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Suitability of floating net cage system of lobster cultivation site (*Panulirus* spp.) through GIS approach in Samaturu Sub-district, Kolaka District, Indonesia

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Abstract. *Syahrir, Prasetya A, Hasidu LOAF, Saleh R, Riana AD, Umar NA, Yusuf M. 2024. Suitability of floating net cage system of lobster cultivation site (*Panulirus *spp.) through GIS approach in Samaturu Sub-district, Kolaka District, Indonesia. Biodiversitas 25: 4105-4116.* The natural habitat of lobsters is in coral reefs of coastal waters from shallow to 100 meters below sea level. In Indonesia, coral reef areas that become the habitat of lobsters are around 67,000 km², including those in the waters of Samaturu Sub-district, Kolaka District, Southeast Sulawesi, Indonesia. The present study uses a floating net cage system to identify and map suitable lobster (*Panulirus* spp.) cultivation areas. The study was conducted from June to July 2023 in the coastal waters of Samaturu Sub-district, Kolaka District. Data were collected in 14 spots of coastal waters by using various oceanographic parameters (protection, depth, current, brightness, temperature, dissolved oxygen, and salinity). The measurement results of the parameters were analyzed using the spatial analysis method, ArcGIS 10 program. The analysis involved interpolation and spatial classification, which overlaid all oceanographic parameters to obtain the scores through a suitability matrix. Thus, it can show the spatial maps for lobster cultivation areas suitability. The study concluded that the environmental parameter values are: (i) The temperature of the sea surface was 28-30°C; (ii) The salinity level was 31-35 ppt; (iii) The brightness was 5-14 meters; (iv) The dissolved oxygen level was 5-7 mg/L; (v) The current speed was around 0.31-0.41 m/s; (vi) The water depth was 4-26 meters. It means that the measurement results are suitable for lobster cultivation in Samaturu waters; the total area of water suitable for lobster cultivation area with a floating net cage system (KJA) is obtained 6,179 (74.22%), including the highly suitable area is 2,290 ha (27.51%), categorized areas that suitable is 2,363 ha (28.38%), and categorized areas that moderately suitable is 1,526 ha (18.33%). Moreover, there are conditionally suitable areas of 1,648 ha (19.80%) and an unsuitable area of 498 ha (5,98%). Thus, the prospect of developing lobster cultivation in Samaturu waters is potential.

Keywords: Brightness, currents, depth, dissolved oxygen, protection, salinity, temperature

INTRODUCTION

Lobster, commonly called crayfish or barong shrimp, is classified as the genus *Panulirus*. The life cycle of lobsters consists of five stages: nauplisoma, filosoma, puerulus (postlarva), juvenile (young lobsters), and adult lobsters (Miller et al. 2023). Morphologically, lobsters have a segmented anatomy like a shrimp (Caputi et al. 2019). The lobster consists of two main parts: the head, called the cephalothorax, and the body, called the abdomen (Tuffley et al. 2018). Further, the body consists of segments with five pairs of legs for walking and a tail fan. The body parts of lobsters differentiate it from shrimp. The lobster's natural habitat is a coral reef in coastal waters from shallow waters to 100 meters below sea level. In Indonesia, coral reefs in which lobsters live cover an area of around 67,000 km^2. Lobster habitat in Indonesia is spread across the waters of West Sumatera, East Sumatera, South and North Java, Bali, Nusa Tenggara, Malacca Strait, East Kalimantan, West Kalimantan, South Kalimantan, North and South Sulawesi, Maluku, Papua, and particularly the Arafuru Sea (Irwani et al. 2020).

Lobster (*Panulirus* spp.) is a potential fishery commodity with significant economic value. Lobster is a vital fishery commodity in Indonesia because of its high price, nutritional content, and market demand (Masithah et al. 2023). A lobster is an invertebrate with hard skin and belongs to the arthropod group. Domestic and export market demand for lobster to Hong Kong, Taiwan, Singapore, Japan, and China continues to increase. However, to date, no lobster hatchery business has fulfilled the needs of the cultivation business (Alborés et al. 2019). Currently, Indonesia has seven types of lobster: sand lobster (*P. homarus*), *batik* lobster (*P. longipes*), rock lobster (*P. penicillatus*), pakistani lobster (*P. polyphagus*), pearl lobster (*P. ornatus*), bamboo lobster (*P. versicolor*), and spiny lobster (*P. femoristriga*). Pearl and sand lobsters have the most potential to be developed through Indonesia's existing fisheries cultivation system. The potential for cultivating lobster seeds in Indonesia is very large and is estimated to reach around 20 billion annually. Natural factors, including oceanographic and climatology dynamics, significantly influence the existence and availability of natural lobster seeds in Indonesian seas. Moreover, the quality of the marine environment and fishing activities also contribute to lobster availability. However, there is no adequate information or references on factors most determine the existence and availability of lobster seeds in nature. Thus, it is challenging to obtain the seeds. Further, the death rate for natural lobster seeds is also very high. There are two factors: aquatic environmental conditions and predators. The survival rate of lobster seeds in Indonesian waters is only 0.01%. This means that if 100,000 lobster seeds are hatched, then only ten seeds will be able to survive in nature.

The other factors in lobster development are the low knowledge of local farmers on cultivation's ideal location, technological system utilization, and the vulnerability to death caused by disease and unsuitable waters (Apriliani et al. 2021). Furthermore, the low productivity of lobster cultivation causes people to sell their catch seeds continuously rather than cultivating the lobsters up to consumption size. Lobster seeds around 2-3 cm can be sold for around IDR 30,000/pcs. It is very profitable for the fishermen and distributors of seeds. Floating net cages, commonly used for cultivating groupers and lobsters, have now changed their function as a medium for collecting lobster seeds. The condition encourages the Ministry of Maritime Affairs and Fisheries to revise the Ministerial Regulation about lobster management activities by prohibiting lobster seed trade abroad and prioritizing domestic cultivation needs. Providing a particular time, such as the spawning season, must be implemented to make the existence of lobster continuous. Moreover, developing friendly fishing gear and increasing the number of lobster hatcheries will help to maintain and grow its population (Larasati et al. 2018). In addition, the use of satellite image technology and GIS applications to determine the location of lobster cultivation is very important, as research conducted by Wamnebo and Rauf (2022) that the results of the overlay using the Geographic Information System (GIS) application show that Kayeli Bay is suitable for lobster cultivation using the floating net cage or *Keramba Jaring Apung* (KJA) in Indonesian.

Lobster cultivation is very profitable. However, the low availability of seeds from both natural and cultivated sources and the low level of public knowledge regarding lobster cultivation starting from the planning stage, determining a suitable location, utilizing cultivation systems, and handling pests and diseases bring challenges to lobster cultivation. One of the determining factors for the success of lobster cultivation is choosing the right location; a suitable location will provide certainty of results/benefits in lobster cultivation. Mir et al. (2020) stated that the success of mariculture, including lobster cultivation, is based on choosing the right location for lobster cultivation, as shown by the research results of Wamnebo and Rauf (2022), namely the use of GIS applications to identify the suitability of land for lobster cultivation; it used the KJA method based on water quality parameters in Kayeli Bay, Namlea Sub-district, Buru District, Maluku Province, Indonesia. Therefore, it is necessary to conduct a study to determine the location for cultivating lobsters (*Panulirus* spp.) suitable for the floating net cage system using a Geographic Information System (GIS) based on hydro oceanographic parameters in Samaturu waters, Kolaka District, Indonesia.

MATERIALS AND METHODS

Study site

The study was conducted from June to July 2023 along the coast of Samaturu waters, Kolaka District, Southeast Sulawesi Province, Indonesia. There were 14 points of sample locations. The location of Samaturu waters was chosen as the research location, considering that the potential of lobsters in these waters is quite suitable, marked by lobster cultivation and fishing activities by fishermen. The location is chosen based on hydro-oceanographic parameters, such as protection, water fertility, temperature, salinity, substrate, currents, and water brightness. The research location and sampling points are described as follows (Figure 1).

Types and methods of collecting data

The primary data was used in the present study. Primary data is obtained from the field through the survey. Further data collection in the quantitative method is direct measurement (in-situ and ex-situ). In-situ measurements are measurements directly on objects (in water) or parameter measurements by the use of measuring instruments in direct contact with the object. In-situ oceanographic parameters include station coordinates, water temperature, salinity, dissolved oxygen, substrate, brightness level, and location protection. Meanwhile, ex-situ measurements are measurements made using measuring instrument recording whose results require further interpretation or are not directly known. Therefore, ex-situ parameter data includes current speed and water depth obtained from satellite imagery. This research collected data at 14 sampling points spread across the northern and southern waters of Samaturu Sub-district. The 14 sampling points are considered to be sufficiently representative of the research location, where the determination of sampling points is based on bathymetry and information from fishermen regarding the potential location of lobster cultivation development or looking at marine aquaculture locations with a floating net cage system (KJA). Image data was collected from the National Oceanic and Atmospheric Administration (NOAA) Etopo1 satellite for the Environmental Research Division's Data Access Program (ERDDAP).

Data analysis method

The data were analyzed using ArcGIS 10 software to analyze the suitability of the waters. The method used an interpolation analysis and spatial classification approach. The data then overlays all oceanographic parameter data to provide scoring based on the suitability matrix. After that, the spatial map of land suitability will be obtained. The suitability criteria are based on the required environmental parameters using the suitability matrix (see Table 1). The suitability classification divides three categories: highly suitable (S4), suitable (S3), moderately suitable (S2), conditionally suitable (S1), and not suitable/unsuitable (NS). The calculation of the Suitable Index (SI) adopted from (Prasetya and Hasidu 2021) is as follows:

$$SI = \sum [Ni/Nmax] \times 100\%$$

Where:
SI : Suitable Index
Ni : Value Parameter of -i (Weight x Score)
Nmax : Maximum Class Value

Table 1. Suitability matrix for lobster cultivation with floating net cage system

Parameter	Measurement results	Suitability criteria				
		Highly Suitable	**Suitable**	**Moderately suitable**	**Conditionally Suitable**	**Unsuitable**
Protection	Unprotected	Protected (bay, strait)	Protected enough (shallow water with barrier island)	Protected enough (shallow water with barrier coral)	Protected small part	Open waters/ unprotected
Depth (meters)	4.0-26.0	10.0 - <20.0	10.0 - <15.0	5.0 - <10.0	3.0 - 5.0	<3.0 - >30.0
Current (m/s)	0.31-0.41	0.20 - <0.60	0.1 - <0.20	0.05 - <0.10	0.03 - <0.05	<0.05 - >0.60
Substrate	Muddy Sand	Sand, coral fragments, coral	Muddy sand	Muddy sand	Muddy sand	Mud
Brightness (meters)	5.0-14.0	>15	10 - <15	5 - <10	3 - <5	<3
Temperature (°C)	28.0-30.0	27.0 - 33.0	25.0 - <27.0	20.0 - <25.0	15.0 - <20.0	<15.0 - >33.0
Dissolved oxygen (mg/L)	5.0-7.0	5.0 - 8.0	4.0 - <5.0	3.0 - <4.0	2.0 - <3.0	<2.0 - >8.0
Salinity (ppt)	31.0-35.0	30.0 - 35.0	27.0 - <30.0	25.0 - <27.0	20.0 - <25.0	<20.0 - >35.0

Note: Modification of Beveridge (1996); Radiarta et al. (2008); Navas et al. (2011); Affan (2012)

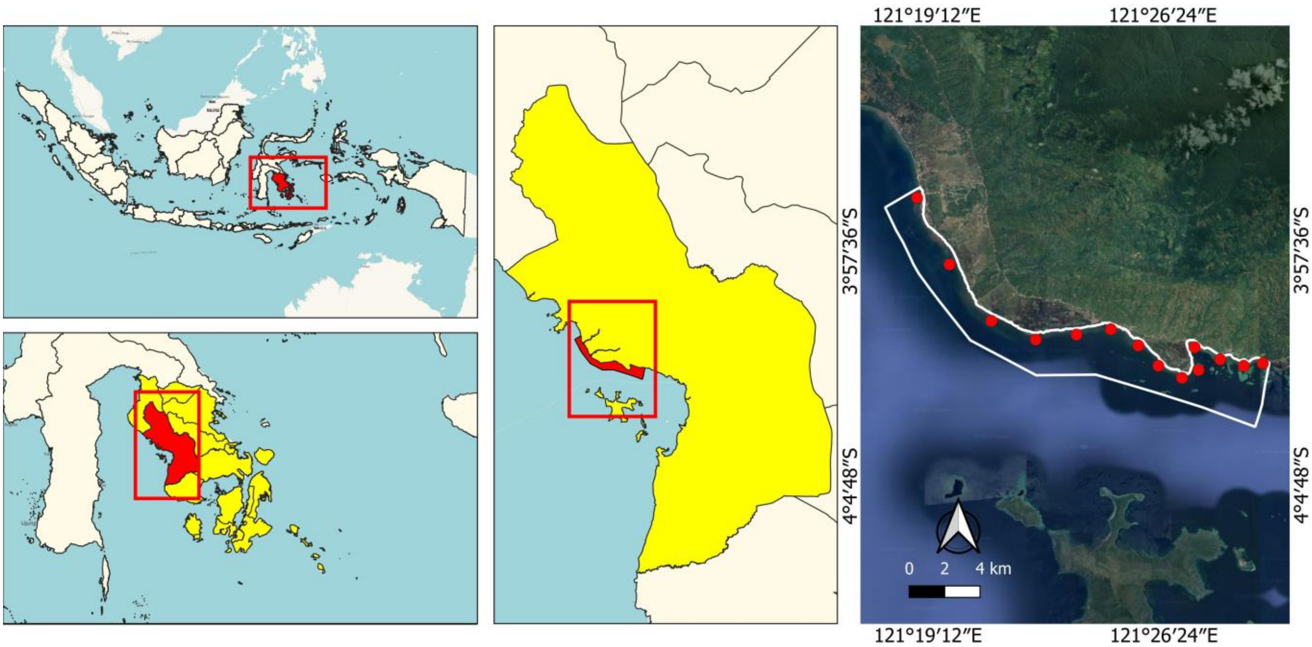

Figure 1. The research location and sampling point in Samaturu waters, Kolaka District, Southeast Sulawesi Province, Indonesia

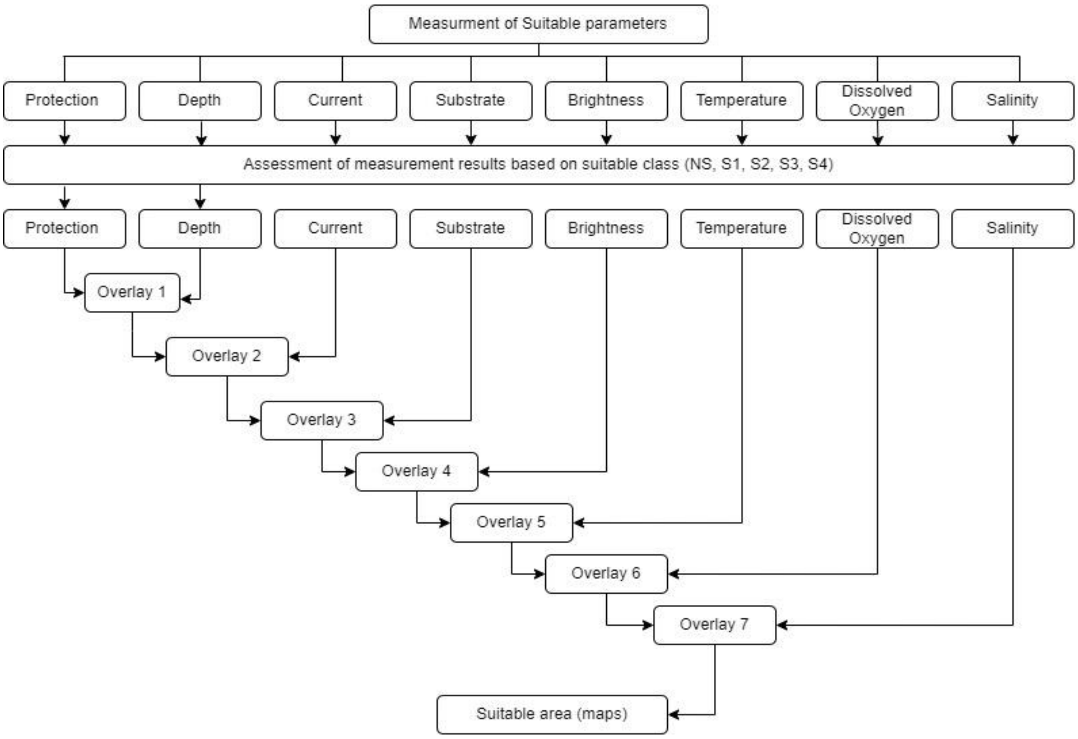

Figure 2. Overlay stages of suitable analysis

Therefore, to get the area (suitable cultivation location), a GIS analysis was carried out with the help of ArcGIS 10.4 software with stages: (i) Determining hydro-oceanographic parameters based on theories and results of previous research related to suitable cultivation locations for lobsters on the floating net cages (KJA), (ii) Measure each parameter (in-situ, ex-situ), (iii) Determine the class value of measurement results of each parameter based on class criteria, (iv) Overlay (union) of each parameter, (v) Justification of overlay results with suitable class, and (vi) Analyze the area (ha) class based on suitable. In detail, the stages of analyzing the suitability of lobster cultivation locations with the floating net cage system (KJA) are visualized in Figure 2.

RESULTS AND DISCUSSION

Protection

The protection is one of the main factors in the mariculture, including lobster cultivation. The protection is highly considered in determining a cultivation location to avoid the damage of strong winds and large waves in cultivation. Baeza et al. (2016) state that the cultivation location must be protected from strong waves by building a reef as a barrier or island that can reduce the giant waves. The ideal mariculture location will provide successful cultivation, particularly avoiding physical damage to marine cages. Furthermore, Childress et al. (2015) it will affect the growth of cultivated lobster or fish. Coral or island as a barrier will reduce large waves and strong winds. Thus, water currents will be calm and suitable for mariculture (Espinosa-Magaña et al. 2017).

The observation results show that the location was not entirely protected from strong winds and large waves since there was no coral or island as a barrier. The only island is Padamarang Island, but it is located far away (<500 m) from the coast of Samaturu. As a result, floating net cages and lobster cultivation will be affected as Kolaka waters have strong winds and high waves in the west wind season. Carloni et al. (2018) state that the mariculture location is greatly influenced by protection to avoid large waves and strong winds that affect the floating net cage and technical operation. Furthermore, Higgs et al. (2016) state that protection is the main factor in marine aquaculture, where a fully protected location is ideal for marine aquaculture. Therefore, it is essential to determine the right spot to prevent the damage of lobster cultivation in Samaturu waters from high waves and strong winds.

Depth

The depth is one of the factors that influences the absorption of sunlight in water (Junaidi et al. 2022). Sunlight is related to photosynthesis, which produces food for growth. Cultivated organisms, including lobsters, can grow well and produce high if cultivated at an appropriate depth of around 8-20 m (Ma et al. 2021). Goldstein et al. (2019) state that the ideal water depth is at least 5 meters or a distance from the bottom of the net is around 2 meters. The depth of the net allows for changes in water mass, especially at the bottom, and prevents friction with the seafloor. Additionally, it prevents food buildup, disturbance of bottom organisms, fish waste, and other debris at the bottom of the net.

The data processing results from the National Oceanic and Atmosphere Administration (NOAA) Etopo1 satellite, overlaid with field coordinates, show that the depth range is around 4-26 meters. Some of these depth values were suitable for cultivating float net cage lobsters, but others were not. Studied lobster cultivation location in Vietnam by Ton Nu Hai et al. (2018) found that the ideal depth for fixed net cage lobster cultivation is around 3-5 meters, and float net cage is around 6-20 meters at the lowest low tide. The depth distribution map can be seen in Figure 3.

The map in Figure 3 shows that the Western Samaturu Sub-district has a shallower water depth than the eastern. The water depth will significantly influence lobster cultivation activities since the ideal location for lobster is 10-20 m depth, with a temperature around 20-30°C. However, lobsters will have a coast depth of around <30 meters in the larval or seed phase. It is in line with Wandira et al. (2020) that the lobster seeds (*Panulirus* spp.) that dominate the Ranooha Raya waters in Moramo, South Konawe, Southeast Sulawesi were caught at 4 meters depth. There were 221 lobster seeds, including 147 pearl and 74 sand lobster seeds. Budiyanto (2021) also found lobster seeds in the Ekas Bay of Lombok, West Nusa Tenggara, Indonesia were caught at a depth of 10-20 meters, and some were even caught at a depth of <10 meters. Thus, an appropriate water depth for lobster cultivation in Samaturu waters is needed.

Ocean currents

Ocean currents are one of the essential factors in mariculture (Hays 2017). Lee et al. (2016) state that the currents significantly influence water fertility since much-needed nutrients can be supplied and distributed through water movement. Currents also can assist the water exchange process in cultivation areas. The currents can clean up accumulated waste from the metabolism of fish or cultured organisms, carry dissolved oxygen needed by cultured organisms, distribute nutrients evenly, and reduce attached organisms (biofouling) (Holmberg and Cosofret 2020). However, the high current speeds can damage physical construction and disrupt the cultivation process (maintenance).

Based on the results of satellite image data processing of current data in the National Oceanic and Atmospheric Administration's (NOAA) for Environmental Research Division's Data Access Program (ERDDAP) by ArcGIS, a current range was found to be 0.31-0.41m/s. The current distribution map can be seen in Figure 4.

The current speed in the western Samaturu waters was higher than in the eastern Samaturu waters. The current speed was around 0.3-0.4 m/s. The condition was suitable for a lobster on a floating net cage cultivation system since the ideal current speed for growth is 0.2 m.s to 0.4 m.s. Current plays an essential role during the circulation process in the cage. The circulation is essential for the lobsters' lives because it affects the surrounding environment. Optimum circulation can provide oxygen for the lobster's respiration (Ton Nu Hai and Speelman 2020). Furthermore, the circulation of ocean currents can also quickly break down food remains in cages; thus, there are no residue deposits and dangerous compounds from the remains feed, such as ammonia. It is in line with Corela et al. (2023), who state that ocean current speeds of more than 0.5 m/s can affect the position of the net and anchorage system. Meanwhile, a weak ocean current can reduce the exchange of water flow of the net. Thus, it affects the availability of oxygen in the net and the ease of diseases, mainly parasites, to attack the cultivated organisms being maintained. The ocean current speed at Samaturu waters is categorized as ideal and suitable for cultivating lobsters by adopting a floating net cage system.

Substrate

The bottom substrate of water is related to the nature of cultivated organisms, including lobsters, a basal (bottom) species (Gao et al. 2018). The natural substrate of lobsters is sand or muddy sand. Thus, sand lobster (*P. homarus*) is one of the lobster types that have the potential to be cultivated through a floating net cage system, apart from the pearl lobster (*P. ornatus*). Both types of lobsters are part of the five lobsters that grow well in Indonesian waters. Based on the results, it was found that the bottom substrate of Samaturu waters was varied. They include mud, muddy sand, and sandy substrate. The mangrove vegetation on the Samaturu coast can threaten mud sedimentation for lobster cultivation. It will cause the brightness of water to bring in high turbidity and disrupt the photosynthesis process (Ngabito and Aulita 2018). Furthermore, the muddy substrate waters are unideal for lobster cultivation. It can affect low brightness levels and the photosynthesis process. According to Amin et al. (2022), one of the typical natural habitats for lobster larvae is sandy or coral sandy coastal. In the Samaturu waters, there are sandy and sandy with coral fragments substrates, which are dominantly located in the western of Samaturu Waters. Meanwhile, muddy substrates are dominant in the eastern Samaturu waters due to sedimentation and the dominance of mangrove vegetation. Thus, the suitable location for lobster cultivation in Samaturu Waters is in the western, which contains a sandy substrate.

Brightness

Brightness is the intensity of sunlight that penetrates water (Powell et al. 2017). It is significantly influenced by turbidity. Brightness is a supporting parameter for the success of the mariculture business since it is related to suspended particles in the water. The brightness greatly influences suspended solids in water. The higher the amount of suspended solids in the water, the lower the brightness level of the water. The increased amount of suspended solids causes water to become turbid and even forms organic deposits at the bottom of the water. Organic deposition can reduce water's dissolved oxygen through natural oxidation processes, including microbial respiration and aerobic decomposition, negatively impacting cultivated biota (Khattab 2018). The water brightness significantly influences the lobster seeds' life (*Panulirus* spp.) as Radhakrishnan and Kizhakudan (2019) state that the brightness level and turbidity of ocean water significantly affect the marine biota growth, which determines the level of photosynthesis of biota in marine waters. The following is the distribution map of the brightness level in Samaturu waters.

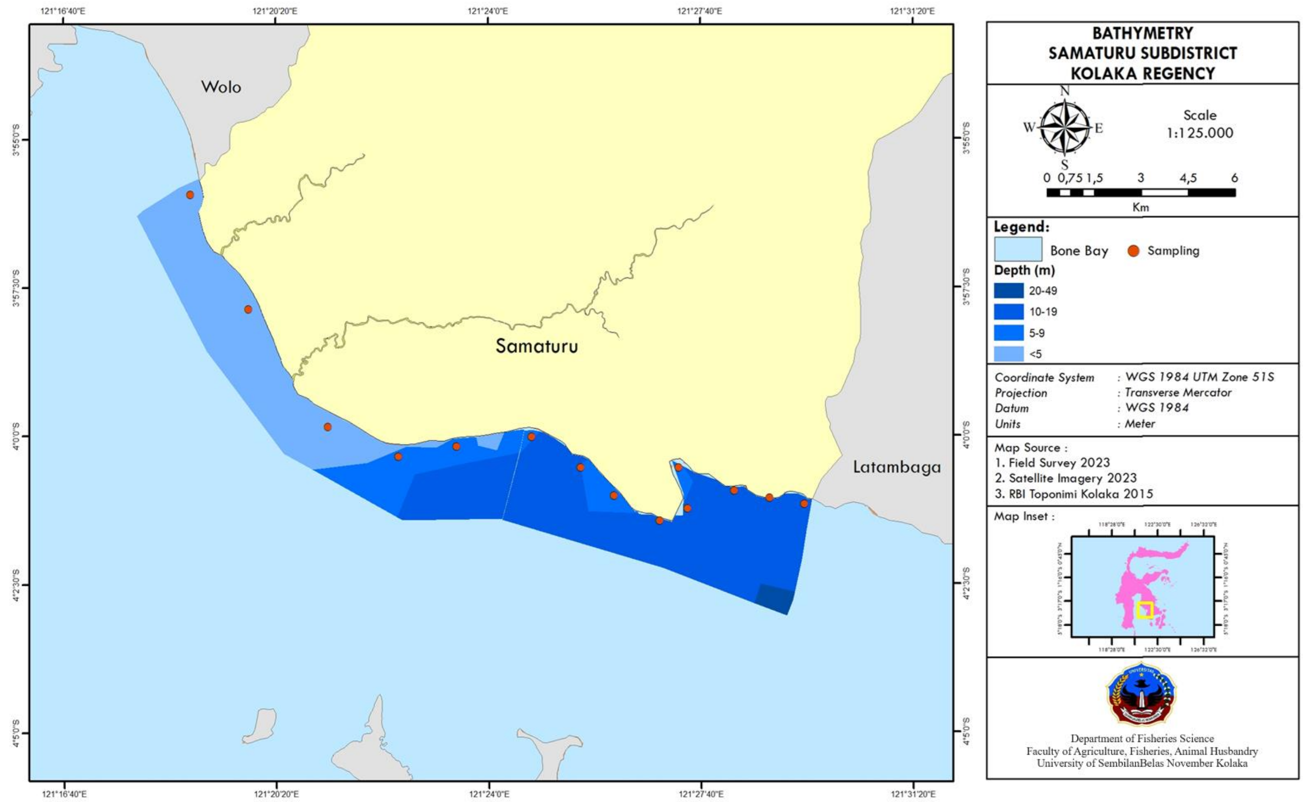

Figure 3. The depth distribution map of Samaturu waters, Kolaka District, Southeast Sulawesi Province, Indonesia

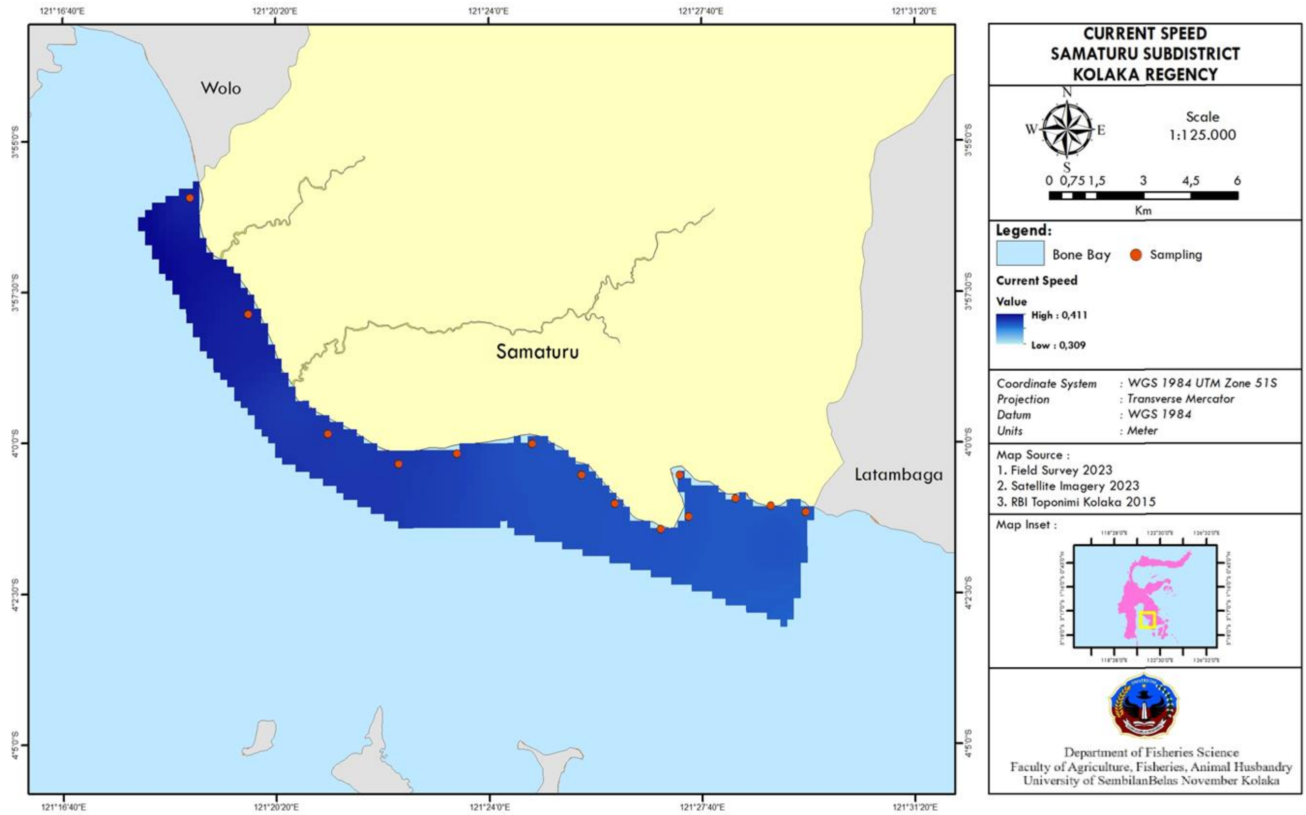

Figure 4. The current speed distribution map of Samaturu waters, Kolaka District, Southeast Sulawesi Province, Indonesia

The results on 14 points of samples show that the water brightness level was 5-14 m (see Figure 5). The highest brightness was found in the eastern Samaturu waters. Meanwhile, a lower brightness level was in western Samaturu waters. The low brightness is due to several locations close to mangrove vegetation, rivers, estuaries, and mining companies. Oniam et al. (2015) state that the ideal water brightness for cultivation is >3m. Furthermore, Liu et al. (2018) state that 13-15 m of brightness level is categorized as high, 8-17 m is medium, and <8 m is low (poor). Thus, the eastern Samaturu waters as a suitable place for cultivation is recommended since the brightness level is around 10-14 m.

Temperature

Temperature is an essential factor influencing oxygen consumption in aquatic organisms. High-temperature changes in ocean waters will affect metabolism processes, appetite, and body and nervous activity. García-Echauri et al. (2020) state that temperature is one of the environmental parameters that influence the survival level of marine biota. As Sumbing et al. (2016) state, temperature changes affect the ideal water level as a habitat for aquatic organisms. Thus, every aquatic organism has a maximum and minimum temperature. Furthermore, Baeza et al. (2018) state that marine biota are generally cold-blooded or poikilothermic animals, including lobsters. Temperature can be an influence factor for distribution and biological processes in the ocean. The following is the distribution map of water temperatures at 14 points of measurement (Figure 6).

The temperature distribution in Samaturu waters was around 28-30°C, where the eastern of Samaturu waters was higher than the western area. This is because several points are close to the estuary east of Samaturu. Based on the environmental parameter suitability matrix, the temperature distribution on the data is highly suitable for lobster cultivation. According to Cobb, as stated by Downie et al. (2020), lobsters are often found in waters with temperatures between 26-30°C or cold water. Furthermore, Waluyo and Arifin (2004) found that the temperature for lobster growth is between 28-30°C. However, Radhakrishnan et al. (2019) state that lobsters can grow better in warmer waters than in the cold. Temperature affects the growth of juvenile and adult spiny lobsters. Thus, the location for lobster cultivation in Samaturu waters should be done at all sampling points since the water temperature was 28-30°C.

Dissolved oxygen

Dissolved oxygen is a limiting factor for all living organisms. It is an essential requirement for the life of living creatures in water. Oxygen concentration in water can affect growth, feed conversion, and reduce the water resources carrying capacity. The minimum concentration for most fish to live is 5 mg/L, although several types of fish can survive with an oxygen concentration of around 3 mg/L in water. Oxygen concentration below 4 mg/L in water will make the fish survive but decrease the fish's appetite. Dissolved Oxygen (DO) is the fundamental substance in aquatic living systems since it plays a vital role in metabolic and respiration processes. It is also that DO is needed by all living organisms for respiration, metabolic processes, and the exchange of substances to produce energy for growth and reproduction, as well as to the extent that the body of water accommodates aquatic biota, such as fish and microorganisms. The following is the distribution of dissolved oxygen in Samaturu waters.

The dissolved oxygen distribution in 14 measurement points was 4.15-6.80 mg/L. It can also be seen that the western Samaturu waters have a higher dissolved oxygen level than the eastern Samaturu waters (Figure 7). The dissolved oxygen level was higher in the west of Samaturu waters due to strong currents and many rivers supplying water from land. According to Affandi et al. (2023), the suitable dissolved oxygen level for a floating net cage lobster cultivation system is 3.0-10.0 mg/L. Meanwhile, Bozorg-Haddad et al. (2021) state that the ideal dissolved oxygen level for mariculture is more than 5 mg/L. The high and low levels of dissolved oxygen are influenced by turbidity and activity of organisms in the waters. Thus, the dissolved oxygen levels in Samaturu waters are categorized as suitable for lobster cultivation, around 5.0-7.0 mg/L.

Salinity

Salinity is the concentration of all salt solutions from ocean water. Salinity is an environmental parameter that influences biological processes and indirectly affects the growth rate, amount of food, and survival level of organisms, including lobsters (Ondara et al. 2018). According to, higher or lower salinity can cause the disruptive growth of cultivated organisms. Lobsters are very sensitive to the salinity and temperature. Poor water quality can cause lobsters to be unhealthy and may cause them to die due to stress and lack of appetite. Thus, maintaining the stability of water levels, including salinity, is essential. The following is an illustration of the salinity level of Samaturu waters (see Figure 8).

From the results at 14 points of temperature measurement, it was found that the highest salinity level was in the east of Samaturu waters, around 33-35 ppt. According to Senevirathna et al. (2017), the ideal salinity level to support the lobster seeds' life, growth rate, amount of food, and survival rate in nature is 29-34 ppt. It is in line with Hinojosa et al. (2016) state that salinity is one of the water quality parameters to support the organisms' survival. Furthermore, Szuwalski et al. (2016) state that the ideal salinity level for mariculture is around 30-35 ppt. The body's higher and lower water salinity levels can be influenced by weather, water circulation, evaporation, rainfall, and river flow. Thus, lobster cultivation location in Samaturu waters can be done in all 14 sampling points since its level is around 31-35 ppt or can be said to be suitable for lobster cultivation.

Suitability of aquatic for floating net cage lobster cultivation system

Mariculture is an activity to maintain and develop marine biological resources involving various fish, shrimp, shellfish, seaweed, and lobsters in coastal waters. The mariculture development aims to increase production and preserve the environment to balance fishing caught (Ton Nu Hai et al. 2018). Furthermore, it also aims to maintain the biodiversity of species and ecosystems. One of the essential factors in mariculture is determining the cultivation location. Lobster cultivation is necessary and urgent to be developed, considering the lobster seeds continue to increase as well as the high demand. According to O'Rorke et al. (2014), the high demand for lobster seeds causes the natural source production to be uncontrolled. Setyanto et al. (2023) state that lobsters are caught using various types of fishing gear throughout the year, but fishermen of lobsters mainly use special nets called krender (traps). The suitability of environmental parameters for lobster cultivation's floating net cage was analyzed using the overlay method and suitability matrix for scoring. The spatial analysis involves five categories: highly suitable (S4), suitable (S3), moderately suitable (S2), conditionally suitable (S1), and not suitable/unsuitable (NS). It can be seen in Figure 9.

Based on Figure 9, it was found that the suitable area to be developed as a floating net cage of lobster cultivation system in Samaturu waters was 7,827 ha, including; a highly suitable area is 2,290 ha (27.51%), categorized areas that suitable is 2,363 ha (28.38%), categorized areas that moderately suitable is 1,526 ha (18.33%). Thus, the prospect of developing lobster cultivation in Samaturu waters has a potential area of 6,179 (74.22%), are remaining area conditionally suitable area is 1,648 ha (19.80%), and the unsuitable area is 498 ha (5.98%). The wide lobster cultivation area is due to various factors, especially location protection from strong winds, waves, and currents. This is because there is an island that protects the cultivation site. Meanwhile, there are unsuitable locations due to a lack of protection for the location and river estuaries with a relatively large supply of freshwater. These conditions will increase TSS and TDS and gradually cause sedimentation. Another impact is the lack of stability in water conditions due to the influence of high freshwater, which can occur during the high rainy season. This is also in line with the research results by Hasim et al. (2017). The factors that affect a suitable location for marine aquaculture are the depth and brightness of the waters. These two factors have a significant influence on the success of cultivation. Meanwhile, according to Shodiq et al. (2024), the physical parameters that indicate suitable areas for marine cultivation include water depth, brightness, and current speed.

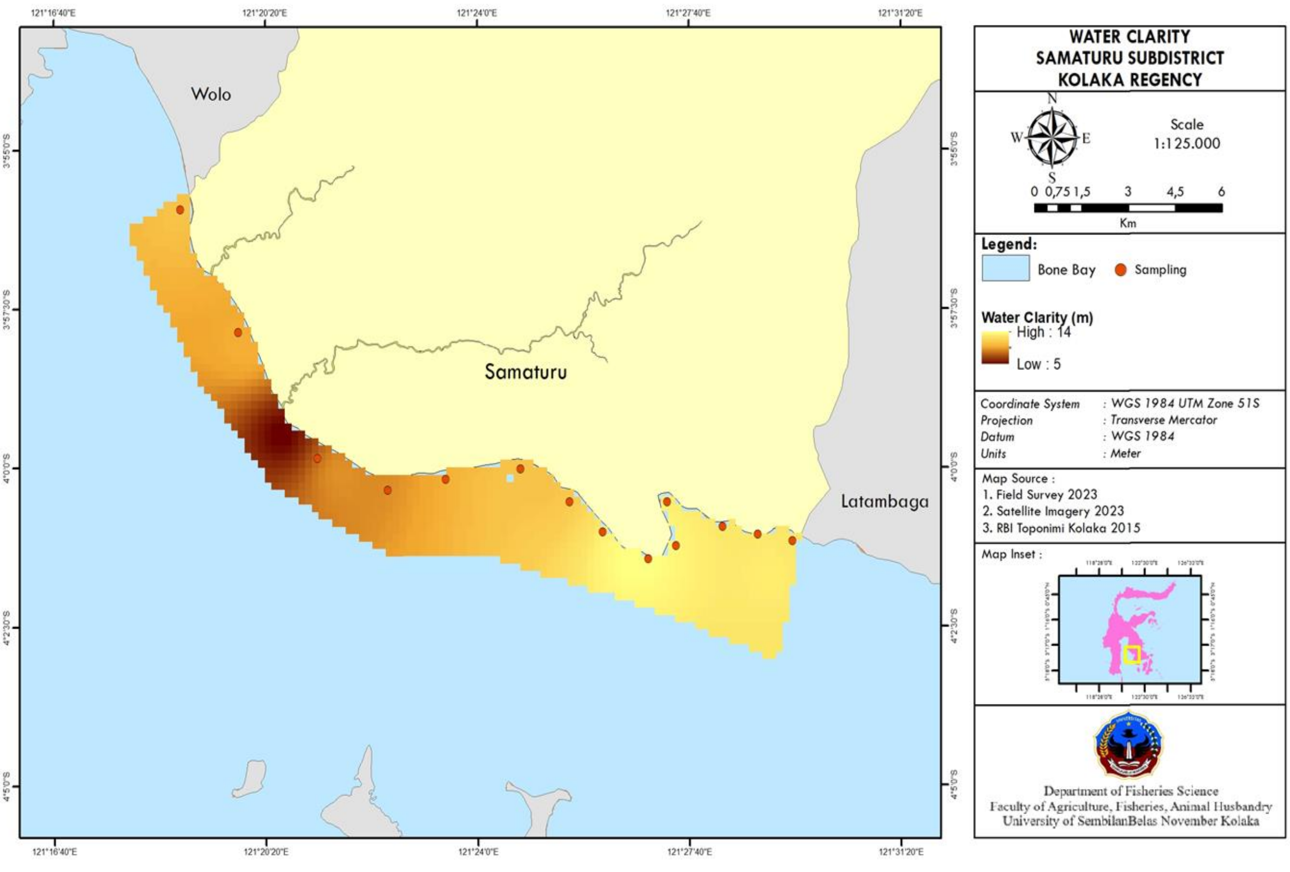

Figure 5. Distribution map of brightness in Samaturu waters, Kolaka District, Southeast Sulawesi Province, Indonesia

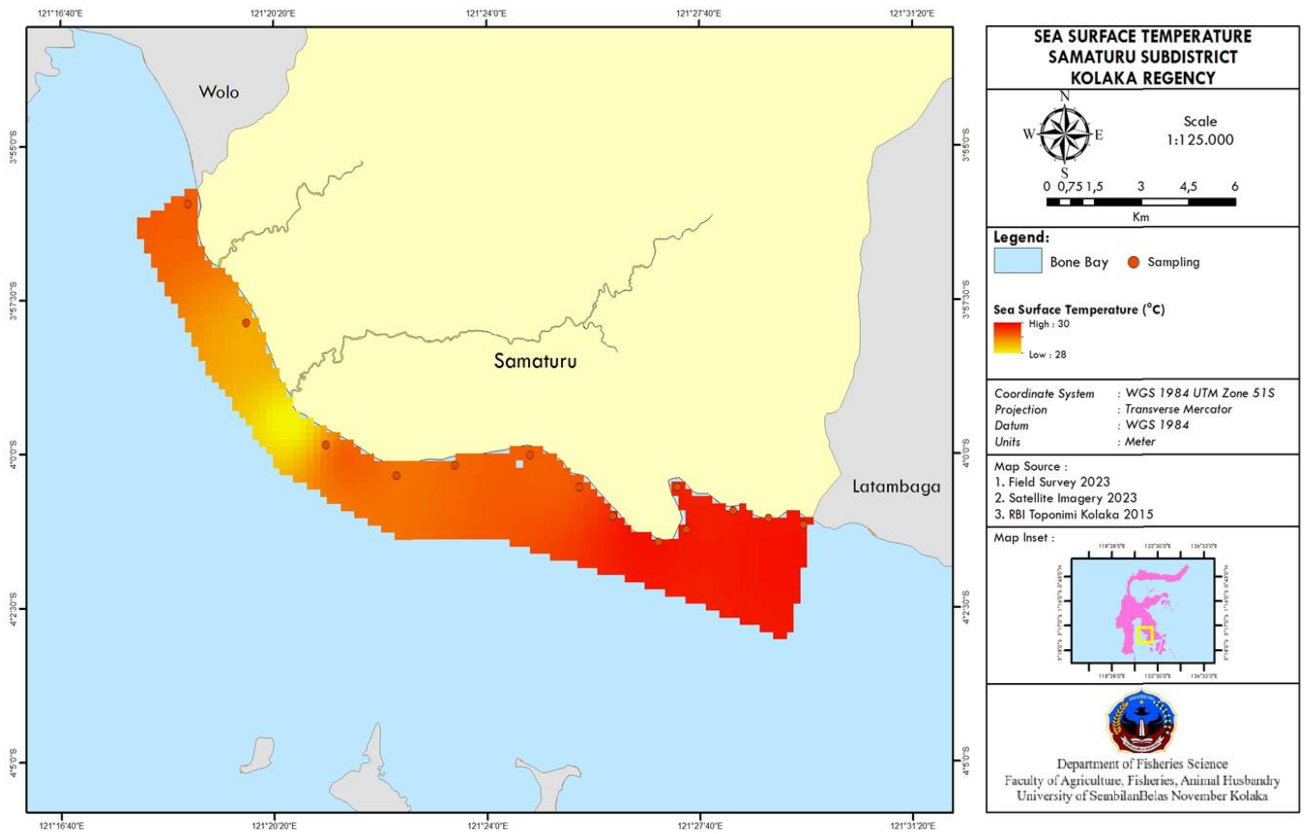

Figure 6. Distribution map of temperature in Samaturu waters, Kolaka District, Southeast Sulawesi Province, Indonesia

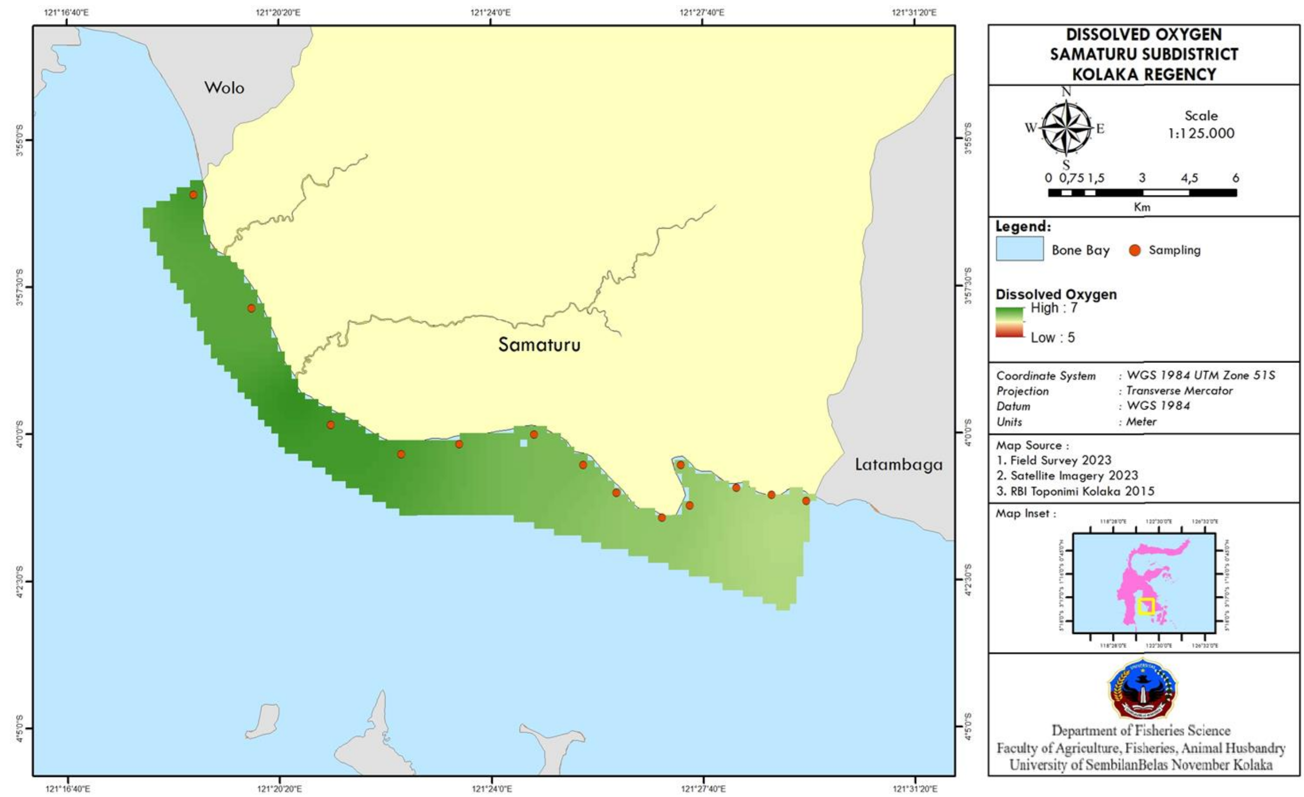

Figure 7. Distribution map of dissolved oxygen in Samaturu waters, Kolaka District, Southeast Sulawesi Province, Indonesia

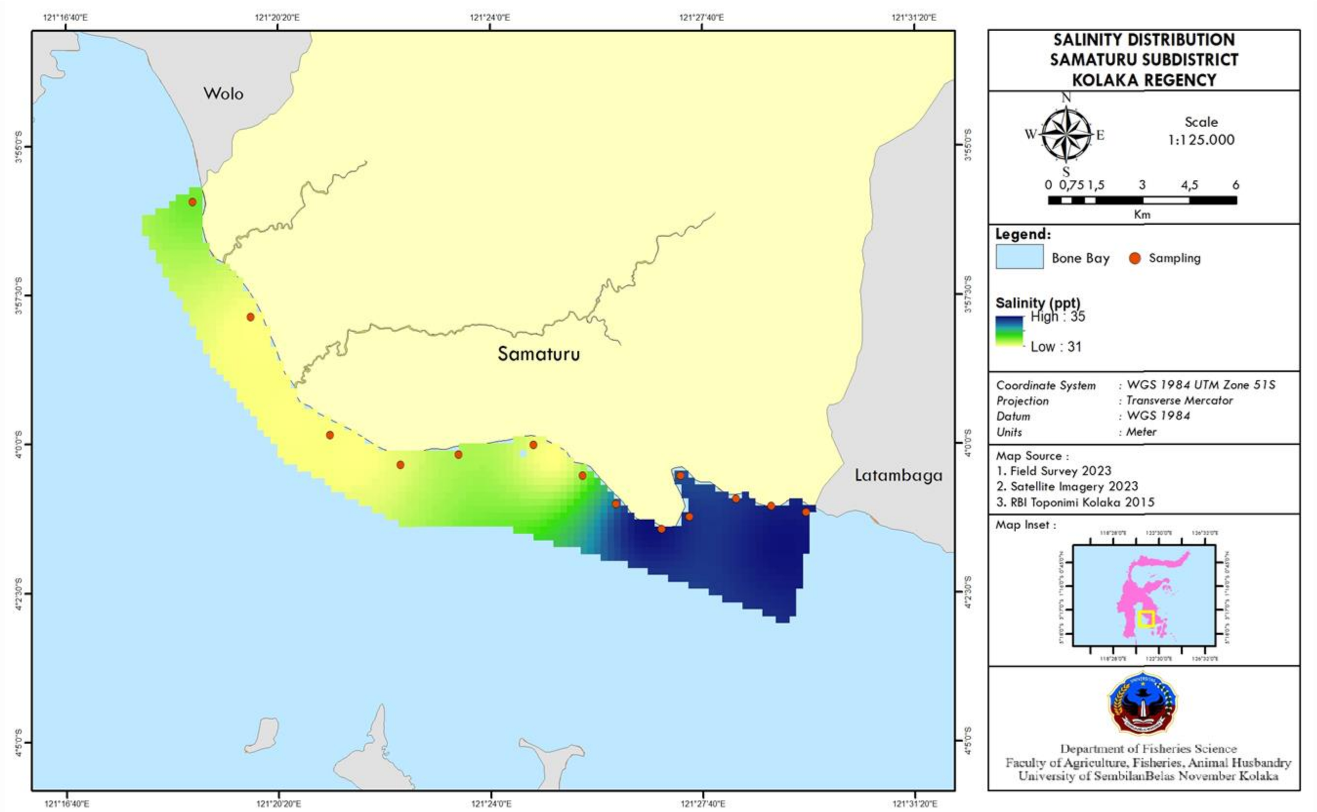

Figure 8. Distribution map of salinity at Samataru waters, Kolaka District, Southeast Sulawesi Province, Indonesia

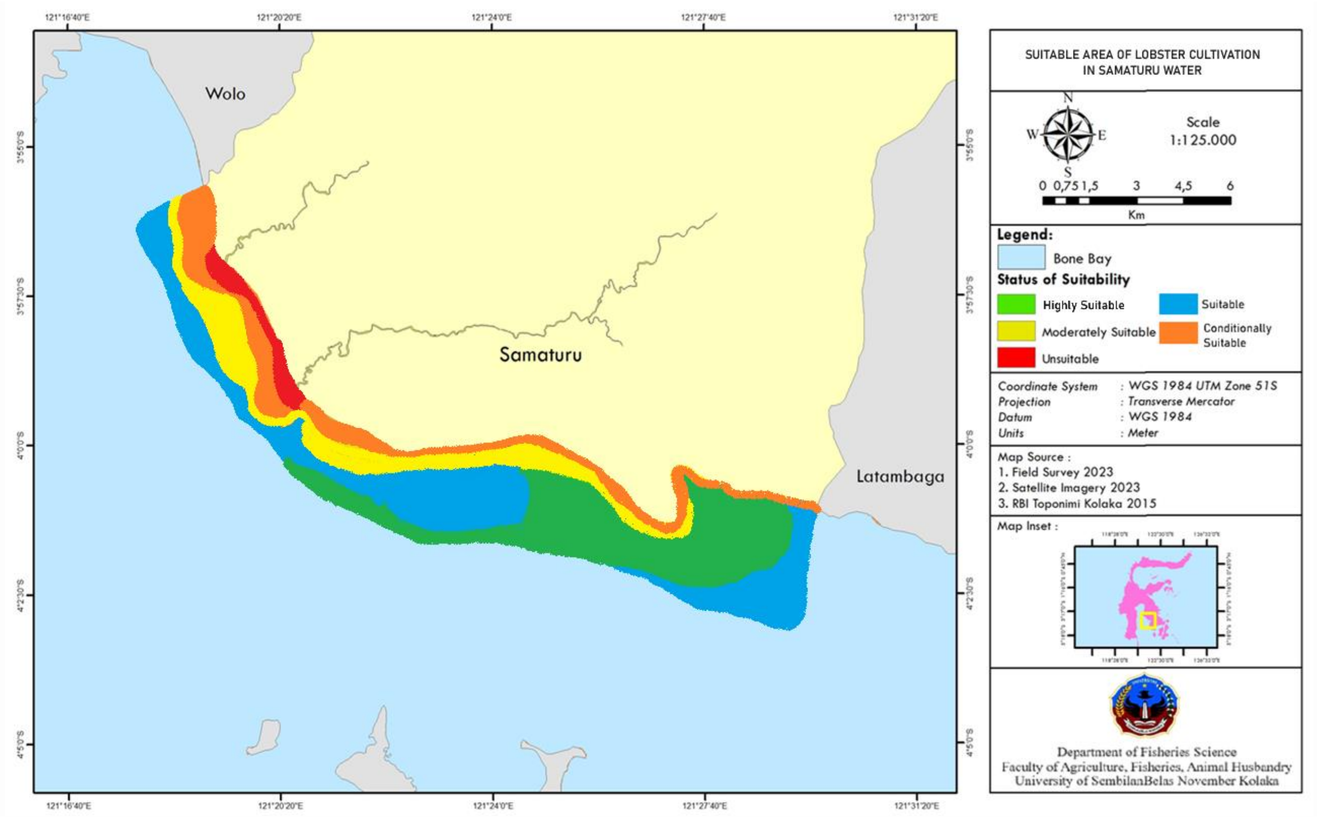

Figure 9. Map of the suitability of aquatic for the floating net cage at Samaturu waters, Kolaka District, Southeast Sulawesi Province, Indonesia

Based on the results of the research, it was obtained that there was one parameter that did not meet the requirements for the location of lobster cultivation with a floating net cage system (KJA), namely the protection parameter. However, there is an island outside the coast; the distance is too far, so the influence on protection is very small. Meanwhile, other parameters are quite supportive and meet the requirements. The total area suitable for lobster cultivation sites with a floating net cage system (KJA) is 6,179 (74.22%), are remaining area for conditionally suitable area is 1,648 ha (19.80%), and the unsuitable area is 498 ha (5.98%). Thus, it can be concluded that the location of Samaturu waters is quite potential for lobster cultivation with a floating net cage system (KJA).

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