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THE CATCH OF MACKEREL (*Euthynnus affinis)* IN RELATION TO OCEANOGRAPHIC CONDITIONS IN BULUKUMBA WATERS, FLORES SEA

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ABSTRACT

This study aims to describe the relationship between mackerel (Euthynnus affinis) catch and oceanographic conditions in the Flores Sea. This research was conducted from September to December 2020 in the waters of Bulukumba, Flores Sea. This research uses two methods: collecting primary data on tuna catches and geographic points; measuring parameters of Sea Surface Temperature (SST), chlorophyll-a, and salinity; and collecting secondary data in the form of satellite imagery of Sea Surface Temperature (SST) and chlorophyll-a and salinity obtained from several sites. Data analysis was carried out using multiple regression analysis and spatial analyst techniques. The results showed significant effects of SST parameters, chlorophyll-a, and salinity on tuna catch ($p < 0.1$).

Keywords: Tuna fish, Flores Sea waters, oceanography, purse seine.

INTRODUCTION

The Fisheries Management Area of the Republic of Indonesia 713 (WPP–RI 713) is a water area covering the Pacific Ocean, Makassar Strait, Bone Bay, and Flores Sea. WPPNRI 713 includes waters rich in potential fish resources. It is an important fishing area in Indonesia, especially for small pelagic, large pelagic, demersal, and reef fish for consumption (Koeshendrajana, 2019). Large pelagic fish resources, such as skipjack and tuna stocks, are economically important and have the potential for development. The waters of the Flores Sea are one of the three best fishing areas besides the Makassar Strait and the Gulf (Mallawa et al., 2014).

Oceanographic conditions strongly influence fish adaptation and behavior, and each fish species has a specific temperature tolerance range for survival. The distribution of fish in the waters is closely related to the oceanographic conditions there. Laevastu & Hayes (1981) stated that temperature and salinity are important physical parameters in studying marine life; changes in these two factors will affect the state of organisms in the water. According to Gaol & Sadhotomo (2007), the distribution and abundance of biological resources in waters are influenced by conditions and variations in oceanographic parameters. Therefore, complete and accurate information about the oceanographic character of a water

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body is very useful for understanding its relationship to the distribution and abundance of fish resources (Cahya et al., 2016).

MATERIAL AND METHOD

Research Location and Time

This research was carried out from September to December 2020, which took place in the waters of Bulukumba, Flores Sea

Data Collection

The data collection method used in this study is a survey, with datasets comprising primary and secondary data. Primary data were collected by following fishing operations using a purse seine to collect coordinate points for fishing and catches in the Flores Sea, yielding as many as 45 catch points. Secondary data were obtained from several sites in the form of satellite imagery of sea surface temperature, salinity, and chlorophyll-a. One computer unit, as a supporting device, is equipped with spatial data processing software to process, analyze, and present data.

Data Analysis

Primary data obtained in the next study were analyzed with secondary data. To achieve the research objectives with the following analysis.

Multiple Linear Regression Analysis

In this study, regression analysis was used. This analysis is used because it can show or determine the independent variables that have a dominant influence on the dependent variable. The multiple linear regression equation is as follows.

$$Y = a + b1X1 + b2X2 + \ldots + bnXn \quad (1)$$

Analysis (F Test)

This test was conducted to assess the combined effect of the independent variables on the dependent variable. When conducting the F test, it suffices to focus on the significance values in the ANOVA output table. If the value of sig <0.1, then the hypothesis is accepted, meaning that the independent variable affects the dependent variable. Conversely, if the value of sig > 0.1, then the hypothesis is rejected, meaning that the independent variable does not affect the dependent variable, as shown in the following equation.

$$F = r^2 / k \, (1 - r^2) / (n - k - 1) \quad (2)$$

Analysis (t-test)

This test was conducted to test the effect of each independent variable on the dependent variable. In conducting the T-test, it can be seen from the table of output coefficients by looking at the significant column in each t. If the value of sig < 0.1, then the hypothesis is accepted, meaning that the independent variable affects the dependent variable. Conversely, if the value of sig > 0.1, then the hypothesis is rejected, meaning that the independent variable does not affect the dependent variable, as shown in the following equation.

$$t = r\sqrt{n-2} / \sqrt{1-r^2} \quad (3)$$

Spatial Analyst Technique

The relationship between oceanographic conditions and the distribution of pelagic fish was assessed using the spatial analyst technique. Oceanographic conditions of the waters (sea surface temperature, chlorophyll-a, and salinity) obtained from satellite image data were processed and extracted using the ArcMap application. Then the data on pelagic fish catches during the study were visualized using GIS (Geographic Information Systems) techniques based on fishing points in the waters of the Flores Sea.

The process of processing data with spatial analyst techniques begins with downloading satellite imagery from the data provider's website. Furthermore, data cropping is carried out according to the coordinates of the Flores Sea waters. Then, the visualization is done by interpolating the data using the IDW (Inverse Distance Weighting) method. The next stage is to overlay the fishing point so that the oceanographic parameters at the capture point can be known.

RESULTS AND DISCUSSION

Composition of Catch Types

In this study, several types of catch were caught on the purse seine during 45 fishing trips. The composition of the catch type can be seen in Table 1.

Table 1 shows that 8 types of fish are predominantly caught with the Purse Seine. The most caught type of fish was tuna, with as many as 3481 catches, while the least caught type of fish was Lemadang fish, with as few as 9 catches.

Table 1. Table of Catch Composition for September-December 2020

No	Fish type	Quantity (tail)	Composition (%)
1	Mackerel	3481	53%
2	Tuna	1403	22%
3	Tenggiri	129	2%
4	skipjack	389	6%
5	Cenndro	308	5%
6	Pogo-pogo	76	1%
7	Lemadang	9	0%
8	Kio-kio	705	11%
	Total	6.500	100%

In Figure 1 below, the composition of the purse seine catches from the study for 4 months (September-December 2020) is shown. The most common type of catch was tuna, with a total catch of 3841 fish (53%), and the smallest was Mackerel. Lemadang fish have as many as 9 tails (0%).

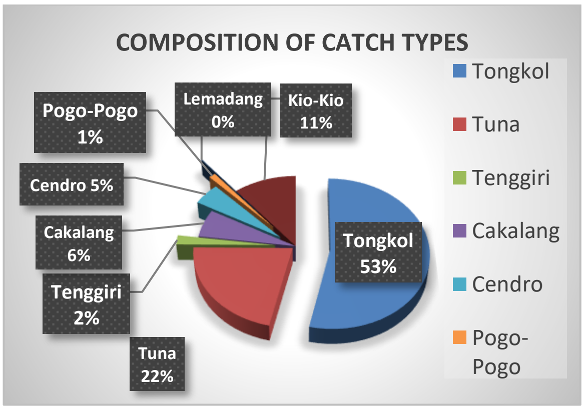

Figure 1. Composition of catch types

Scale :

Sample location

The relationship between the catch of tuna pelagic fish with oceanographic conditions in the waters of Bulukumba, Flores Sea

Sea Surface Temperature (SST)

The distribution of sea surface temperatures in the Flores Sea in September 2020 (Figure 2) ranged from 26.657-32.605°C. The largest catch in September was 192 fish at a temperature of 27.513°C, and the smallest catch was 44 fish at a temperature of 27.401°C. The relationship between catches and sea surface temperature in September is in the temperature distribution between 27.370-27.513°C.

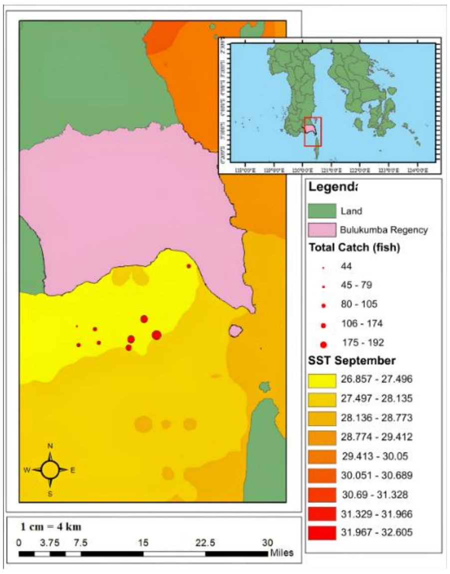

Figure 2. Map of Sea Surface Temperature Distribution (September 2020)

The distribution of sea surface temperatures in the Flores Sea in October 2020 (Figure 3) is in the range of 26.857-32.605˚C. The largest catch in October was 192 fish at a temperature of 28.794˚C, and the smallest catch was 79 fish at a temperature of 28.798˚C. The relationship between catch and sea surface temperature in October is in the temperature distribution between 28.472-28.823˚C.

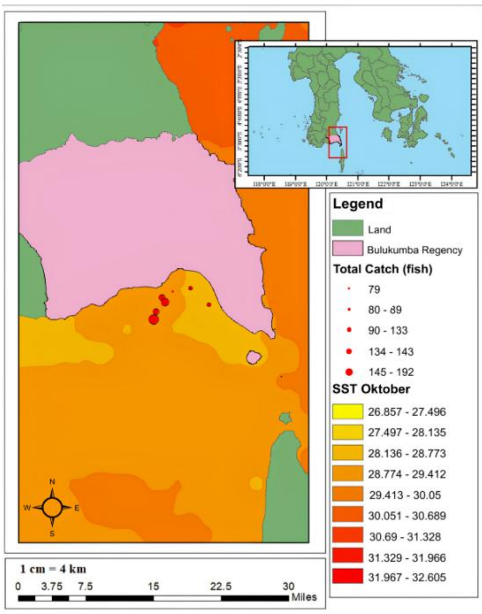

Figure 3. Map of Sea Surface Temperature Distribution (October 2020)

The distribution of sea surface temperatures in the Flores Sea in November 2020 (Figure 4) ranged from 26.857-32.605°C. The largest catch in November was 177 fish at 29.587°C, and the smallest was 58 fish at 29.596°C. The relationship between catches and sea surface temperature in November is at a temperature distribution of 29.587-29.706°C.

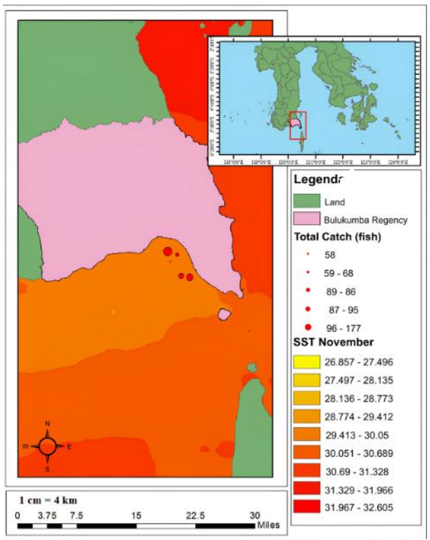

Figure 4. Map of Sea Surface Temperature Distribution (November 2020)

The distribution of sea surface temperatures in the Flores Sea in December 2020 (Figure 5) ranges from 26-857-32.605°C. The largest catch in December was 280 fish at 30.541°C, and the smallest was 58 fish at 30.831°C. The relationship between catches and sea surface temperature in December is in the temperature distribution between 30.521-30,839°C.

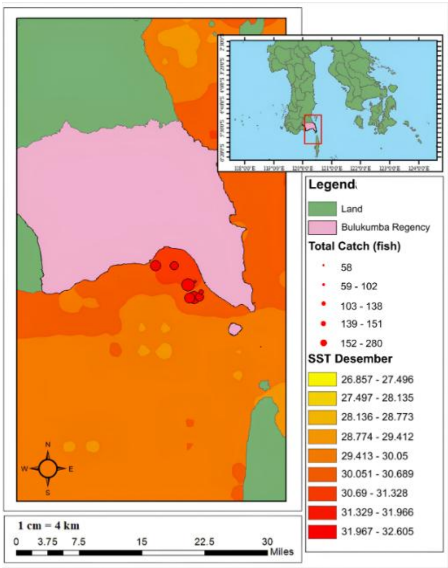

Figure 5. Map of Sea Surface Temperature Distribution (Desember 2020)

Chlorophyll-a

The distribution of chlorophyll-a in September 2020 in the Flores Sea (Figure 6) ranged from 0.124-1.56 mg/m3. The largest catch in September was 192 fish at a chlorophyll-a content of 0.520 mg/m3, and the smallest catch was 44 fish at a chlorophyll-a content of 1.244 mg/m3. The relationship between catch and chlorophyll-a in September ranged from 0.520-1.244 mg/m3.

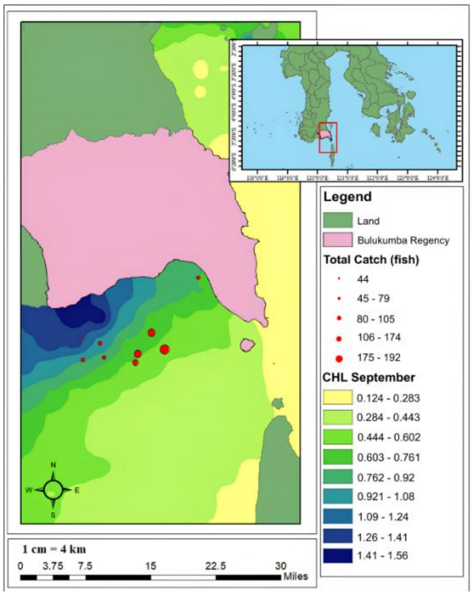

Figure 6. Map of Chlorophyll-a distribution (September 2020)

The distribution of chlorophyll-a in October 2020 in the Flores Sea (Figure 7) ranged from 0.142-1.57 mg/m^3. The largest catch in October was 192 fish at a chlorophyll-a content of 0.635 mg/m^3, and the smallest catch was 79 fish at a chlorophyll-a content of 0.554 mg/m^3. The relationship between catch and chlorophyll-a in October ranged from 0.467-0.664 mg/m^3.

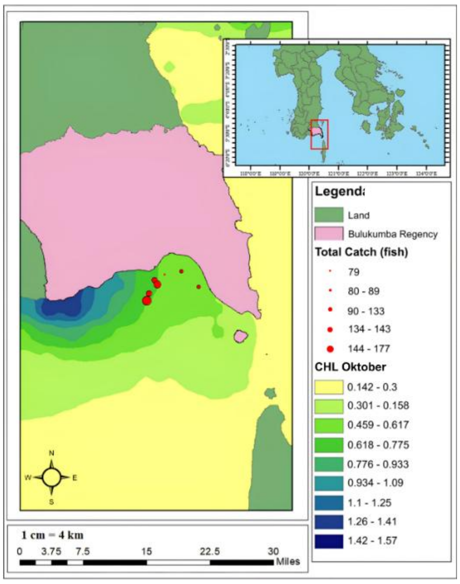

Figure 7. Chlorophyll-a distribution map (October 2020)

The distribution of chlorophyll-a in November in the Flores Sea (Figure 8) ranged from 0.09-1.54 mg/m^3. The largest catch in November was 177 fish with a chlorophyll-a content of 0.466 mg/m^{3,} and the smallest catch was 58 fish at a chlorophyll-a content of 0.457 mg/m^3. The relationship between catch and chlorophyll-a in November ranged from 0.446-0.455 mg/m^3.

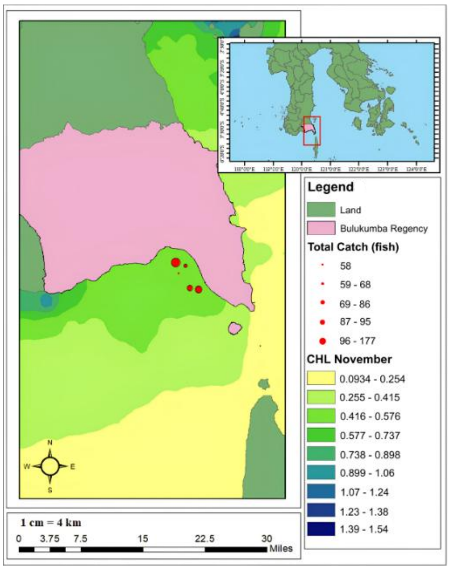

Figure 8. Map of Chlorophyll-a distribution (November 2020)

The distribution of chlorophyll-a in December 2020 in the Flores Sea (Figure 9) ranged from 0.119-1.52 mg/m^3. The biggest catch in December was 280 fish at 0.595 mg/m3 chlorophyll-a content, and the smallest catch was 58 fish at 0.693 mg/m^3 chlorophyll-a content. As for the relationship between catch and chlorophyll-a in September, the range of chlorophyll content was 0.693-0.772 mg/m^3.

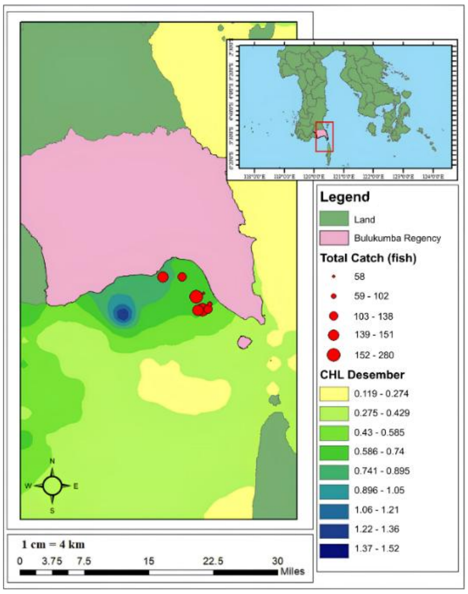

Figure 9. Chlorophyll-a Distribution Map (Desember 2020)

Salinity

Salinity in September 2020 in the Flores Sea (Figure 10) ranged from 32.485 to 34,699 ppt. The largest catch in September was 192 fish at a salinity of 34.358 ppt, and the smallest catch was 44 fish at a salinity of 34.317 ppt. The relationship between catch and salinity in September ranged from 34.294 to 34,358 ppt.

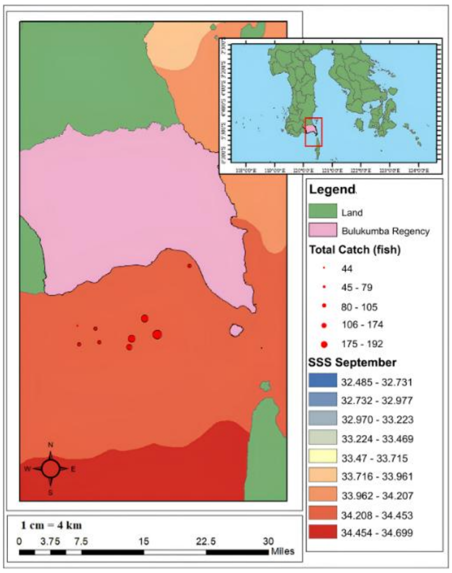

Figure 10. Map of salinity distribution (September 2020)

The distribution of salinity in October 2020 in the Flores Sea (Figure 11) ranged from 32.485 to 34,699 ppt. The largest catch in October was 192 fish at a salinity of 34.453 ppt, and the smallest catch was 79 fish at a salinity of 34.444 ppt. The relationship between catch and salinity in October ranged from 34,441 to 34,453 ppt.

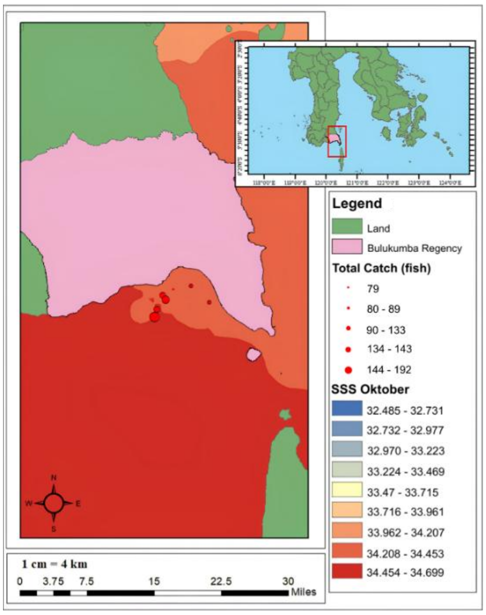

Figure 11. Salinity distribution map (October 2020)

The distribution of salinity in November 2020 in the Flores Sea (figure 12) ranged from 32.485 to 34,699 ppt. The largest catch in November was 177 fish at a salinity of 34,445 ppt, and the smallest catch was 58 fish at a salinity of 33,439 ppt. The relationship between catch and salinity in November ranged from 34,433-34,446 ppt.

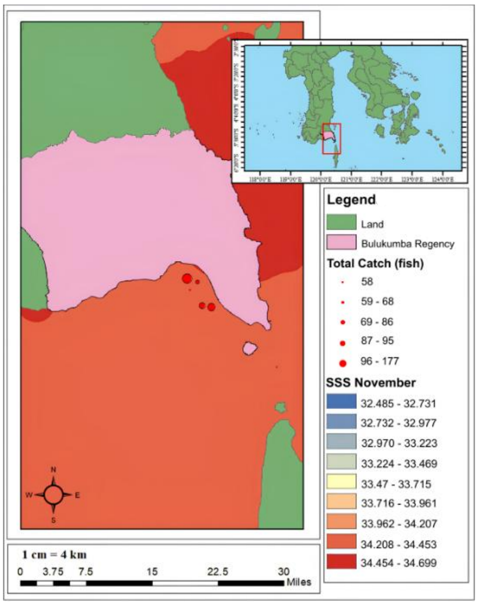

Figure 12. Map of salinity distribution (November 2020)

The distribution of salinity in December 2020 in the Flores Sea (figure 13) ranged from 32.485-34,699 ppt. The largest catch in December was 280 fish at a salinity of 33.604 ppt, and the smallest catch was 58 fish at a salinity of 33.621 ppt. The relationship between catch and salinity in December ranged from 33,604 to 33.634 ppt.

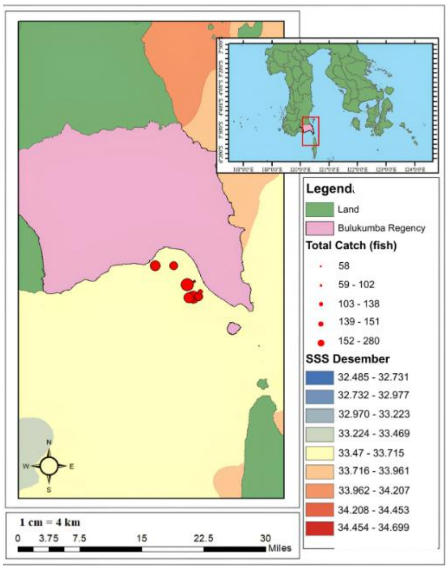

Figure 13. Map of salinity distribution (December 2020)

Graph of the Relationship of Catches to Oceanographic Parameters

Sea Surface Temperature

Sea surface temperature (SST) is an important parameter for studying seasonal variations, climatic phenomena such as El Niño, and the Indian Ocean Dipole, which, in turn, can better inform understanding of climate change (Cahyarini, 2011). The bar chart in Figure 14 shows that the temperature of tuna in the Flores Sea ranges from 27.4 to 31.2 °C at the sea surface. The highest catch of 1248 fish was in the sea surface temperature range of 28-29.9°C, and the lowest catch of 1048 fish was in the sea surface temperature range of 27.4-28.6°C.

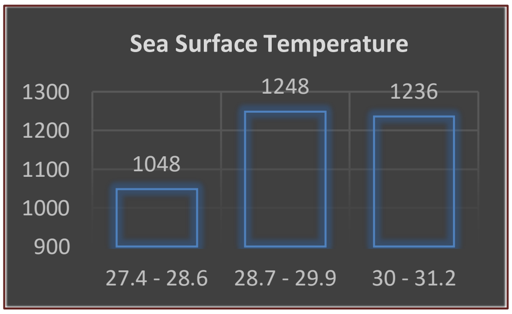

Figure 14. Bar chart of the relationship between mackerel catches and sea surface temperature.

Chlorophyll-a

The results did not show that the abundance of chlorophyll-a content was directly proportional to the fish catch. According to Putri et al. (2018), this was due to the fact that chlorophyll-a takes time to process until it becomes food for pelagic fish. According to Girsang (2008), explaining that the concentration of chlorophyll in the waters is not always directly proportional to the number of fish in the waters. There is a time when the concentration of chlorophyll is first eaten by structures of herbivorous organisms such as zooplankton or small crustaceans (juvenile) and then eaten by the trophic level above.

The bar chart in Figure 15 can be explained that the content of chlorophyll-a for tuna in the Flores Sea is in the range of chlorophyll-a content of 0.4-1.5 mg/m^3. The highest catch of 2917 fish was in the range of chlorophyll content of 0.4-0.7 mg/m^3 and the lowest catch of 44 fish was in the range of chlorophyll content of 1.2-1.5 mg/m^3.

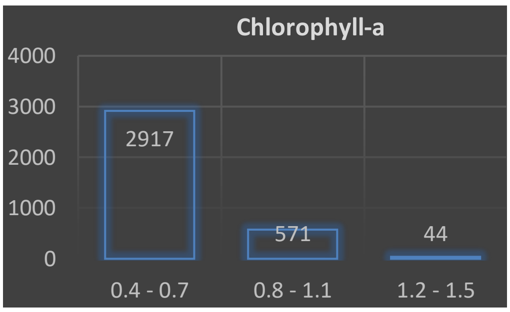

Figure 15. Bar chart of the relationship between mackerel catches and chlorophyll-a

Salinity

The bar chart in Figure 16 can be explained that the salinity for tuna in the Flores Sea is in the salinity range of 33.6-34.7 ppt. the highest catch of 2229 fish was in the salinity range of 34.4-34.7 ppt and the lowest catch of 67 fish was in the salinity range of 34-34.3 ppt.

This result is supported by research by Rizkawati (2009) in Ibrahim (2018) which states that tuna spreads in the salinity range of 32.21-34.40 ppt. Ibrahim's research results (2018) also state that the average value of SSS (Sea Surface Salinity) ranges from 34.0-43.3 ppt. It can be said that salinity from September to December ranged from 33.6 to 34.4 ppt, which was still within the tolerance range for tuna. The salinity of the waters favored by tuna is around 32-35 ppt (Nontji, 1987). Mujib's research (2013) also stated that the field data obtained showed the measured salinity parameters were optimal and adequate for the habitat of tuna, namely: average salinity of 33 ppt.

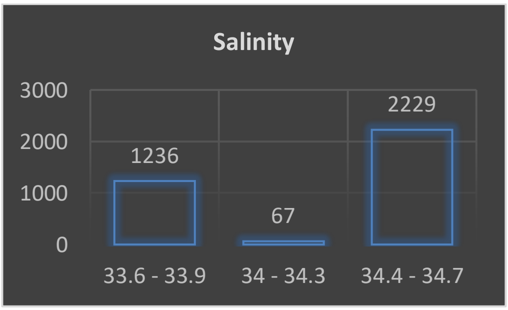

Figure 16. Bar chart of the relationship between mackerel catches and salinity.

Effect of Oceanographic Factors on Mackerel Catches

F-Test Analysis

In accordance with the results of the F-test calculations carried out with the help of the SPSS 16 program (Table 2), a significance value of 0.098 <0.1 was obtained. Because the value (sig <= 0.098 < 0.1) means that the independent variables (chlorophyll-a, salinity, and sea surface temperature) simultaneously affect the dependent variable (catch).

Table 2. Analysis of Multiple Linear Regression Correlation F Test

Model	Df	Mean Square	F	Sig.
Regression	3	6651.927	2.336	.098[a]
Residual	25	2847.479		
Total	28			

T-test analysis

Based on the results of the t-test (Table 3), from each independent variable, it can be seen that:

a. The effect of chlorophyll-a (X1) on the number of catches (Y) obtained a significant value of 0.082 <0.1, then the hypothesis is accepted, which means that there is an effect of chlorophyll-a (X1) on the number of catches (Y) purse seine.
b. The effect of salinity (X2) on the number of catches (Y) obtained a significant value of 0.060 <0.1, then the hypothesis is accepted, which means that there is an effect of salinity (X2) on the number of catches (Y) purse seine

c. The effect of sea surface temperature (X3) on the number of catches obtained a significant value of 0.350 > 0.1, so the hypothesis is rejected, which means that there is no effect of sea surface temperature (X3) on the number of purse seine catches (Y).

Table 3. Analysis of Multiple Linear Regression, Correlation, and t-test

Model	Unstandardized Coefficients		T	Sig.
	B	Std. Error		
(Constant)	3968.282	2099.790	1.890	.070
X1 (Chl-a)	-130.488	72.092	-1.810	.082
X2 (Salinity)	-98.134	49.871	-1.968	.060
X3 (SST)	-14.036	14.725	-.953	.350

CONCLUSION

Based on the results of the study, it can be concluded that the relationship between tuna catches and oceanographic conditions in the waters of Bulukumba, Flores Sea, for the parameters measured using the F test, the results show that oceanographic parameters influence the catch, and the t-test results in chlorophyll-a and salinity having an effect. on the distribution of catches, while the sea surface temperature parameter does not affect the distribution of catches.

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