The estimation of mackerel tuna (*Euthynnus affinis*) fishing ground in Malacca Strait

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Abstract. In fishing activity, the success is indicated by the number of catches that extremely influenced by the conditions of fishing ground. Information of the potential fishing ground is needed for fishermen to increase the effectiveness and efficiency in fishing activity. Sea Surface Temperature (SST) and chlorophyll-a in waters are two things that can affect the potential of fishing ground. The research aims to create distribution map of SST and chlorophyll-a and to presume the potentials of fishing ground in Malacca Strait based on distribution of SST and chlorophyll-a in Malacca Strait (2015-2019). The data of SST and chlorophyll-a distribution in Malacca Strait were using Aqua MODIS satellite imagery. Based on the result of SST and chlorophyll-a analysis, potential fishing ground in Malacca Strait is expected located around East Aceh in Western season, Malaysian waters in the Transition I season, between Asahan and Malaysian waters in Eastern season and between Deli Serdang and East Aceh in the Transition II season.

1. Introduction

Malacca Strait is a strait that connects the shipping lanes between the Indian Ocean and the Pacific Ocean which becomes a strategic fishing ground with high-level exploitation. One of the commodities haul from those is Mackerel Tuna (*Euthynnus affinis*) which is part of small pelagic fish species that strategically has an essential economic value in Indonesia because it is the fishermen's livelihood resources and foreign exchange. They belong to pelagic fish commodities that derive from *Scombridae* which comprise 10% of the world's seafood trade. Mackerel Tuna (*Euthynnus affinis*) is an oceanodromous that spread in coastal areas and around tropical and subtropical islands [1].

Utilization of fishery resources in the form of fishing activities always observing the area of fishing target. The fishing ground is a zone or area that becomes fishing targets where the fish usually gather. A type of fish usually converges in an area where it has plenty of foods for itself (feeding ground) [2].

Scientifically, the estimation of pelagic fishing grounds can be determined based on two things, they are the distribution of the Sea Surface Temperature (SST) and chlorophyll-a. By knowing the oceanographic parameters, therefore the estimation of the fishing grounds can be implemented properly, which the results can be used as a guide for catching fish purposes (exploitation) of pelagic fish resources in waters.

The measurement of SST and chlorophyll-a in waters can be carried out directly or indirectly, however direct measurements are considered less effective because it’s high time-consuming and
somewhat complicated compared to indirect measurements, it is through remote sensing techniques by utilizing satellite imagery. One of the satellites that can detect SST and chlorophyll-a is Aqua (EOS PM) with a Moderate Resolution Imaging Spectroradiometer (MODIS) sensor. By knowing the Mackerel Tuna (Euthynnus affinis) fishing ground, the fishermen are capable to fishing effectively and efficiently and increase the number of hauls to optimize the use of fishery resources in Malacca Strait.

2. Materials and methods

2.1. Tools and materials
Tools and materials that use in this research are laptop as a hardware, Aqua MODIS satellite images 3rd level (monthly) in 2015-2019 data to determine the distribution of SST and chlorophyll-a in waters, Software SeaDAS 7.3.2 to process the result of Aqua MODIS satellite images download, Microsoft Office Excel 2019 to input the data and manufacturing graphics, Software Ocean Data View (ODV) 4.1 to process data of ASCII’s Aqua MODIS and Software ArcMap 10.8 to do overlay between SST and chlorophyll-a data and create an estimation map of Mackerel Tuna (Euthynnus affinis) fishing ground in Malaca Strait.

2.2. Research procedure
SST and chlorophyll-a concentration data were obtained from Aqua MODIS satellite images 3rd level monthly composite data in 2015-2019 which were cloud-free and radiometrically and geometrically corrected with 4 km spatial resolution collected by downloading from the National Aeronatic Space Agency (NASA) site.

2.3. Data analysis

2.3.1. Data analysis of SST and chlorophyll-a distribution. The distribution of SST and chlorophyll-a that have been downloaded from Aqua MODIS satellite images were spatially and temporally analyzed. Spatial analysis was done visually to determine the distribution of SST and chlorophyll-a by looking at and comparing the contour shapes and color degradation of the images. The SST and chlorophyll-a distribution temporal analysis was carried out based on time series charts for the two seen parameters. Both analyzes were performed to find out the variations based on time and spaces, and phenomenon which appeared during the research period based on seasonal patterns.

Processing SST and chlorophyll-a distribution data were obtained through several steps, by collecting image data, trimming image data (cropping), processing SST and chlorophyll-a distribution data, data control, and SST and chlorophyll-a data visualization. SeaWIFS Data Analysis System (SeaDAS) 7.3.2. is used to process the image data. At this stage, cropping images were obtained according to the research area. The result (output) of the image cropping is an American Standard Code for Information Interchange (ASCII) data which consists of latitude, longitude, and chlorophyll-a, and SST concentration estimated values. Data processing was subsequently carried out by using Microsoft Excel 2019 for ASCII data control. Data control aims to adjust the data and eliminate high and low data extreme which are estimated as the cloud cover intensity values and intensity values of the land. At this stage, SST and chlorophyll-a values were analyzed and area that have low SST values and large amounts of chlorophyll-a are considered to be the most potential fishing ground. ASCII data from SST and chlorophyll-a that have been controlled by the data then reprocessed using Ocean Data View (ODV) 4.1 software to design SST and chlorophyll-a distribution maps of Malacca Strait in 2015-2019 in every season along with the line contours. The last step is do overlay between SST and chlorophyll-a using ArcMap 10.8 to create an estimation map of Mackerel Tuna (Euthynnus affinis) fishing ground in Malaca Strait (2015-2019).

2.3.2. The estimation of fishing grounds. The making of the fishing ground map is based on the distribution of SST and chlorophyll-a from satellite imagery. The coordinate that have the lowest SST
and the largest amount of chlorophyll-a values (optimum) is considered to be the most potential fishing ground. The fishing ground assessment through the SST indicator is shown in table 1 [4] and the fishing ground assessment through the chlorophyll-a indicator is shown in table 2 [4].

**Table 1.** Fishing ground assessment through the SST indicator.

| No. | SST Categories  | Criteria       | Fishing Ground Categories |
|-----|-----------------|----------------|--------------------------|
| 1.  | Optimum         | 24 °C – 26 °C  | High Potential            |
| 2.  | Medium          | 26 °C – 30 °C  | Medium Potential          |
| 3.  | Less optimum    | < 24 °C or > 30 °C | Low Potential |

**Table 2.** Fishing ground assessment through the chlorophyll-a indicator.

| No. | Chlorophyll-a | Criteria            | Fishing Ground Categories |
|-----|---------------|---------------------|--------------------------|
| 1.  | Large         | > 0.2 mg/m³        | High Potential            |
| 2.  | Medium        | 0.1 mg/m³ – 0.2 mg/m³ | Medium Potential |
| 3.  | Small         | < 0.1 mg/m³        | Low Potential             |

3. **Results and discussion**

**3.1. Sea surface temperature values**

The graphic of values fluctuation and the spatial distribution of SST in Malacca Strait (2015-2019) according to Aqua MODIS analysis image shown successively in figure 1 and figure 2.

![Figure 1. Fluctuation graphic of sea surface temperature in 2015-2019.](image)

The highest sea surface temperature in Malacca Strait occurred in the Transition I season and continually decreases until the lowest sea surface temperature in Western season. The difference in sea surface temperature is affected by the movement and speed of the west monsoon and the east monsoon winds. In the West monsoons, the surface winds strongly blow but in the Transitional the winds are not too strong so there will be not strong stirring in the surface layer of the water that causes low temperatures and larger water density to move from the bottom to the sea surface. This is in accordance with [5] which states that when the West monsoon takes place the winds blow from the West to the East, so the flows move from the Asia Continent to the Australia Continent. However, during the Transitional season, the flows irregularly move and tend to be divided into two directions, they are from the Asian Continent to the Australia Continent and from the Australia Continent to the Asia Continent with a weak average flow speed.

Based on the sea surface temperature average values in every season, it is known that there are no potential seasons to fishing Mackerel Tuna (*Euthynnus affinis*) in Malacca Strait because of the SST
with that value range is not the optimum temperature for the life of Mackerel Tuna (*Euthynnus affinis*). This is in accordance with [6] which states that Mackerel Tuna (*Euthynnus affinis*) like to live in which have 20.7 °C-28.5 °C temperatures with 26.9 °C average temperatures and live at the depth of 0-200 m.

![Figure 2](image-url)

**Figure 2.** Spatial distribution of SST in Malacca Strait (2015-2019): (a) Western Season, (b) Transition I Season, (c) Eastern Season, (d) Transition II Season.

Based on the figure above, it can be seen that the SST of Malacca Strait in every season has a different distribution pattern. Based on the statement, it can be interpreted that the SST value in Malacca Strait was influenced by the wind direction and speed in each season.

### 3.2. Chlorophyll-a concentration values

The graphic of values fluctuation and the spatial distribution of chlorophyll-a in Malacca Strait (2015-2019) according to Aqua MODIS analysis image shown successively in figure 3 and figure 4.

The Malacca Strait waters have high rate of the fertility, this can be seen from chlorophyll-a concentration average values in that water in every season, it’s about 1.724 mg/m³ – 2.342 mg/m³. This is in accordance with [7] which states that the biological factor that affects the fertility level of waters is chlorophyll-a. The lowest average chlorophyll-a in Malacca Strait occurred in the Transition I season, it is 1.24 mg/m³ and the highest average chlorophyll-a in the Western season, it is 2.342 mg/m³. The high and low concentrations of chlorophyll-a are affected by the strength and weakness of the wind gusts which play an important role in the process of chlorophyll-a spreading in waters. This is in accordance with [8] which states that the current is one of the oceanographic parameters that causes nutrients and chlorophyll-a happen to be distributed due to the water mass movement that affects them.
Based on the results of image data processing of chlorophyll-a distribution it is using Ocean Data View (ODV) 4 software is a chlorophyll-a spatial distribution map in Malacca Strait, it can be seen that on this map is contained of difference striking colors between coastal waters and open seas. The map informs that coastal waters have a higher chlorophyll-a concentration than the open seas which have lower concentration values. This is in accordance with [9] which states that the distribution of chlorophyll-a concentrations is higher in coastal waters than in the open seas because of the high supply of nutrients from land.
3.3. The estimation of mackerel tuna (*Euthynnus affinis*) Fishing Ground

Based on the calculation of the lowest SST and the highest chlorophyll-a, map of the estimated Mackerel Tuna (*Euthynnus affinis*) fishing grounds of Malacca Strait in 2015-2019 can be seen in figure 5.

![Figure 5. Potential fishing ground map.](image)

**Figure 5.** Potential fishing ground map.

4. Conclusions

The fishing ground that is expected to be the most potential in the West season it is in East Aceh at 4°55'01.2" - 5°05'42" N and 98°09’28.8” - 98°56’34.8” E coordinates, in the Transition I season it is in Malaysian waters at 2°13’04.8” - 2°50’20.4” N and 101°10’01.2” - 102°05’13.2” E coordinates, in the East season it is between Asahan and Malaysian waters at 3°04’55.2” - 3°43’01.2” N and 100°04’40.8” - 100°45’21.6” coordinates, and in the Transition II season it is between Deli Serdang and East Aceh waters at 4°04’15.6” - 4°53’06.0” N and 98°49’40.8” - 99°32’56” E coordinates.

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