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# THE SUITABILITY OF LOCATION BATU ANGUS BITUNG FOR AQUACULTURE IN TERMS OF SEVERAL PHYSICAL AND CHEMICAL PARAMETERS OF WATER QUALITY

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## ABSTRACT

Aquaculture activities require appropriate and supportive environmental requirements to live and develop optimally, this study aims to (1) Analyze the physical and chemical parameters of water quality in Batu Angus waters, (2) Evaluate the suitability of water quality as a potential aquaculture location in Batu Angus waters. This research was conducted in the waters of Batu Angus Bitung in July - August 2022. Water quality analysis was carried out by measuring the parameters of depth, temperature, salinity, pH and oxygen carried out in situ using a Multi-purpose water quality tool (Horiba U-52G), measuring current speed using a Current floating meter and measuring brightness using a Secchi disk tool. In situ data collection of seawater samples at 3 stations (St) was carried out 3 times with a time interval of 2 weeks at 05:00, 09:00, 13:00, 17:00 and 21:00 WITA. Meanwhile, ammonia, nitrate, nitrite and phosphate measurements were carried out using the spectrophotometer method at the Manado Industrial Research and Standardization Center Testing Laboratory. The results of the suitability analysis show that the Batu Angus Bitung water area is very suitable for aquaculture activities.

**Keywords:** Water quality, physical chemical parameters, aquaculture.

## 1. INTRODUCTION

The global development of aquaculture is currently experiencing significant growth (Joesidawati, 2018). Marine aquaculture in Indonesia is still being developed and there are still many obstacles, some of the obstacles experienced are the selection of the location of cultivation that is not in accordance with the aquaculture activities or the type of cultivation, one of the causes is water quality parameters that are not suitable for aquaculture activities. In order to anticipate that marine aquaculture activities can continue to grow, it is very necessary to study the condition of water quality before determining the location of cultivation supported by appropriate data analysis so as to obtain ideal water conditions for cultivation sites (Hutabarat, 2005).

In the fisheries sector, pollution that occurs in marine waters can result in reduced fish production due to ecological damage. This statement is supported by Narayanan et al. (2015), which states that the current condition of marine water quality has been degraded by the increasing pollution that occurs in water bodies. The business of marine aquaculture activities is influenced by the condition of its water quality. Changes in chemical, physical and nutrient parameters in a body of water can affect the growth of cultivated biota, even leading to death

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which can cause a decrease in the production of aquaculture activities (Radiarta and Erlania, 2015).

In essence, water quality monitoring is meant to determine the value of water quality based on water quality parameters, compare the results of water quality measurements with quality standards in accordance with their designation and assess the feasibility of water resources for a particular purpose. Water quality monitoring in a waters also serves to maintain habitat and aquatic ecosystems because both components will be affected by a reduction in water quality in a water area (Effendi, 2003).

Batu Angus contributes greatly to the economic activities of Bitung City. The development of the Batu Angus marine area began from various interests such as marine tourism, residential, and marine maritime as well as the development of marine aquaculture and fisheries. These activities greatly affect the quality of waters in Batu Angus, where the quality of seawater becomes a benchmark for the condition of marine waters. This research reviews the potential feasibility or suitability of the water quality in Batu Angus area, in Bitung City as a recommendation to be used as an aquaculture site by using data analysis of aquaculture site feasibility criteria and quality standards applicable in Indonesia.

## 2. MATERIALS AND METHODS

Water quality analysis was carried out by measuring the parameters of depth, temperature, salinity, pH and oxygen carried out in situ using a multi-purpose water quality (Horiba U-52G), measuring current speed using a Current floating meter and measuring brightness using a Secchi disk. In situ data collection of seawater samples at 3 stations (St) was carried out 3 times with a time interval of 2 weeks at 05:00, 09:00, 13:00, 17:00 and 21:00. Meanwhile, ammonia, nitrate, nitrite and phosphate measurements were carried out using the spectrophotometer method at the Laboratory of the Manado Industrial Research and Standardization Center.

### 2.1 Analysis of the Pollution Index

Determination of pollution status is determined by using the pollution index according to Nemerow and Sumitomo (1970) in the Decree of the Minister of Environment Number 115 of 2003.

$$PI_j = \sqrt{\frac{(C_i/L_{ij})_M^2 + (C_i/L_{ij})_R^2}{2}}$$

Description:

Li: Concentration of the water quality parameter in the water designation quality standard

Ci: Concentration of water quality parameter from the survey

PIj : Pollution index for designation

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(Ci/Lij)M : Maximum Ci/Lij value

(Ci/Lij)R : Average Ci/Lij value

The relationship between the level of pollution and the pollution index criteria based on the Decree of the Minister of Environment Number 115 of 2003 concerning Determination of Water Quality Status as follows:

1) $0 \leq PIj \leq 1.0$: Meet quality standards (good condition)

2) $1.0 < PIj < 5.0$: Lightly polluted

3) $5.0 < PIj \leq 10$: Moderately polluted

4) $PIj > 10$ : Heavily polluted

Water quality management based on the Pollution Index can provide input to decision makers in order to assess the quality of water bodies for a designation and take action to improve quality if there is a decline in quality due to the presence of polluting compounds. The Pollution Index includes various groups of quality parameters that are independent and meaningful (Sahabuddin et al., 2014).

**2.2 Analysis of the Suitability of Aquaculture Area**

The suitability of parameters for aquaculture is divided into three levels for each parameter, namely highly suitable (S1), suitable (S2), and unsuitable (S3). The suitability level is determined based on the suitability of physical and chemical parameters of waters for aquaculture (Hastari et al., 2017). The suitability criteria are prepared based on the required physical and chemical parameters of the waters by referring to the suitability matrix.

**Table 1. Criteria of the Suitability of Aquaculture Area**

| No | Parameter | Weight | S1 | | S2 | | S3 | |
|---|---|---|---|---|---|---|---|---|
| | | | Class | Score | Class | Score | Class | Score |
| 1 | Brightness (m) | 10 | >5 | 5 | 3 - 5 | 3 | <3 | 1 |
| 2 | Temperature ($^0$C) | 10 | 27 - 32 | 5 | 20 - 26 | 3 | <20 or >35 | 1 |
| 3 | Current speed (m) | 10 | 0,2 - 0,4 | 5 | 0,05 - <0,2 or >0,40 - <0,50 | 3 | <0,05 or >0.5 | 1 |
| 4 | Depth (m) | 10 | 8 - 20 | 5 | 5 - < 8 or >20 - | 3 | < 5 or >25 | 1 |

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| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | < 25 | | | |
| 5 | Salinity (ppt) | 10 | 30 - 35 | 5 | 20 - 26 | 3 | <20 or >35 | 1 |
| 6 | pH | 10 | 7,0 - 8,5 | 5 | 4,0 - <7,0 or >8,5 - <9,0 | 3 | <4,0 or >9,0 | 1 |
| 7 | *Dissolved Oxygen* (mg/l) | 10 | >5 | 5 | 3 - <5 | 3 | < 3,0 | 1 |
| 8 | Ammonia (mg/l) | 10 | <0,1 | 5 | 0,1 – 0,2 | 3 | <0,3 | 1 |
| 9 | Nitrate (mg/l) | 10 | 0,2 – 0,4 | 5 | 0,02 – 0,19 | 3 | <0,02 or >0,04 | 1 |
| 10 | Nitrite (mg/l) | 10 | 0,2 – 0,4 | 5 | 0,02 – 0,19 | 3 | <0,02 or >0,04 | 1 |
| 11 | Phosphate (mg/l) | 10 | 0,2 – 0,5 | 5 | 0,004 – 0,19 | 3 | <0,004 or >0,5 | 1 |
| Total : Weight x score | | | | 550 | | 330 | | 110 |

The calculation of the suitability index is based on the formula (Noor, 2009):

**IK = (Σ Ni / Nmax) x 100%**
Description:

IK = Suitability Index

Ni = value parameter (Weight x Score)

Nmax = Maximum value of the category

Based on the calculation of the suitability index formula above, the suitability class of physical and chemical parameters of waters is obtained as presented in the table below:

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**Table 2. Suitability class of water physical and chemical parameters**

| Category | Criteria |
|---|---|
| Very suitable (S1) | >80% |
| Suitable (S2) | 40% - 80% |
| Not suitable (N) | < 40% |

## 3. RESULTS

The results of the observation of the average value of water quality parameters at three observation stations during the study in the Batu Angus Bitung can be seen in the following table:

**Table 3. Mean values of water quality parameters of Batu Angus area**

| Parameter | Stations (St) | | |
|---|---|---|---|
| | St.1 | St.2 | St.3 |
| Depth (m) | 7,57 | 16,29 | 26,80 |
| Brightness (m) | 7,57 | 8,85 | 9,01 |
| Current Speed (m/sec) | 0,30 | 0,29 | 0,33 |
| Temperature (0C) | 29,65 | 29,55 | 29,57 |
| Salinity (ppt) | 31,37 | 31,48 | 31,44 |
| pH | 7,46 | 7,51 | 7,45 |
| Dissolved Oxygen (mg/l) | 7,73 | 7,74 | 8,43 |
| Ammonia (mg/l) | <LOD | <LOD | 0,005 |
| Phosphate (mg/l) | 0,006 | 0,008 | 0,007 |
| Nitrate (mg/l) | 1,75 | 1,71 | 1,35 |
| Nitrite (mg/l) | 0,003 | 0,002 | 0,002 |

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According to Hastari et al (2017) the ideal depth of the waters ranges from 8-20 m or at low tide between the floating net cages with the bottom of the water is 4-5 m, this is in accordance with the results obtained at St.2 which is 16.28 m. While in St.1 with a depth of 7.57 m, this depth is quite suitable for seaweed aquaculture activities where all waters when viewed in terms of depth can be used for seaweed cultivation (Burase et al., 2012), the minimum depth of water is one of the limiting factors for seaweed growth, the minimum depth is determined by the point where the lowest low tide of the waters and should still be around 0.5 m at the lowest low tide level, while there is no maximum depth limit that can affect seaweed growth (Adipu, 2013). At St.3 with a depth of 26.80 m is deep water, this results in more and more expensive container construction materials, because the mooring system that will use more materials and installations in the field is more complex besides that operations in the field will be more expensive (Lumi, 2019).

Based on the results of observations, in general the level of brightness of Batu Angus waters is classified as suitable, with the level of water brightness ranging from 7.57-9.01 m. and based on the overall average of each station (St): St.1 7.57; St.2 8.85; and St.3 9.01 m. Most of the observation results are still above the seawater quality standards for marine biota in Government Regulation of the Republic of Indonesia Number 22 of 2021. At St.1 the value of brightness and depth is the same, namely 7.57 m where the light entering the water body can penetrate to the bottom of the water, at St.2 has a value of 8.85 m and at St.3 which reaches 9.01 m this value is very much in accordance with the quality standard value for marine biota which is> 5 m, Kangkan (2006) states that, the brightness will decrease in intensity along with the greater the depth. Factors that can affect the brightness of waters are mud content, plankton density, and other dissolved materials. Based on the level of brightness, the brightness in Batu Angus waters is still classified as appropriate based on the requirements.

Current speed recorded at all stations showed a range between 0.29-0.33 m/sec and based on the overall average of each station (St): St.1 0.30; St.2 0.29; and St.3 0.33 m/sec. In research conducted by Adipu in 2013 and Hastari et al. 2017 wrote that the appropriate current speed for aquaculture is 0.20-0.40 m / sec. This shows that the current speed in Batu Angus waters is classified as appropriate based on the requirements. The current functions as a carrier of much-needed nutrients and to carry new water masses containing sufficient oxygen for the respiration process of fish, low current speed values can result in low water mass turnover, in floating net cages will cause the accumulation of fish waste or uneaten feed residues, and in seaweed or shellfish there will be a process of sediment buildup or thickening. Meanwhile, if the value of high current speed can cause damage to the floating net cage building or wash away cultivated organisms due to being carried away by the current (Adipu, 2013).

Temperature of Batu Angus waters at each station were carried out directly in the field (insitu), it was found that the temperature of Batu Angus waters tended to be relatively the same between observation stations, which ranged from 29.55-29.65℃ and based on the overall average of each station (St): St.1 29.65; St.2 29.55; and St.3 29.57℃ this value is still within normal limits and in accordance with the needs for marine biota metabolism, namely 28-32°C contained in the quality standards of sea water in Government Regulation of the Republic of Indonesia Number 22 of 2021. Based on existing data, the temperature of marine waters in the

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tropics will not differ much from one location to another, in general the surface temperature of waters is between 28-31℃, water temperature can be influenced by the radiation of the sun, weather, air and location (Nontji, 2005).

The results of salinity measurements in Batu Angus waters are not too different between observation stations, which range from 31.37-31.48 ppt and based on the overall average of each station (St): St.1 31.37; St.2 31.48; and St.3 31.44 ppt this value is quite in accordance with the value of sea water quality standards for marine biota with monitoring data as a reference, namely, natural is a normal condition in nature, which varies within a day (day, night) or varies due to the season. For salinity, it is allowed to change up to 5% (five percent) of the average salinity of the season (Government Regulation Number 22 of 2021 concerning the Implementation of Environmental Protection and Management). According to Mansyur (2008), the distribution of salinity in the sea is also influenced by various factors such as season, water circulation, evaporation, rainfall, and river flow. Salinity is a crucial parameter for the cultivation of every marine organism commodity, each species of marine organism has a specific tolerance range for optimal growth.

pH of Batu Angus waters measured between each station is 7.46-7.51 and based on the overall average of each station (St): St.1 7.46; St.2 7.51; and St.3 7.45. These results are relatively higher when compared to the pH results of research in surrounding waters, as comparative data, research conducted by Lumi (2019) which obtained a pH of 5-6 in the waters of Pintu Kota, North Lembeh District, Bitung City and research conducted by Rajagukguk et al., (2020) obtained a pH of 6.2-6.9. The low pH of the measurement results can occur because the pH in a body of water is influenced by several factors including photosynthetic activity of marine biota, temperature and salinity of the water. Hamuna et al (2018) that the pH of seawater is relatively more stable and is usually in the range of 7.5 and 8.4, except near the coast. Ghufran and Kordi (2005) state that water conditions will work well with a pH ranging from 6.5-9.0. Water conditions that are very alkaline or very acidic will endanger the survival of organisms because it will interfere with metabolic processes and respiration. Based on Government Regulation Number 22 of 2021 concerning the Implementation of Environmental Protection and Management, the pH of Batu Angus waters is in accordance with the quality standards for marine biota, which ranges from 7-8.5.

Dissolved oxygen of Batu Angus waters at the observation station is quite varied, ranging from 7.73-8.43 mg/l and based on the overall average of each station (St): St.1 7.73; St.2 7.74; and St.3 8.43 mg/l. At each data collection station, the dissolved oxygen value obtained indicates that the waters are in good condition, and still meet the seawater quality standards in Government Regulation Number 22 of 2021 concerning the Implementation of Environmental Protection and Management for the life of marine biota with a DO value of >5 mg/l, so that the DO concentration in Batu Angus waters is classified as suitable for marine biota. In Valentino et al. (2018), the value of land suitability for aquaculture ranges from 7.30 mg/l to 9.54 mg/l. According to Evalawati and Aditya (2001), in this range fish can live in floating net cages with dissolved oxygen concentrations >6 mg/l. Dissolved oxygen availability is an important factor in aquaculture. With increasing values of temperature, salinity and pressure will cause a decrease in oxygen levels in water and vice versa (Lumi, 2019).

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Ammonia concentration in Batu Angus waters has a very low value and is in accordance with sea water quality standards based on Government Regulation Number 22 of 2021 for marine biota, which has a value below 0.3 mg / l where the results obtained are at St.1 and St.2 have a value <LOD or <0.0004 mg / l and at St. 3 which is 0.005 mg / l. Ammonia levels in seawater vary widely and can change rapidly. Ammonia can be toxic to biota if levels exceed the maximum threshold (Silalahi et al., 2017). The high concentration of total ammonia in a body of water can mostly be thought to come from settlement waste and animal and human waste in the form of urine. where most of the population settlements are located in coastal and marine areas. In addition, naturally ammonia compounds in waters can also come from the metabolic products of animals and the results of the decomposition process of organic matter by bacteria. High ammonia levels can indicate the presence of organic matter pollution from domestic waste, industrial waste, and agricultural fertilizer runoff (Effendi, 2003).

The phosphate content in Batu Angus waters at each measurement station has a St.1 content value of 0.006; St.2 0.008; St.3 0.007 mg/l. This value indicates that the phosphate content in Batu Angus waters is still in accordance with the seawater quality standards for marine biota contained in Government Regulation Number 22 of 2021 concerning the Implementation of Environmental Protection and Management, which is 0.015 mg/l. According to Anhwange (2012) that the maximum level of phosphate recommended for waters that have been reported is 0.1 mg/l. Waters whose phosphate value is more than 0.1 mg/l are eutrophic waters, where phytoplankton blooming often occurs (Subarijanti, 2005 in Kadim et al., 2017). According to Moriber (1974) in Affan (2010), phosphate compounds in waters come from natural sources such as soil erosion, animal waste and plant weathering. Concentrations increase with the influx of domestic, industrial and agricultural or plantation wastes that contain a lot of phosphate, crushed organic matter and phosphate minerals.

The results of the analysis of nitrate measurements in Batu Angus waters get high values, namely St.1.75; St.2 1.71; St.3 1.35 mg/l, based on the results obtained this value exceeds the limit of nitrate levels based on quality standards in Government Regulation No. 22 of 2021 where the quality standard for nitrate concentration for marine biota is 0.06 mg/l. Similar to phosphate nutrients, nitrate is also one of the nutrients needed by living things in waters. Simanjuntak, 2012 states that water nitrate levels > 0.2 mg/l can result in eutrophication which can stimulate rapid phytoplankton growth (blooming). This condition may be due to the supply of organic substances containing nitrate nutrients into coastal waters carried by currents, and the process of stirring (turbulence) of seawater containing high nitrates.

The nitrite content obtained in the analysis of Batu Angus waters, which is St.1 0.003; St.2 0.002; St.3 0.002 mg/l, this level shows a value that is in accordance with the quality standards for marine biota based on Government Regulation Number 22 of 2021 which is 0.06 mg/l. The presence of nitrite in waters is caused, among others, by the rest of the feed, both natural and artificial feed, the process of decay, and the results of waste where all these materials contain a lot of protein. The presence of nitrite in water can cause disturbances to marine biota, where nitrite content in media water greater than 0.5 mg/l can cause fish death. Nitrite in the water can cause the formation of "methaemoglobin" which can inhibit the passage of oxygen in the body, this is characterized by gray-brown fish blood (Ghufron and Kordi, 2005). Another

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effect is that it can cause anaerobic conditions. Nitrite is an intermediate form of ammonia gas oxidation into nitrate. With the presence of nitrite in water, sufficient oxygen will be needed for a more complete oxidation process from nitrite to nitrate. If this process occurs continuously, one day the level of dissolved oxygen in the water will decrease so that it eventually runs out, then an anerobic state occurs.

The results of the analysis of water quality pollution index at three observation stations in Batu Angus area, Bitung City can be seen in the following table

**Table 4. The result of pollution index analysis**

| Stations | value $PI_j$ | Description |
|---|---|---|
| St.1 | 5,96 | Moderately Polluted |
| St.2 | 5,92 | Moderately Polluted |
| St.3 | 5,56 | Moderately Polluted |

The quality status of water quality can be seen from the value of the pollution index. The results of the calculation of the water quality pollution index at each research station in the Batu Angus waters of Bitung city show the quality status in moderately polluted conditions, which has a PIj value ranging from 5.56 - 5.96 where moderately polluted conditions have a value of 5.0 <PIj≤10, this condition is caused by the high value of the nitrate parameter which has the highest concentration exceeding the concentration of seawater quality standards in waters for marine biota which ranges from 1.35 - 1.75 mg/l. High nitrate concentrations in waters can stimulate the growth and development of aquatic organisms if supported by nutrient availability. Nitrate concentrations of more than 0.2 mg/liter can lead to eutrophication (enrichment) of waters, and further stimulate the rapid growth of algae and aquatic plants (blooming) (Effendi, 2003). This condition indicates that Batu Angus waters are rich in nutrients, especially algae and phytoplankton growth, this needs to be a concern if eutrophication (blooming) occurs which will have a dangerous impact on the sustainability of biota life.

The results of the index value and suitability class at the observation station in Batu Angus area can be seen in the following table

**Table 5. Index values and suitability classes in Batu Angus area**

| Station | Total Score (weight x score) | Suitability Index | Suitability Class |
|---|---|---|---|
| 1 | 490 | 89,0% | S1 (Very suitable) |
| 2 | 510 | 92,7% | S1 (Very suitable) |
| 3 | 490 | 89,0% | S1 (Very suitable) |

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The results of the suitability class based on the multiplication of weights and scores at each station (St): St.1 is 89.0%; St.2 is 92.7%; St.3 is 89.0%, the results of the area suitability analysis show that the area for the development of mariculture in Batu Angus area based on water quality parameters produces a very suitable category. The process of assessing the suitability of fish farming land by comparing the requirements of land use for aquaculture designation with land quality can determine the success in the development of fish farming.

The suitability of Batu Angus aquaculture land serves to provide recommendations in the selection of land suitable for the development of aquaculture activities. According to Lumi (2019) evaluation for land suitability serves to provide an understanding of the relationships between the condition of a land and its use and also provides planners to compare alternative land suitability classification options, to reduce the negative impact of land damage that may be caused, so that cultivation activities can continue optimally, integrated and sustainable.

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