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ESTIMATION OF SMALL PELAGIC FISHING GROUNDS *SELAR CRUMENOPHTHALMUS* IN THE MAKASSAR STRAIT, INDONESIA

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ABSTRACT

The waters of the Makassar Strait are known as part of the Indonesian throughflow (Arlindo), which influences the dynamics of the waters in the distribution patterns of temperature, salinity, and chlorophyll-a, which are oriented towards the occurrence of upwelling phenomena creating ideal conditions for the development of phytoplankton which are the basis of the marine food chain. This study aims to determine the determination of the potential for small pelagic fishing grounds. The study area taken is the Makassar Strait by mapping the conditions of parameters and areas that have the potential for fishing in August 2024 to July 2025 using interpolation and probability models. This study shows that the lowest sea surface temperature (SST) parameters occur in the east season and the highest occur in the west season with an average value of 30.15°C, this is influenced by the El Nino event in that season which reduces rainfall. Chlorophyll-a concentrations increase the highest in the west and east seasons with values of 0.36 mg/m^3 and 0.32 mg/m^3 and in the transition season II decreases. Similarly, the lowest salinity concentrations occurred during the west monsoon, with an average value of 32.94 ppt, and the highest during the east monsoon. Potential fishing grounds show upwelling occurring across a very broad area of potential fishing potential. Chlorophyll-a and salinity significantly affected catches, while sea surface temperature had no significant effect.

Keywords: Upwelling, El Nino, Chlorophyll-a, Sea surface temperature, *Selar crumenophthalmus*

1 INTRODUCTION

The Makassar Strait is a body of water typically flanked by two landmasses, Sulawesi and Kalimantan, with distinct characteristics. This naturally affects the oceanographic parameters in the Makassar Strait. Lack of adequate information regarding the distribution of fishing grounds can lead to overfishing. If this problem is left untreated, it will continue for a long time and cause disruption to the balance of the aquatic ecosystem due to excessive exploitation.

Several methods can be used to select fishing grounds, including utilizing oceanographic research data and meteorological conditions to understand fish distribution. Furthermore, data on past fishing operations can be used to identify potential fishing seasons and areas. Efforts to obtain information on the resource potential of coastal and marine areas can be achieved by utilizing remote sensing technology and Geographic Information Systems (GIS) [1].

Information regarding the presence of fish is a key factor in the successful development of capture fisheries businesses [2]. The use of this technology allows us to determine the distribution of fishing grounds based on several parameters observed in oceanographic conditions, such as salinity, sea surface temperature (SST), and chlorophyll-a. The condition of fish in a body of water is closely related to oceanographic parameters, one of which is temperature. Temperature is one of the oceanographic parameters that has a very dominant influence, particularly on the life of fish species and marine resources in general.

According to [3] stated that the temperature and salinity in the Makassar Strait are influenced by Arlindo, a depth of 13 to 68 m with a temperature characteristic of 25.0 to 29.0°C and a salinity of 28 to 35%, between a depth of 69 to 450 m with a temperature characteristic of 8.0 to 24.0°C and a salinity of 34.4 to 36.4%, and between a depth of 111 to 860 m with a temperature characteristic of 6.0 to 22.0°C, and a salinity of 34.5 - 35.8%. Changes in water temperature will affect the biological and ecological processes that occur in the water which will ultimately affect the biological community in it.

Chlorophyll-a content, which is used as a measure of the amount of phytoplankton in a given body of water and can be used as an indicator of aquatic productivity, is distributed throughout the ocean geographically and based on water depth. This is another oceanographic component that influences the presence of fish populations. Differences in sunlight intensity and nutrient concentrations in the water cause these variations [4]. Base on the above study, research was conducted to estimate the location of the purse seine in the Makassar Strait.

2 MATERIAL AND METHODS

The research was conducted for 3 months from April to June 2025 at the Untia Fisheries Port (PP), Makassar City, South Sulawesi, to obtain fishing data in the form of fishing time, fishing position and fish caught.

Figure 1: Research Location

2.1 Method of collecting data

Primary catch data were obtained from May to July 2025. The data used in this study were oceanographic data and catch data in the form of catch time, catch point and the number of small pelagic fish landed at the Untia Fisheries Port (PP) based on a case study on a purse seine vessel. The data required for this study include SST, chlorophyll-a, salinity, fishing ground locations, and fish catches. Primary data were obtained through direct observation, involving fishing activities and recording fishing tracks, as well as from fishermen's GPS records, which were then presented in a fishing operations journal.

2.1.1 Secondary data

Secondary data was collected by downloading satellite imagery data on chlorophyll-a, SST, and salinity. The data from the satellite imagery is pre-processed and then modeled. The tools and materials used for secondary data include: Software providers of satellite image data used for study purposes such as marine image data in oceanographic aspects, and Software Geographic Information Systems (GIS) are used to process image data, then digitize or edit it and turn it into a map.

2.2 Data Processing Method

The following are the data processing methods used in this research for each research objective:

Conducting data visualization analysis is as follows:

- Collecting the necessary data, the data needed in this study is divided into oceanographic data obtained through the website https://data.marine.copernicus.eu in the form of position, time and weight of small pelagic fish catches.
- Oceanographic data was obtained using the ArcGIS 10.8 application to layout the data and enter fishing ground points.
- Classification of oceanographic parameters, was carried out to see the results of the values obtained from the parameters used, namely Sea Surface Temperature (SST), salinity and chlorophyll-a.

After obtaining the value based on each parameter, data analysis was carried out using multiple linear regression analysis. In addition, data analysis was carried out to determine the estimated potential location of fishing grounds by assessing several indicators of fishing ground locations.

2.2.1 Processing of Sea Surface Temperature (SST) data and Chlorophyll-a data

Processing of SST data and Chlorophyll-a data is carried out as follows:

- Data collection and processing
- Image pre-processing, with Aqua Modis level 3 image data download in Nasa Ocean Color; Result data Cropping Area extracted; Input extracted data and NaN correction is performed and Input NaN correction data and interpolation is performed;
- Combine SST and Chlorophyll-a with fishing ground points

2.2.2 Salinity data processing

The processing of current data is carried out as follows:

- Data collection and processing.
- Pre-processing of images with Downloading current data in Marine Copernicus in the form of salinity data; Cutting or Cropping area, is the process of cutting the image and leaving the study area; Data Cropping converted into points, each point has a value of the current wave.

2.3 Data Analisys Methods

2.3.1 Multiple Linear Regression Analysis

Efforts to see the influence of several parameters used, namely SST, salinity and chlorophyll-a, on catch results. *Selar crumenophthalmus*. Then, multiple linear regression analysis is carried out. The regression analysis will obtain several values, namely the coefficient of determination (R^2), F_{count} and t_{count}. The regression equation used with the dependent variables SST, salinity and chlorophyll-a is formulated as follows [5]:

$$Y = a + b_1X_1 + b_2X_2 + b_3X_3$$

Information:

- Y = CatchSelar crumenophthalmus
- A = Intercept coefficient
- X_1 = Sea Surface Temperature (˚C)
- b_1 = Regression coefficient of temperature parameters
- X_2 = Salinity (ppt)
- b_2 = Regression coefficient of salinity parameters
- X_3 = Chlorophyll-a (mg/m^3)
- b_3 = Regression coefficient of chlorophyll-a parameters

The coefficient of determination (R^2) value was obtained to see the diversity between the independent variables, namely SST, salinity and chlorophyll-a, against the dependent variable in the form of small pelagic fish catches [6]. The determination of the value of the determinant coefficient can be formulated as follows:

$$R^2 = \frac{SSR}{TSS}$$

Information:

SSR = Sum of squares of regression

TSS = Total sum of squares

R^2 = Coefficient of determination

If the value is obtained from the table significance f_{count} smaller value than the value of f_{table} at a 95% confidence level it means it is real and if f_{count} greater than f_{table} at a 95% confidence level not true [6]. Determination of the value of f_{count} can be formulated as follows:

$$F_{count} = \frac{R^2/(k-1)}{(1-R^2)/(n-k)}$$

Information:

R^2 = Coefficient of determinant

k = Number of variables including intercept

n = Number of observations

T_{value} countused in decision making based on significance or probability values. If the probability value > α (0.05) then oceanographic parameters such as SST, salinity and chlorophyll-a do not significantly influence the catch, while the probability value < α (0.05) then the oceanographic parameters significantly influence the catch. The t_{count} can be found by using the following formula:

$$t_{count} = \frac{bi - \beta i}{Sb_i}$$

Information:

Bi = i regression coefficient

Sbi= Standard deviation of the i regression coefficient

βi = Hypothesized i variable

2.4 Estimated Fishing grounds

Several oceanographic parameters, such as SST, salinity, chlorophyll-a, weather, and changes there in, will affect the life and growth of fish, such as feeding rate, metabolism, spawning, and other activities. This proves that changes in oceanographic parameters will affect the existence of fish [7].

2.5 Oceanographic Parameters

Assessment of the location of fishing grounds determines the presence and distribution of fish through several oceanographic parameter indicators, as can be seen in the following table [1].

Table 1: Assessment based on oceanographic parameters

No	Parameters	2 (Less potential)	4 (medium)	6 (Potential)
1	SST	<24 and >30°C	25 - 28°C	29 - 30°C
2	Salinity	<30 and >35 ppt	-	30 – 35 ppt
3	Chlorophyll-a	<0.1 mg/m^3	0.1 - 0.2mg/m^3	>0.2 mg/m^3

Source : [8]

Based on the oceanographic parameter assessment in Table 1, one of the oceanographic parameters, salinity, does not have a moderate value scale. This is because the optimal value scale for pelagic fish generally ranges from 30 to 33 ppt.

2.6 Assessment of fishing ground location indicators

The weight determination obtained in Table 1 will then be added up in Table 2. In this research, [9] the determination of the location of the fishing ground is carried out by grouping the weight values which are the sum of the existing indicators, including:

- If the combined weight value is in the highest range, then the fishing ground location can be categorized as a potential location.
- If the combined weight value is in the moderate range, then the fishing ground location can be categorized as a moderate location.
- If the combined weight value is in the low range, then the fishing ground location can be categorized as a location with less potential.

Table 2: Assessment of location indicators for fishing grounds

Fishing grounds Location Indicator			**Fishing grounds Location Category**
SST (°C)	Chlorophyll (mg/m^3)	Salinity (ppt)	
Optimal (n= 6)	Many (n= 6)	Many (n= 6)	Potential (n= 15 - 18)
Medium (n= 4)	Medium (n= 4)	-	Medium (n= 11 - 14)
No Opt (n= 2)	Few (n= 2)	Few (n= 2)	Less (n= 7 - 10)

*Note: n = Combined Weight

3 RESULTS AND DISCUSSION

Geographically, the Makassar Strait is known as part of the Indonesian Throughflow (*Arlindo*), which carries water masses from the Pacific Ocean to the Indian Ocean. This current influences the dynamics of the strait's waters, including the distribution patterns of temperature, salinity, and chlorophyll-a, which directly impact marine ecosystems and fisheries resources. Furthermore, the upwelling phenomenon that occurs in the Makassar Strait during the east monsoon increases water productivity by bringing nutrients from the lower layers to the surface, creating ideal conditions for the growth of phytoplankton, the foundation of the marine food chain.

Figure 2: Research Location

The Makassar Strait ecosystem supports high biodiversity, including populations of small pelagic fish such as *Selar crumenophthalmus*, mackerel, and spangled fish. The presence of these various species makes the FMARI 713 region one of Indonesia's important fisheries centers. According to [10], The Makassar Strait provides optimal habitat for small pelagic fish, mainly due to the dynamics of currents and upwelling which increase the availability of nutrients and plankton as the main food source.

[11] noted that the sustainability of fisheries in the Makassar Strait is highly dependent on proper management, including regulating fishing seasons and using environmentally friendly fishing gear. A thorough understanding of the interaction between environmental conditions and fish distribution is crucial for developing sustainable and adaptive fisheries management strategies that can maintain ecosystem balance and the well-being of coastal communities around the Makassar Strait.

3.1 Distribution of Sea Surface Temperature (SST)

Distribution of SST obtained through the website https://data.ocean.color.eu The results showed varying SST values in the Makassar Strait, after classification using ArcGIS 10.9 software. These variations can be seen based on each fishing season in one fishing year from August 2024 to July 2025, which determines the estimated fishing ground location.Selar crumenophthalmus. The SST distribution was digitized using an interpolation model with color gradation visualization. different according to the SST level. The color gradation used is blue to red, which indicates that the more intense the blue color, the lower the SST level, and the more intense the red color, the higher the SST level. SST in the Makassar Strait in August 2024 - July 2025 was in the range of 28.48 to 30.39°C.

The distribution of SST tends to be warm and its distribution is inconsistent from month to month. Monthly temperature changes are caused by currents, wind, water turbidity, and waves, commonly referred to as ocean dynamics [12]. The high and low levels of SST values in the Makassar Strait waters are related to the time pattern of SST movement, namely the west season, transition season l, east season, and transition season ll [13].

3.1.1 West Season

During the west monsoon, which lasts from December to February, the SST distribution is displayed using a color scheme that depicts different temperature ranges. High SST is indicated by red, while moderate temperatures are represented by orange, green, and light blue, indicating variations in the mean temperature levels. Conversely, low SST is indicated by dark blue. These color differences are caused by various meteorological factors that influence SST during the west monsoon, such as rainfall, evaporation, air temperature, humidity, wind speed, and solar radiation intensity. These factors interact and influence the dynamics of SST, which is then reflected in the color variations on the distribution map (Figure 3 - 6).

The results of the SST data analysis in the West season are interpolated data from December 2024 to February 2025. This year's West season is a different season from the previous year, where the SST which is usually the fishing season with the lowest average SST value compared to other fishing seasons in the late 2022 period with an average distribution of SST values of 29°C.

According to [14] The west monsoon, influenced by rain and higher winds, causes low sea level readings (SST) and also causes the east monsoon to blow westward, crossing the Pacific Ocean from the Australian continent to Asia. Rainfall levels are one factor contributing to low sea surface temperatures. The increased rainfall intensity lowers sea surface temperatures during this month. [15] This decline was caused by the El Niño phenomenon, which increased sea surface temperatures, resulting in drier conditions in the region. The previous year was influenced by La Niña, which tends to increase rainfall.

3.1.2 Transition Season I

Spatial analysis of SST distribution during the March to May period shows significant monthly thermal variations, represented by a color scale on the map. High temperatures are indicated by the red spectrum, while moderate temperatures are represented by the orange, green, and light blue spectrum, and low temperatures are depicted by the dark blue spectrum. These differences in sea surface temperature distribution each month are caused by the influence of meteorological parameters such as rainfall, evaporation rate, air temperature, atmospheric humidity, wind speed, and solar radiation intensity (Figure 3 - 6).

The results of the sea surface temperature data analysis during the Transitional Season I are the result of SST interpolation from March to May. This season is the fishing season with the highest SST distribution values, with a range of values from 29.95 to 30.65 °C. During the Transitional Season I, the SST distribution tends to be relatively warm due to the transition from the west to the east monsoon. The high sea surface temperature during this month is associated with the movement of wind direction and speed. This is in accordance with the statement [16] in the transition season, the distribution of SST in the Pacific Ocean experiences a relatively hot temperature change so that in this season there is a transition from the west season to the east season. Meanwhile, according to [17] The transitional season has lower rainfall and a weakening of the wind movement blowing on the sea surface, which causes solar radiation to be effective in heating the water mass on the surface, causing the sea surface temperature to rise.

3.1.3 East Season

During the East monsoon, which lasts from June to August, the SST distribution is displayed with a color scheme that depicts different temperature ranges. High SST is indicated by red, while moderate temperatures are represented by orange, green, and light blue, indicating variations in the moderate temperature levels. Conversely, low SST is indicated by dark blue. These color differences are caused by various meteorological factors that influence SST during the West monsoon, such as rainfall, evaporation, air temperature, humidity, wind speed, and solar radiation intensity. These factors interact and influence the dynamics of SST, which is then reflected in the color variations on the distribution map.

The results of the analysis of SST data during the east monsoon, which covers the months of June to August, show that the average SST is in the range of 28.21 to 28.65°C. Recent research indicates that this temperature range not only shows significant thermal stability, but also has a direct impact on regional weather and climate patterns. [18] This stability can be attributed to the El Niño and La Niña phenomena, which significantly affect SST as well as atmospheric circulation in the Pacific Ocean and influence global weather patterns. [19] This increase in SST is also correlated with increased phytoplankton activity, which plays an important role in the marine food chain and can trigger significant ecological changes in marine ecosystems [20].

3.1.4 Season of Transition II

Spatial analysis of SST distribution during the September-November period shows significant monthly thermal variations, represented by the color scale on the map. High temperatures are indicated by the red spectrum, while moderate temperatures are represented by the orange, green, and light blue spectrum, and low temperatures are depicted by the dark blue spectrum. These differences in SST distribution each month are caused by the influence of meteorological parameters such as rainfall, evaporation rate, air temperature, atmospheric humidity, wind speed, and solar radiation intensity. (Figure 3 - 6).

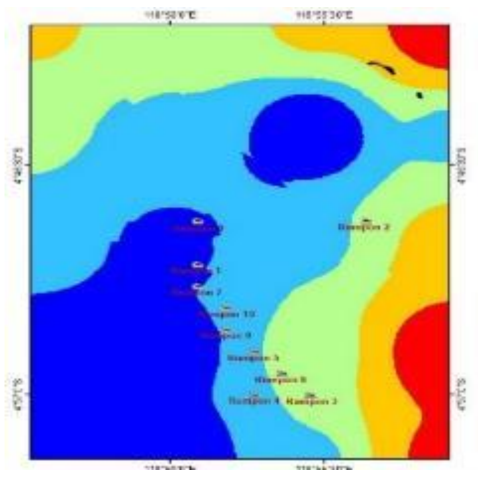


Figure 3: Sea Surface Temperature (SST) distribution during the West Monsoon.

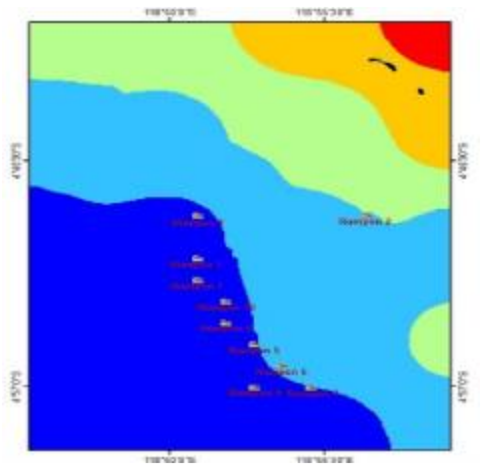


Figure 4: Distribution of SPL Transition Season I

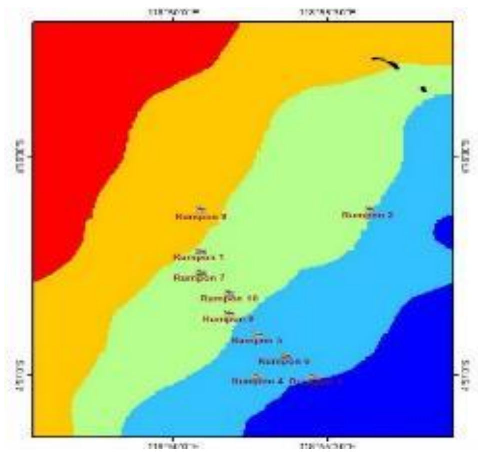


Figure 5: Sea Surface Temperature (SST) distribution during the East Monsoon.

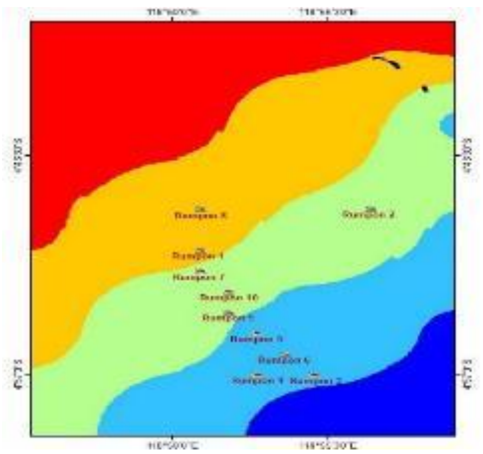


Figure 6: Distribution of SPL Transition Season II

Analysis of SST data during the second transitional season, spanning September to November, shows that the average SST ranged from 29.29 to 29.71°C. Recent research in Indonesia indicates that this temperature range indicates high thermal conditions and has a significant impact on marine ecosystems and local weather patterns. According to the study, [21] increased SST in Indonesian waters has the potential to increase the intensity of extreme weather, such as tropical storms, and impact rainfall variability in coastal areas.

The increasing SST in Indonesia's tropical waters also affects ocean current patterns and upwelling phenomena, which are important for increasing biological productivity and supporting the sustainability of marine ecosystems [22]. The second transitional season feels colder because there is a shift from the east to the west seasons at the end of the year. This is in accordance with research [23] that the fishing season has an impact on fish migration both vertically and horizontally, because there are influences regulated by changes in temperature and light intensity. SST continues to decrease during the East Season until the beginning of the Transition Season II due to the influence of the southeast monsoon winds which strengthen in intensity at the end of the East Season and the beginning of the transition season

II. This Southeast Monsoon wind will cause the Ekman current to head southwest away from the coast, causing water from cooler depths to rise to the surface and causing a decrease in SST or upwelling.

Based on the fishing season, SST plays a crucial role in determining the presence of fish, particularly small pelagic fish species whose habitat is at the sea surface. Small pelagic fish, such as *Selar crumenophthalmus*, generally prefer cooler SST conditions to regulate their body temperature and increase metabolic efficiency. Research by [24] shows that small pelagic fish prefer SST temperatures ranging from 25 to 28°C.

On the contrary [25] noted that small pelagic fish groups tend to avoid higher temperatures and prefer cooler waters to prevent thermal stress. Therefore, understanding the oceanographic conditions in the waters before installing fishing gear is crucial, as oceanographic conditions, including temperature, significantly influence fish survival. SST plays a key role in supporting the growth of phytoplankton, the primary food source for small pelagic fish, and directly influences fish physiology [26].

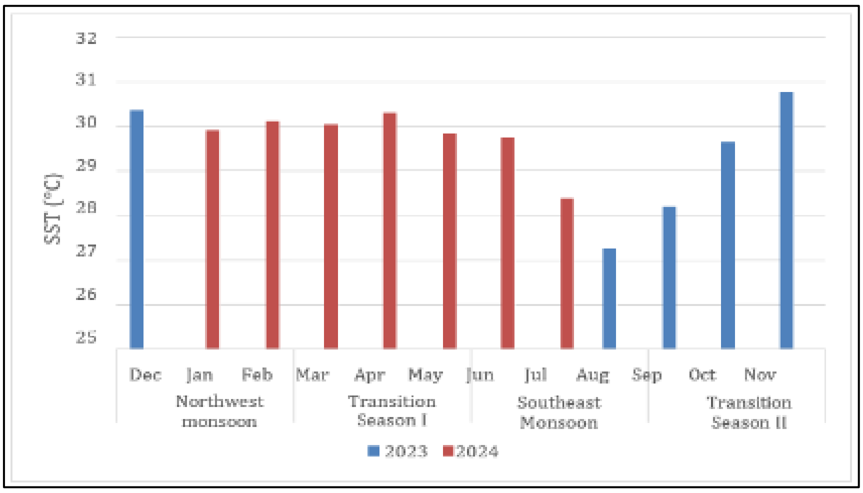


Figure 7: Average SST Distribution Graph

Based on the graph above, the distribution of SST values in the Makassar Strait shows quite significant variations each year, with a temperature range between 28 to 31°C. In the west monsoon, the highest average SST was recorded in December, reaching 30.35°C, while in the east monsoon, the lowest SST occurred in August, namely 27.26°C. Interestingly, although the west monsoon is usually characterized by high rainfall, in that year, the SST remained in a warm condition, which is inconsistent with the patterns of previous years.

According to [27] higher SST during the rainy season may be caused by global warming and climate phenomena such as El Niño which reduce the evaporation rate and increase. [28] SST also found that the unusual increase in SST during the west monsoon may affect the distribution patterns of small pelagic fish, such as *Selar crumenophthalmus*, in tropical Indonesian waters. Conversely, lower temperatures during the east monsoon favor upwelling, where cold, nutrient-rich water rises to the surface.

3.2 Distribution of Chlorophyll -a Concentration

Distribution of Chlorophyll–a Concentration obtained through the website https://data.ocean.color.eu produces varying chlorophyll-a values in the Makassar Strait after classification. These variations can be seen based on each fishing season in August 2024 to July 2025 which determines the potential fishing grounds for small pelagic fish. The distribution of chlorophyll-a was digitized using an interpolation model with different color gradation visualizations according to the chlorophyll-a level. The color gradation used is blue to yellow, indicating that the more intense the blue color, the lower the chlorophyll-a level, and the more intense the yellow color, the higher the yellow level. The chlorophyll used in the study of fishing zones is chl-a, which is found at the sea surface [29].

3.2.1 West Season

The distribution of chlorophyll-a starts from December - February, where each month has a different distribution, such as yellow is chlorophyll-a which has a high content, light green, dark green and light blue have a medium content of chlorophyll-a, then dark blue has a low content of chlorophyll-a, the difference in chlorophyll-a color each month can be seen from the color gradation that changes during the west season {figure 8).

Analysis of chlorophyll-a data during the 2024 - 2025 west monsoon, from December to February, showed significant concentration fluctuations. In December 2024, the average chlorophyll-a concentration was recorded at 0.24 mg/m^3. This data was influenced by geographic and meteorological conditions at the time, including wind patterns and ocean currents that affect nutrient distribution in the waters. In January 2025, the average chlorophyll-a concentration increased to 0.46 mg/m^3. This increase correlated with changes in sea surface temperature and upwelling activity that increased nutrient availability for phytoplankton. However, in February 2025, the chlorophyll-a concentration decreased to 0.37 mg/m^3. This decrease can be attributed to seasonal changes in sunlight intensity and rainfall patterns that affect the process of nutrient leaching from land to water.

According to [30] during the westerly monsoon with its more intense rainfall, river flows carry rich nutrients from the land to the coast, resulting in high concentrations of chlorophyll-a in the area. High concentrations of chlorophyll-a in the waters can indicate abundant fish richness because the waters provide abundant food sources. The high and low concentrations of chlorophyll-a have a direct relationship with the number of small pelagic fish found in the waters, then the small pelagic fish are associated with small pelagics as a food chain.

3.2.2 Transition Season I

The distribution of chlorophyll-a starts from March to May, where each month has a different distribution, such as yellow is chlorophyll-a which has a high content, light green, dark green and light blue have a medium content of chlorophyll-a, then for dark blue it has a low content of chlorophyll-a, the difference in chlorophyll-a color each month can be seen from the color gradation that changes during the transition season. (Figure 9).

The results of the analysis of chlorophyll-a data during the first transition season, from March to May, showed a decrease in chlorophyll-a concentration in each month. In March, the chlorophyll-a concentration was recorded at 0.43 mg/m^3, then decreased to 0.23 mg/m^3 in April and remained stable in May with the same concentration, namely 0.23 mg/m^3. The average chlorophyll-a concentration during this first transition season was 0.29 mg/m^3, which is a decrease compared to the previous west season.

Another study by [31] also showed that the decrease in chlorophyll-a during the first transitional season could be caused by a reduction in nutrient supply due to decreased upwelling activity and changes in ocean current patterns. This results in less food available for small pelagic fish and can affect their population dynamics.

In addition, research [32] stated that although oligotrophic conditions limit primary productivity, some phytoplankton species are able to adapt to low nutrient conditions, allowing the ecosystem to survive within certain limits. Meanwhile, [33] adding that small pelagic fish may develop adaptive strategies, such as moving to areas with higher productivity or utilizing alternative food sources, to survive in less than optimal environments.

3.2.3 East season

The distribution of chlorophyll-a during the period from March to May shows significant variations each month, as indicated by different color gradations on the distribution map. Yellow indicates high chlorophyll-a concentrations, while light green, dark green, and light blue indicate moderate chlorophyll-a levels. Meanwhile, dark blue represents low chlorophyll-a levels. These color gradation changes reflect the dynamics of chlorophyll-a distribution that occur during the east monsoon, where these variations are caused by oceanographic factors such as water mass movement, sea surface temperature, and nutrient availability (Figure 10).

The results of the analysis of chlorophyll-a data in the east season, which lasts from June to August, show an increase in concentration compared to the previous season, namely the transition season I. Based on satellite image analysis, the concentration of chlorophyll-a varies every month, with a record of 0.23 mg/m^3 in June, increasing significantly to 0.52 mg/m^3 in July, and decreasing again to 0.22 mg/m^3 in August. Overall, the average concentration of chlorophyll-a in the east season is 0.32 mg/m^3, which is higher than the average in the previous transition season I which was at 0.29 mg/m^3.

In contrast, July showed a chlorophyll-a concentration of 0.52 mg/m^3, falling into the eutrophic category, reflecting high productivity and abundant nutrient availability. These conditions are optimal for supporting the growth of phytoplankton, the primary food source for small pelagic fish, and thus positively impacting the marine ecosystem during that month [34].

3.2.4 Transition season II

The distribution of chlorophyll-a during the period from September to November shows significant variations each month, as indicated by different color gradations on the distribution map. Yellow indicates high chlorophyll-a concentrations, while light green, dark green, and light blue indicate moderate chlorophyll-a levels. Meanwhile, dark blue represents low chlorophyll-a levels. These color gradation changes reflect the dynamics of chlorophyll-a distribution that occur during the east monsoon, where these variations are caused by oceanographic factors such as water mass movement, sea surface temperature, and nutrient availability (Figure 11).

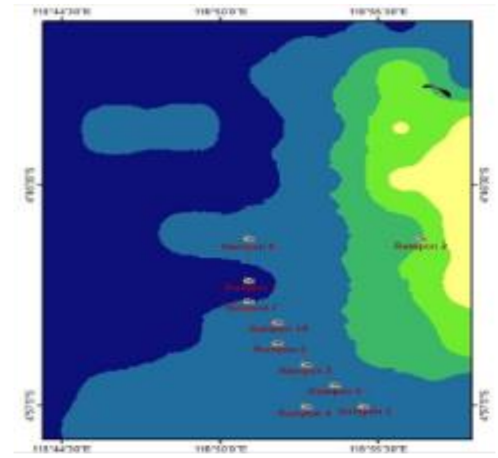


Figure 8: Distribution of Chlorophyll-a West Monsoon

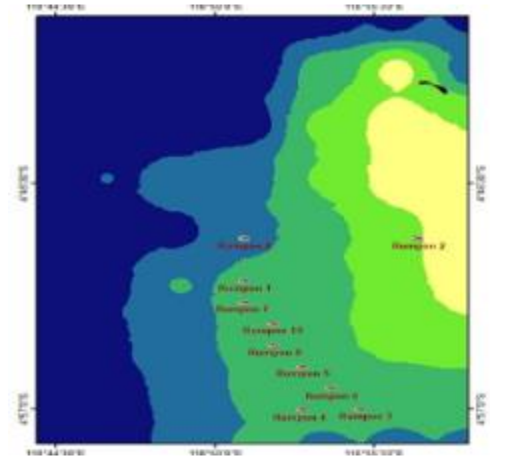


Figure 9: Distribution of Chlorophyll-a Transition Season I

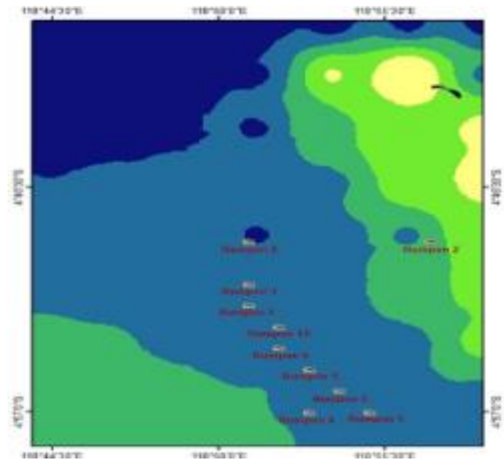


Figure 10: Distribution of Chlorophyll-a East Monsoon

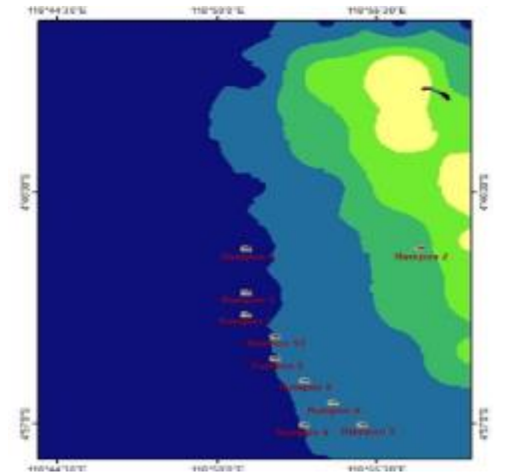
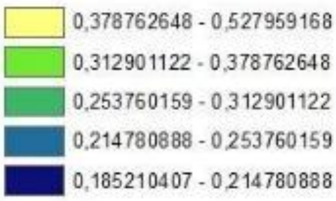


Figure 11: Distribution of Chlorophyll-a Transition Season II



The results of the analysis of chlorophyll-a data during the second transition season, which lasts from September to November, show a drastic decrease in chlorophyll-a concentration compared to the average of the previous season. Based on satellite imagery data, the chlorophyll-a concentration in September was recorded at 0.22 mg/m^3, decreased to 0.21 mg/m^3 in October, and slightly increased to 0.28 mg/m^3 in November. The average chlorophyll-a value during the second transition season was 0.23 mg/m^3, which is the lowest value compared to all other seasons.

This decrease in chlorophyll-a concentration indicates low primary productivity in the waters during this period, which may have implications for reduced nutrient availability to support marine ecosystems, especially for small pelagic fish populations [35]. According to [36] that the distribution of chlorophyll-a in the second transition season is influenced by the past east season and the upcoming west season.

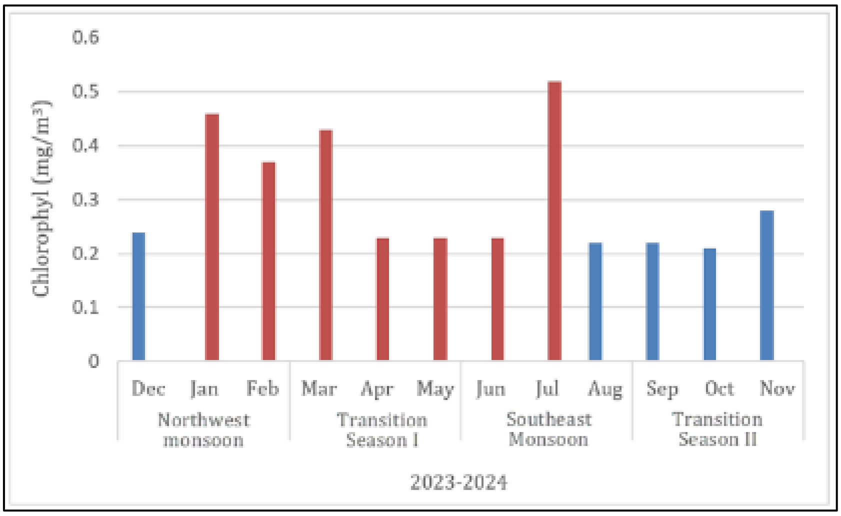


Figure 12: Graph of Average Distribution of Chlorophyll-a

The distribution value of chlorophyll-a in the Makassar Strait, each season with an average of 0.23–0.36 mg/m^3. Fluctuations in the distribution value of chlorophyll-a influence the determination of catchment areas and the fertility of a body of water [37]. A body of water is considered fertile if it has optimal chlorophyll-a content. Higher chlorophyll-a values indicate a higher level of fertility. Based on the fishing season, the highest average chlorophyll-a values occur during the west monsoon, while the lowest chlorophyll-a distribution occurs during the second and first transitional seasons.

3.3 Salinity Distribution

Analysis of salinity distribution in the Makassar Strait has been carried out by utilizing data obtained through the website https://data.marine.copernicus which was then analyzed using ArcGIS 10.9 software. This study showed that salinity in the area varied significantly during the period August 2023–July 2024, according to the fishing season classification. This salinity variation is important in determining potential fishing grounds for small pelagic fish.

According to [38] Salinity levels will decrease if there is an increase in the volume of river water flowing into the sea, while higher salinity levels tend to occur when the amount of river water flowing into the sea decreases. This statement is supported by research [39] which states that the relatively high salinity of seawater at various observation stations is due to their remote location from land, so the influence of river water is minimal. Analysis of salinity satellite imagery and reference data shows that the average salinity in the Makassar Strait waters ranges from 33.29 to 34.37 ppt, and fluctuates according to seasonal changes.

3.3.1 West Season

The salinity distribution observed from December to February shows significant variations in color gradation, with each month having a different salinity distribution. In this mapping, dark yellow indicates high salinity levels, while light yellow, orange, and dark red represent moderate salinity levels. Red reflects low salinity levels. These differences in salinity color across months are influenced by various factors, including geographic structure, freshwater inflow from rivers, rainfall, evaporation rates, and water mass circulation (Figure 13).

The results of the analysis of salinity data from December to February show fluctuations in the results of salinity in the range of the West season. Image data varies each month where in December the salinity distribution is generally dominated by an average of 33.2 ppt, for January the salinity distribution is generally dominated by an average range of 32.94 ppt, and for February the salinity distribution is dominated by an average range of 32.67 ppt. The west season (December to February) is the fishing season with the lowest average salinity value compared to other fishing seasons. This is because in that month the west monsoon winds move from the Asian continent to Australia which passes through the Indian Ocean and carries a lot of water vapor. The low value of salinity distribution in the west season occurs due to the movement of water masses from the west season [40].

[41] states that the high and low salinity values in the sea are influenced by various factors such as water circulation patterns, evaporation, rainfall, and river flow. Differences in seawater salinity values can be caused by mixing due to ocean waves or water mass movements caused by wind.

3.3.2 Transition Season I

The salinity distribution observed from March to May shows significant variations in color gradation, with each month having a different salinity distribution. In this mapping, dark yellow indicates high salinity levels, while light yellow, orange, and dark red represent moderate salinity levels. Red reflects low salinity levels. These differences in salinity color across months are influenced by various factors, including geographic structure, freshwater inflow from rivers, rainfall, evaporation rates, and water mass circulation (Figure 14).

During the first transitional season, analysis of salinity data in the Makassar Strait waters showed striking variations, which could affect the dynamics of the region's marine ecosystem. In March, the average salinity was recorded at 32.56 ppt, which is categorized as low salinity by Indonesian oceanographic standards. These low salinity conditions can affect nutrient distribution and biological processes in the ocean, including the spawning activity of several small pelagic fish species that prefer moderate to high salinities. High salinity is significantly associated with increased thermohaline stability and water column stratification in tropical waters.

3.3.3 East Season

The salinity distribution observed from June to August shows significant variations in color gradation, with each month having a different salinity distribution. In this mapping, dark yellow indicates high salinity levels, while light yellow, orange, and dark red represent moderate salinity levels. Red reflects low salinity levels. These differences in salinity color across months are influenced by various factors, including geographic structure, freshwater inflow from rivers, rainfall, evaporation rates, and water mass circulation. Mapping of salinity distribution during the west monsoon was conducted using ArcGIS 10.9 software to obtain accurate and detailed visualizations of salinity changes in the region (Figure 15).

The east monsoon in the Makassar Strait, which lasts from June to August, is characterized by the highest salinity levels compared to other seasons, with an average of 34.07 ppt. In June, the average salinity was recorded at 34.09 ppt, followed by a slight decrease to 33.94 ppt in July, and again increasing to 34.16 ppt in August. The high salinity levels during this season can be attributed to the low inflow of freshwater from the mainland and the high evaporation rate due to the increase in sea surface temperatures [42].

High intensity of sunlight results in greater evaporation of seawater, thus increasing the distribution of salinity. This is in accordance with what was stated by [43] that this increase in salinity is due to the reduced influence of freshwater input from the mainland as depth increases. The size of the salinity distribution value indicates that salinity is influenced by several factors such as circulation patterns in the water, evaporation and rainfall, such as in small pelagic fish generally found in water salinities of 32 – 35 ppt [44]. This high salinity indicates the presence of saltier and denser water conditions, which can affect the structure of the marine ecosystem in this area.

3.3.4 Season of Transition II

The salinity distribution observed from September to November shows significant variations in color gradation, with each month having a different salinity distribution. In this mapping, dark yellow indicates high salinity levels, while light yellow, orange, and dark red represent moderate salinity levels. Red reflects low salinity levels. These differences in salinity color across months are influenced by various factors, including geographic structure, freshwater inflow from rivers, rainfall, evaporation rates, and water mass circulation (figure 16).

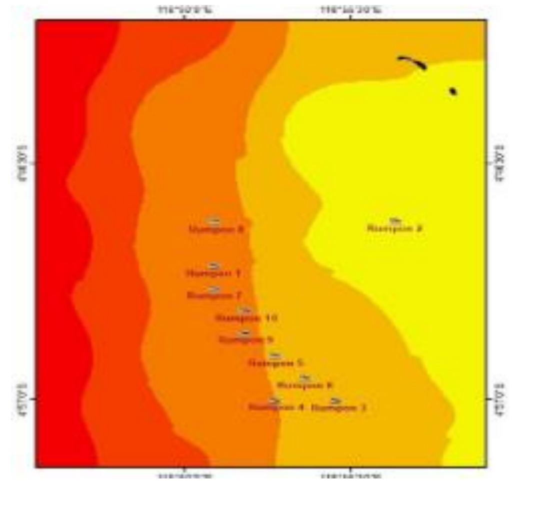


Figure 13: Salinity distribution during the West Monsoon

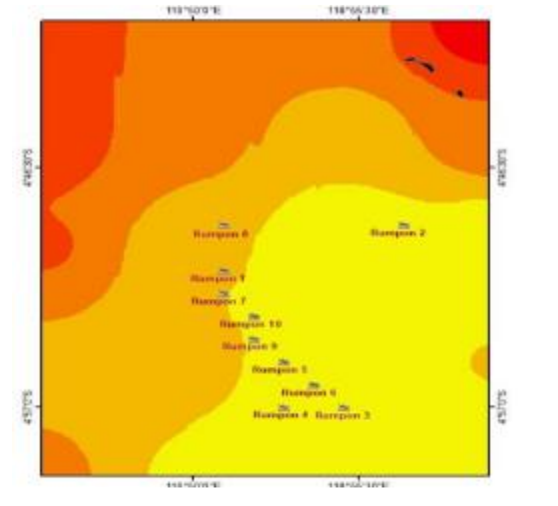


Figure 14: Distribution of Salinity in Transition Season I

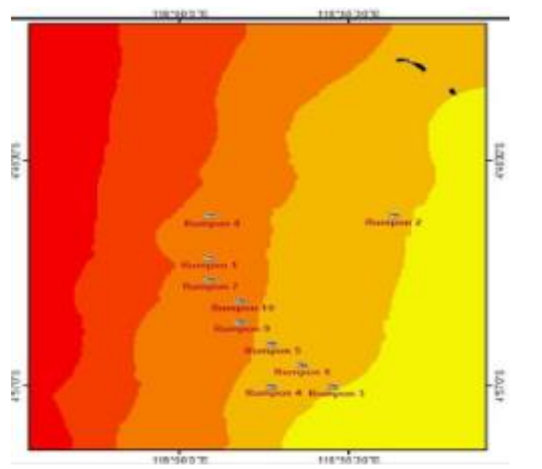


Figure 15: Salinity distribution during the East Monsoon

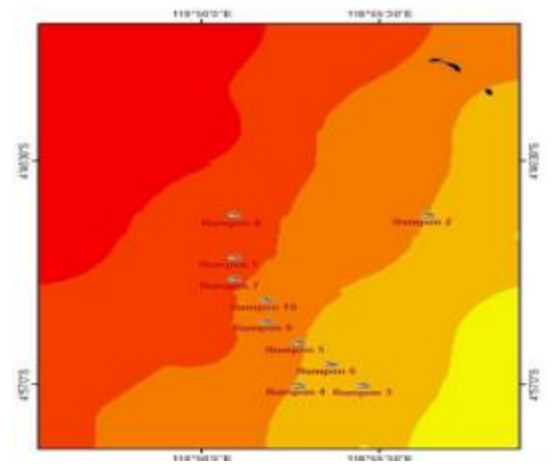


Figure 16: Distribution of Salinity in Transition Season II

The second transitional season in the Makassar Strait, which lasts from September to November, exhibits relatively high salinity levels compared to other seasons, with an average of 33.55 ppt, making it the season with the second highest salinity levels after the east monsoon. Average salinity data shows that September reaches 34 ppt, followed by a gradual decrease to 33.54 ppt in October and 33.10 ppt in November. These salinity fluctuations illustrate the significant hydrological dynamics in the region, where factors such as rainfall, evaporation, and freshwater inflow from the mainland contribute to salinity variations.

According to research [45], Salinity levels approaching 34 ppt can indicate increased thermal stratification in the water column, which can affect the movement of water masses and the distribution of nutrients in the waters. These high salinity conditions can also affect the composition and distribution of marine organisms, especially species that are sensitive to changes in salinity such as phytoplankton and zooplankton [46]. Higher salinity can increase seawater density, reducing the water's ability to mix vertically, which can inhibit nutrient circulation to the surface layer and impact primary productivity. Therefore, understanding salinity variability during this second transitional season is crucial for effectively managing marine resources and predicting its impact on the Makassar Strait ecosystem.

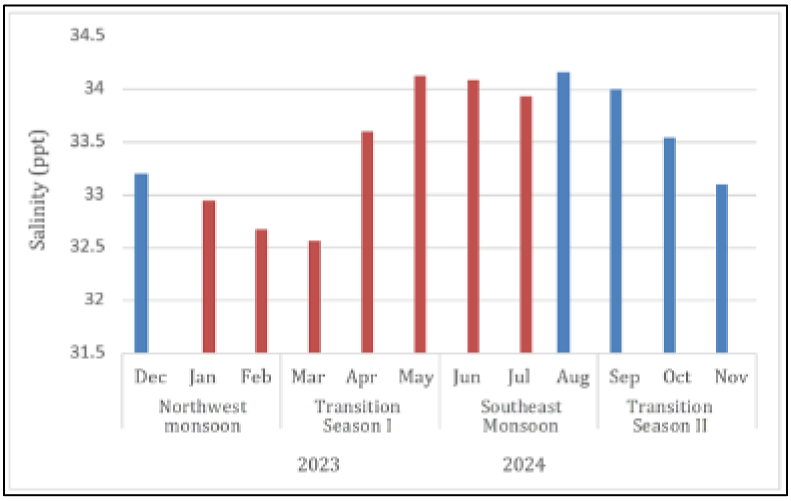


Figure 17: Graph of Average Salinity Distribution

Based on the graph in Figure 17, it shows the distribution of salinity values in the Makassar Strait where the range of salinity values starts from 30 to 34 ppt. Based on the fishing season. In a study of salinity dynamics in the waters of the Makassar Strait, it was found that the highest average salinity value occurred in the east season, while the lowest occurred in the transition season I and the west season.

According to research conducted by [47], factors that influence differences in salinity include weather and wind. Mixing caused by ocean waves and wind-induced water mass movements is one of the main causes of variations in salinity values in these waters. Small pelagic fish such as *Selar crumenophthalmus* tend to be found in lower salinity ranges compared to small pelagic fish, although they can still adapt in the salinity range of 30 to 34 ppt.

3.4 Production of small pelagic fish

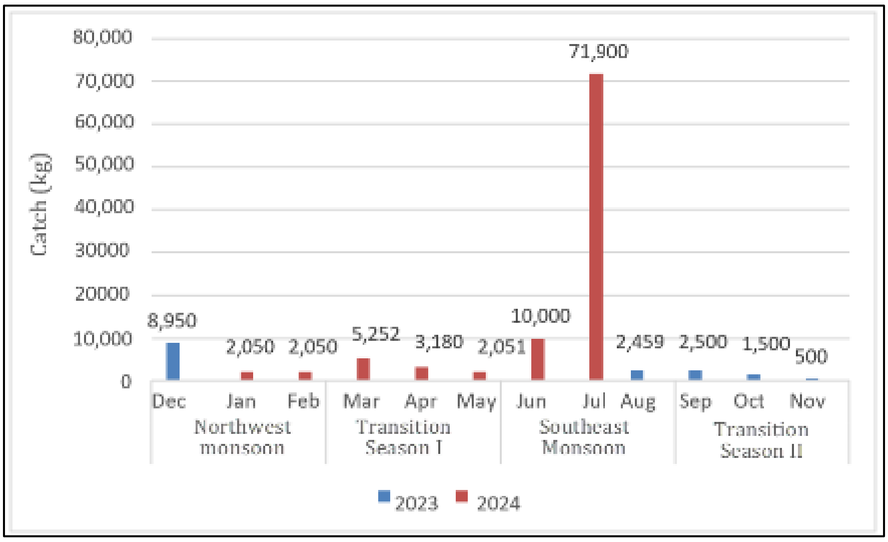


Figure 18: Graph of Catch Results in 2024

Catch *Selar crumenophthalmus* The Makassar Strait, located over a one-year period from December 2024 to July 2025, exhibited significant monthly variations. During this period, the East season was the period with the highest catch, recording a total of 84,356 kg, with a peak in July 2024 with a catch of 71,900 kg in just two fishing trips. Factors influencing successful catches during this season include optimal sea surface temperatures and high chlorophyll-a content, which supports phytoplankton productivity as a food source for small pelagic fish [48].

On the other hand, in the Transition II season, the catch *Selar crumenophthalmus* experienced a drastic decline, with a total catch of only 4,500 kg, and the peak decline occurred at the end of November 2024, recording a lowest catch of 500 kg in only one fishing trip. This decline can be attributed to unfavorable oceanographic conditions, such as increased salinity and decreased chlorophyll-a concentrations that resulted in reduced food availability [49].

Based on the fishing season, the West Season (December 2024 to February 2025) is the second-highest fishing season after the East Season in the Makassar Strait with a catch value of 13,050 kg and a total of 8 trips. While the Transition Season I (March to May) is the medium fishing season with a catch value of 10,483 kg and a total of 8 trips. The East Season (June to August) is the highest fishing season in a span of one fishing year with a total of 84,356 kg and a total of 7 trips, while the Transition Season II (September to November) experienced a drastic decline where in the previous season it was the highest fishing catch, but in contrast to the following season, namely in the transition season II the catch was only 500 kg with a total of 2 trips. In this study, choosing *Selar crumenophthalmus* as a sample object, because it is a fish that can be caught every season, and is distributed throughout the year.

Figure 19: Selar crumenophthalmus

Selar crumenophthalmus is a type of small pelagic fish that is generally found in shallow waters and has adapted to variations in temperature and salinity. These fish tend to gather in areas with abundant food availability and favorable environmental parameters, such as optimal sea surface temperatures between 27-29°C and salinity ranging from 32-35 ppt. These conditions tend to be found during the East season, where upwelling phenomena occur, increasing the concentration of chlorophyll-a which is the main food source for small pelagic fish.

3.5 Relationship between catch and oceanographic parameters

3.5.1 Relationship between catch and SST

The distribution of SST on small pelagic fish catches in each month shows different patterns over a full year, as shown in Figure 20.

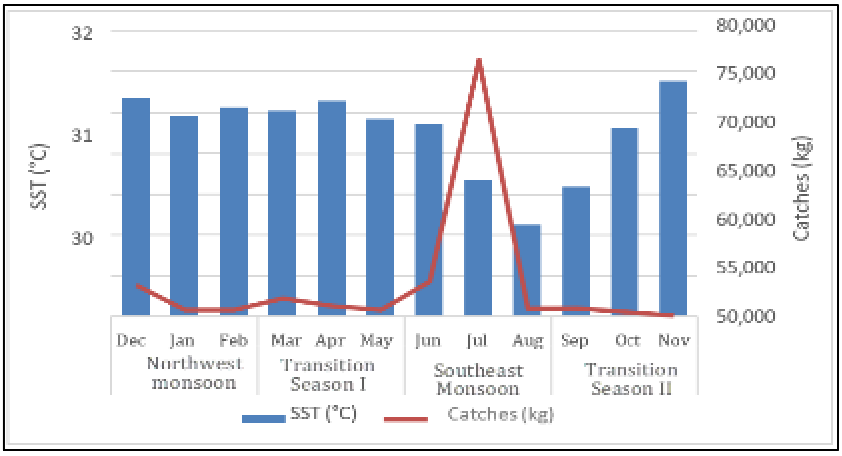


Figure 20: Catch results and SST

The distribution of SST values is consistent from 29.83 to 30.35°C at the beginning of the west season in December until the end of the transition season I in May with catches in the west season of 13,050 kg, and transition season I of 10,483 kg, this shows that the relatively warm SST supports the existence of *Selar crumenophthalmus* in fairly stable amounts. However, a decrease in SST occurs in the middle to late east monsoon, namely from June to August, with temperatures ranging between 28.37 and 27.26 °C.

In this period, the catch *Selar crumenophthalmus* reached its peak, with the highest amount recorded in July at 71,900 kg. This phenomenon can be attributed to the upwelling process that commonly occurs in the Makassar Strait during the east monsoon, where cold, nutrient-rich water masses rise to the surface, creating optimal conditions for the development of phytoplankton, which are the main food source for small pelagic fish. SST parameters can act as an indicator of the occurrence of upwelling and fronts because waters experiencing upwelling generally have lower temperatures and are surrounded by waters with higher temperatures [50].

Furthermore, during the second transition season, which lasts from September to November, the SST increased again, reaching 30.76°C in November. However, fish catches dropped drastically to only 500 kg. This increase in SST likely indicates the end of the upwelling process, which causes a decrease in nutrient availability at the ocean surface. This condition reduces the abundance of plankton, which in turn affects the presence and availability of *Selar crumenophthalmus*.

3.5.2 Relationship Between Catch and Chlorophyll-a

The distribution of Chlorophyll-a in the catch of small pelagic fish each month shows different patterns over a full year, as shown in Figure 21.

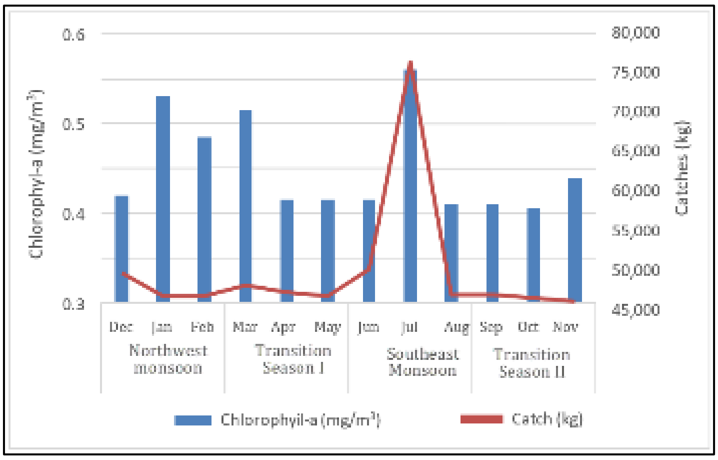


Figure 21: Catch Results and Chlorophyll-a

The distribution of chlorophyll-a in the Makassar Strait waters varies seasonally, with values ranging from 0.23 to 0.36 mg/m^3. High chlorophyll-a values reflect the abundance of phytoplankton, which serve as the base of the marine food chain and play a vital role in supporting aquatic ecosystems. Data show that the highest average chlorophyll-a values were recorded in July, during the east monsoon, reaching 0.52 mg/m^3. During this month, catches of small pelagic fish, particularly *Selar crumenophthalmus*, reaching 71,900 kg. The high chlorophyll-a values this month can be attributed to increased primary productivity resulting from upwelling, where nutrient-rich water masses rise to the surface, providing an ideal environment for phytoplankton growth.

Increased chlorophyll-a concentrations are directly proportional to the increase in the abundance of small pelagic fish in tropical waters. Therefore, the high distribution of chlorophyll-a in the Makassar Strait during the east monsoon can be considered a potential indicator of increased catches. *Selar crumenophthalmus*, making it a very important period for fishing activities in the region.

3.5.3 Relationship between Catch Yield and Salinity

The distribution of salinity in relation to small pelagic fish catches in each month shows different patterns over a full year, as shown in Figure 22.

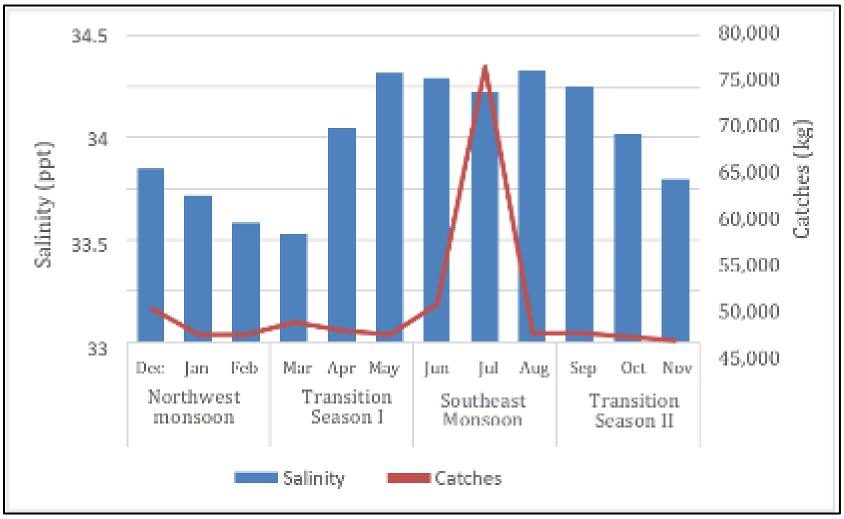


Figure 22: Catch Results and Salinity

The distribution of salinity in the waters of the Makassar Strait ranges between 32.94 to 34.07 ppt in each season, which plays a significant role in determining the distribution and abundance of small pelagic fish such as *Selar crumenophthalmus.* Based on the analysis of the catch and salinity distribution graphs in Figure 33, a pattern is found indicating a relationship between salinity variations and small pelagic fish catches in each fishing season. The highest salinity distribution was recorded in June at the start of the east monsoon, with a value reaching 34.09 ppt, which coincided with a small pelagic fish catch of 10,000 kg. Conversely, the lowest salinity distribution occurred in February during the west monsoon, with a value of 32.67 ppt, coinciding with a drastic decrease in small pelagic fish catches to 2,050 kg.

Existence *Selar crumenophthalmus* in these waters are highly influenced by salinity fluctuations, where small pelagic fish tend to choose habitats with higher salinity conditions. The optimal salinity for small pelagic fish is usually in the range of 33 ppt to 35 ppt, as reported by research [51] which states that salinity directly affects the distribution patterns and habitat carrying capacity of pelagic fish. In June, when salinity peaks, marine conditions become more stable and support the growth of plankton, the primary food source for small pelagic fish.

Conversely, the decrease in salinity in February may be due to increased rainfall and river flow into the sea, potentially leading to water column stratification and reduced food availability for small pelagic fish. This results in a decrease in catches, as indicated by the low catch value. *Selar crumenophthalmus* in that month. This condition indicates that fisheries management must pay attention to salinity variability in the Makassar Strait waters to optimally and sustainably increase small pelagic fish catches. For further clarification, the following is shown in the form (Table 3) of the relationship between catches and oceanographic parameters:

Table 3: Relationship between catch results *Selar crumenophthalmus* with Oceanographic parameters

Season	Time of catch	Fishing trip	Catch (kg)	Total Catch (kg)	SST (^{0}C)	Average	Salinity	Average	Chlorophyll-a	Average
	Dec 2024	4	8,950		30,35		33,2		0,24	
West Season	Jan 2025	2	2,050	13,050	29,91	30,13	32,94	32,94	0,46	0,36
	Feb 2025	2	2,050		30,12		32,67		0,37	
Transition 1	Mar 2025	2	5,252		30,04		32,56		0,43	
	Apr 2025	4	3,180	10,483	30,29	30,06	33,60	33,43	0,23	0,29
	May	2	2,051		29,8		34,13		0,23	

	2025				3					
East Season	Jun 2025	2	10,000	84,359	29,73	28,44	34,09	34,07	0,23	0,32
	Jul 2025	2	71,900		28,37		33,94		0,52	
	Aug 2024	3	2,459		27,26		34,16		0,22	
Transition 2	Sep 2024	2	2,500	4,500	28,19	29,53	34	33,55	0,22	0,23
	Oct 2024	1	1,500		29,63		33,54		0,21	
	Nov2024	1	500		30,76		33,10		0,28	

3.6 Regression analysis of oceanographic parameters with catch results

This study examines the relationship between oceanographic parameters and small pelagic fish catches, including the relationship between SST and catches, the relationship between chlorophyll-a and catches, and the relationship between salinity and small pelagic fish catches. Before analyzing these relationships, it is important to test the collected data for normality.

This normality test aims to determine whether the data is normally distributed, which is a key prerequisite in parametric analysis. Data normality is crucial because parametric analysis relies on the assumption that the data follows a normal distribution, allowing for the application of various further statistical methods to accurately interpret the relationship between oceanographic variables and fish catches.

3.6.1 Classical Assumption Test

Classical assumption tests are a series of statistical tests performed to ensure that the data used in a linear regression analysis meets several basic assumptions. These assumptions must be met for the regression model to produce unbiased, consistent, and efficient parameter estimates. Without meeting these assumptions, the results of a regression analysis can be invalid or misleading [52].

3.6.1.1 Normality Test

If the sig value >0.05, then the data is normally distributed and if the sig value <0.05, then the data is not normally distributed, in appendix 7 the results of the Kolmogorov-Smirnov normality test show that the significance value is 0.200 > 0.05 then the data is normally distributed.

3.6.1.2 Multicollinearity Test

If the value *tolerance* >0.10 or VIF value <10, then the multicollinearity test is passed. If the value *tolerance* <0.10 or VIF >10, then it does not pass the multicollinearity test. In Appendix 8, the results of the multicollinearity test show that all variables have a value *tolerance* >0.10 or VIF value <10, namely it can be concluded that there are no symptoms of multicollinearity or it passes the multicollinearity test.

3.6.1.3 Heteroscedasticity Test

If the sig value > 0.05, then it passes the heteroscedasticity test.

If the value is < 0.05, then the value does not pass the heteroscedasticity test.

The results of the heteroscedasticity test show that all variables have a sig value >0.05, so it can be concluded that there are no symptoms of heteroscedasticity or they pass the heteroscedasticity test.

3.6.1.4 Auto Correlation Test

The positive correlation coefficient value, indicating that there is a unidirectional relationship between the chlorophyll-a variables (X_1), SST (X_2), salinity (X_3) with the catch (Y) The correlation coefficient value (r) = 0.851 which means there is a very strong relationship between Chlorophyll (X_1), SST (X_2), and salinity (X_3) with catch results (Y) The R square

(r^2) value of 0.724 shows that 72.4% of the catch results are jointly influenced by the chlorophyll-a variable (X_1), SST (X_2), and salinity (X_3) while 27.6% is influenced by other variables that were not studied

3.6.2 Multiple Linear Regression Equation

$$\mathbf{Y = a + b_1X_1 + b_2X_2 + b_3X_3}$$

$$Y = -102{,}111 + 17{,}006\ X_1 + 0{,}254\ X_2 + 2{,}063\ X_3$$

The explanation is as follows:

- The constant coefficient value is -102.111 with a negative value, this means that without the chlorophyll-a access variable (X_1), sea surface temperature (X_2), salinity (X_3), the catch yield variable (Y) will experience a decrease of 10211%
- The beta coefficient value of the chlorophyll-a variable (X_1) is 17.006. If the value of other variables is constant and the variable X_1 increases by 1%, the catch variable (Y) will increase by 1701%. Likewise, if the value of other variables is constant and the variable X1 decreases by 1%, the catch variable (Y) will decrease by 1701%.
- The beta coefficient value of the sea surface temperature variable (X_2) is 0.254, if the value of other variables is constant and the variable X_2 increases by 1%, then the catch variable (Y) will increase by 25%, and vice versa if the value of other variables is constant and the variable X_2 decreases by 1%, then the catch variable (Y) will decrease by 25%.
- The beta coefficient value of the salinity variable (X_3) is 2.063, if the value of the constant variable and the X_3 variable increases by 1%, the catch variable (Y) will increase by 206%, and vice versa, if the value of the constant variable and the X_3 variable decreases by 1%, the catch variable (Y) will decrease by 206%.

3.6.3 Hypothesis Test Results

- The results of the Determination Coefficient (R^2) test show an Adj. R Square value of 0.724 or 72.1%. The coefficient of determination value shows that the chlorophyll (X_1), SST (X_2), and salinity (X_3) variables are able to explain the Catch (Y) variable by 72.1%, while the remaining 27.9% is explained by other variables.
- F_{count} of 7.008 > F_{table} is 3.863 and the value of sig. i.e. 0.013 < 0.05 then H_0rejected and $H_a$accepted, meaning that the variables chlorophyll, sea surface temperature, and salinity have an effect on the catch.
- The results of the t-test obtained an explanation of the influence of the independent variable on the dependent variable partially as follows:
    - T_{count} chlorophyll-a variable (X_1) is 4.213 > t_{table} is 2.228 and the sig value, i.e., 0.003 < 0.05, then H_0 rejected and H_a accepted, meaning that the chlorophyll variable has an effect on the catch.
    - T_{count} sea surface temperature variable (X_2) is 0.549 < t_{table} is 2.228 and sig value, i.e. 0.594 > 0.05, then H_a rejected and H_0 accepted, meaning that the SST variable does not affect the catch results
    - T_{count} salinity variable (X_3) is 2.698 > t_{table} is 2.228 and the sig value, i.e., 0.027 < 0.05, then H_0 rejected and H_a accepted, meaning that the salinity variable has an effect on the catch.

3.7 Analysis of the estimated location of fishing grounds for small pelagic fish

In an effort to identify potential fishing ground locations, a mapping of estimated fishing ground locations was carried out based on an assessment of estimated fishing ground locations which can be seen in Table 4.

Table 4: Location Estimation Assessment Fishing Ground of *Selar crumenophthalmus*

Fishing Ground Indicator								
Fishing Season	SST (°C)		Salinity (ppt)		Chlorophyll-a (mg/m³)		Weight Total	Fishing grounds Category
	Mark	Weight	Mark	Weight	Mark	Weight		
West	30,13	6	32,9	6	0,36	6	18	P
Transition I	30,06	6	33,4	6	0,26	6	18	P
East	28,44	4	34,1	6	0,32	6	16	P
Transition II	29,53	6	33,6	6	0,23	6	18	P

*Note: P = Potential; S = Moderate; K = Less

Based on location assessment fishing ground, in the span of one year of fishing starting from August 2024 to July 2025, that the fishing grounds of *Selar crumenophthalmus* in the Makassar Strait is classified as potential. This can be concluded that scad fishing is not limited to the Makassar Strait waters but is spread out into the open sea. This was also expressed by [53] Fishing ground locations are generally unstable and tend to shift. This movement depends on changing environmental conditions, and the fish scientifically select more suitable habitats rich in food sources to maintain their survival.

Fishing grounds Map for small pelagic fish such as *Selar crumenophthalmus* in the Makassar Strait can be developed by utilizing remote sensing data, including SST, chlorophyll-a, and salinity. In this study, the resulting Fishing grounds map for the period August 2024 to July 2025, which covers four fishing seasons (west monsoon, transition season I, east monsoon, and transition season II), showed agreement with actual catches in the field.

4 CONCLUSION

The lowest SST parameter conditions occur in the east season (June to August), conversely the highest SST occurs in the west season (December to February), this occurs due to the La Nina event, which tends to increase rainfall. for chlorophyll-a concentrations there is the highest increase in the west and east seasons and in the transition season II it decreases. The lowest salinity concentration occurs in the west season, and in the east season it becomes the fishing season that has the highest average distribution value compared to other fishing seasons, and based on multiple linear regression analysis it is known that chlorophyll-a and salinity have a strong effect on catch results, in contrast to temperature which tends to have less effect on catch results,

From the results of the analysis of the estimated potential locations of fishing grounds *Selar crumenophthalmus* shows that the Makassar Strait is a suitable water area for estimating potential *Selar crumenophthalmus* fishing grounds.

STATEMENTS ON COMPLIANCE WITH ETHICAL STANDARDS

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No conflict of interest to be disclosed.

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