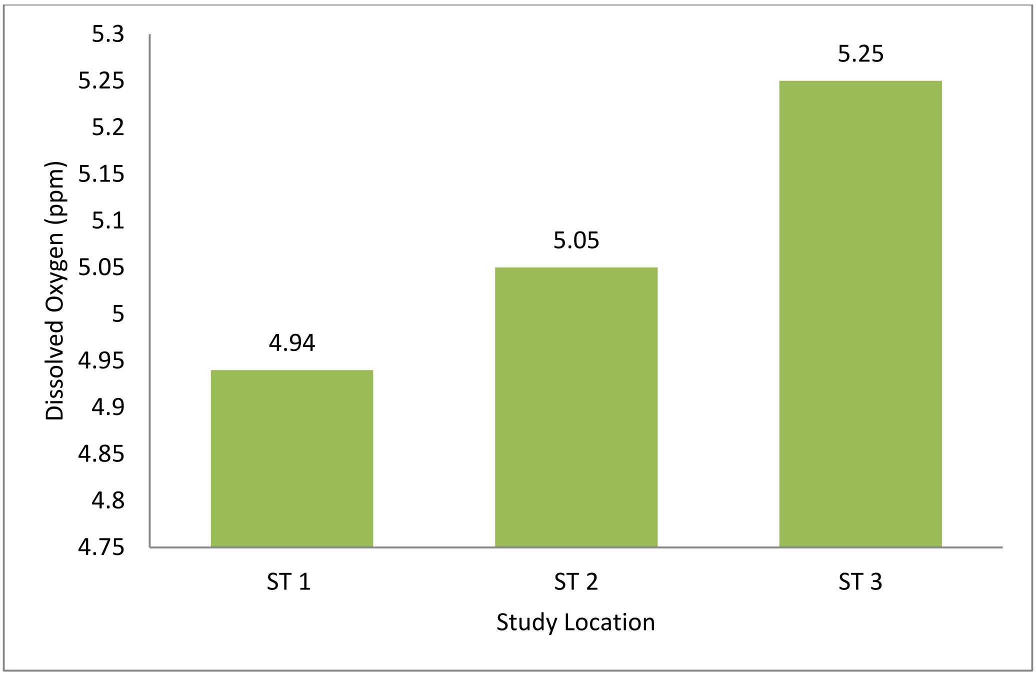

Figure 5. Average Dissolved Oxygen (ppm) During the Study

The source of oxygen is thought to come from photosynthesis of phytoplankton and atmospheric air diffusion, however, oxygen is also reduced by the respiration of aquatic biota (fish and zooplankton) and also the process of decomposition of organic matter deposited at the bottom of the pond (Rahman, 2015). The main source of dissolved oxygen can come from photosynthetic activity by aquatic plants and phytoplankton (Novotny & Olem 1994; Wetzel 2001; Effendi 2003). Lestari *et al*. (2015) who stated that low oxygen causes metabolic and respiration processes to increase which can then increase phosphorus concentrations.

Salinity (ppt)

Sea water salinity has an important role in fish growth because water salinity will affect fish appetite, so that high salinity will increase fish growth if balanced with optimal feeding (Septianawati and Tjahjaningsih, 2010). Furthermore, salinity affects the reproduction, distribution, long live and migration orientation of fish (Effendi, 2003). The results of this study indicate that the value of seawater salinity at the study location is in the range of 33.25-33.5 ppt with the highest salinity value obtained at location 2 with an average salinity value of 33.5 ppt, followed by location 1 and location 3 each of 33.25 ppt (Fig. 6). The salinity of the waters in this study is still higher than the results of research conducted by Yulius *et al*. (2018) who conducted research in Saleh Bay with a salinity range of 30.57-32.80 ppt. The low salinity around the port is of course greatly influenced by the flow of tributaries and sedimentation of the bottom of the waters due to river basins (Thesiana, 2015). The results of Buamona *et al*. (2021) the salinity obtained during the study ranged from 32-34 ppt. Even according to Sihombing *et al*. (2022), a salinity value of 11 ppt can still produce an oxygen solubility of 20 ppm. The results of measurements of salinity in Depapre sea waters carried out by Hamuna *et al*. (2018) showed that the values did not differ too much between observation stations and were in the range of 30-34 ppt. This salinity value is not much different from the salinity value of Indonesian waters, where in general the average surface of Indonesian waters ranges from 32-34 ppt (Dahuri *et al*., 1996). Likewise with the results of research conducted by Haerudin and Putra (2019) who conducted research on Labuhan Haji Beach, showing that at Stations 1-5 it has a range of salinity levels of 32-33 ppt. While Stations 6-10 have a higher salinity level range of 34-35 ppt.

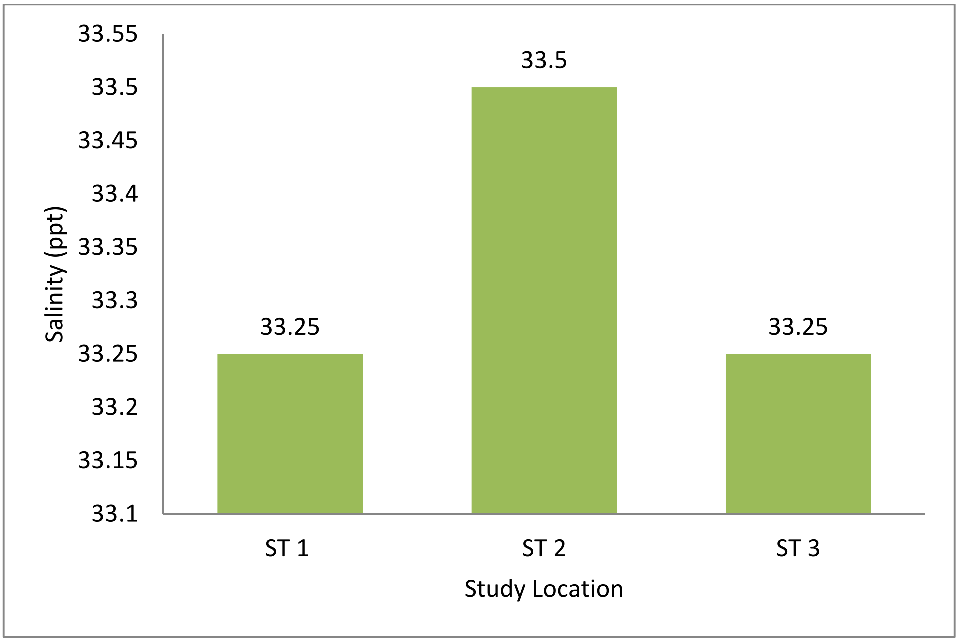

Figure 6. Average Salinity (ppt) During the Study

The distribution of salinity in the sea is influenced by various factors such as water circulation patterns, evaporation, rainfall, and river flow (Joppy *et al*., 2015). For the cultivation of seaweed species Kappaphycus alvarezii able to grow optimally in the range of salinity 29-34 ppt (Doty, 1987), whereas according to Panrenrengi *et al*. (2011), optimal growth tends to be close to sea salinity values of 32-35 ppt. Therefore, in determining the location of cultivation should avoid locations that are close to river mouths or other fresh water sources (Suniada & Indriyawan 2014). High salinity will affect growth and disease resistance. According to Choi *et al*. (2010) seaweed will experience slow growth, if the salinity is very low (less than 15 ppt) or very large (more than 35 ppt) from the range of salinity suitable for its life conditions for a certain period of time. Optimum growth of cultivated fish will be achieved at isosmotic salinity, because fish do not require a large amount of energy for the osmoregulation process. The osmosis process of fish will be disrupted if the salinity is low because more water will enter the fish's body and more salt will leave the fish's body, so that the workload of the fish kidneys to pump water out of the body increases. If this low salinity persists for a long time it can cause kidney damage and culture fish can die (Woo & Kelly, 1995).

CLOSING

Conclusion

The results of this study indicate that the area around Dutungan Island, Barru Regency has the potential for the development of fish and seaweed cultivation based on water quality aspects, where the highest average current speed is obtained at location 1 which is around Dutungan Island, Barru Regency, at 0.52 m/s, the highest average water brightness was obtained at location 2 of 3.43 m, and the highest average water temperature was obtained at location 1 of 28.97ºC. The highest average value of water pH was obtained at location 1 of 8.03. While the highest average dissolved oxygen value occurred at location 3 of 5.25 ppm. Furthermore, the highest average value of water salinity was obtained at location 2 of 33.5 ppt.

Suggestion

It is recommended that in further research, research on the application of fish cultivation at the research location can be carried out

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