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FISH CATCH RESULTS RELATED TO TEMPERATURE AND CHLOROPHYLL IN WESTERN WATERS OF SUMATERA

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Abstract

Western Sumatra is one of the waters that have the potential for coastal and ocean resources. Oceanographic factors that can be related to high productivity in waters are SST (Sea Surface Temperature) and the distribution of chlorophyll concentration. Sibolga waters are geographically quite strategic, because they are located in the Indian Ocean, and most of the catch is landed at the Sibolga Nusantara Fisheries Port. This Study aims to understand the trend of fluctuations in fish catches in the Waters of Western Sumatera, to examine the effect of chlorophyll on fish catches in the waters of Western Sumatera. Sea surface temperature and monthly chlorophyll-a concentrations were obtained from the result of the Aqua Modis months in 2021. Monthly data and data on fishing results were obtained from the Sibolga Nusantara Fisheries Port. The composition of catches in the Western waters of Sumatera which landed at PPN Sibolga in 2021there three dominant fish species, namely Skipjack tuna (*Katsuwonus Pelamis*) 11.655.768 Kg, Layang (*Decapterus Sp*) 4.589.147 (19,95%), Sardinella (*Sardinella sp*) 2.421.523 (10,53%), the variation of fish catch per unit (CPUE); and landed at PPN 2021. The Highest occurred in May at 3.809 kg/trip, the lowest occurred in November at 1.5 at 21,58 kg/trip, and the average monthly CPUE in 2021 was 5.105,88kg/trip. Monthly variations of sea surface temperature and chlorophyll-a in the waters for 12 months (2021) the lowest temperature occurred in August, namely 26,88 ^{0}C while the highest temperature in February was 30,92 ^{0}C, the highest concentration was in May at 1,56 mg/m^3 while the lowest occurred in March at 0,15 mg/m^3.

Keywords: Temperature, chlorophyll-a, Catch Result, Sibolga PPN.

1. Introduction

The western waters of Sumatra are one of the waters that have the potential for coastal and ocean resources. The potential of pelagic fish resources in The western waters of Sumatera is very high and Fishing Productivity is also very potential (Limbong, 2019). Most fishing activities are carried out near the coast and the fish caught in these waters are pelagic fish. The potential of Skipjack tuna (*Katsuwonus Pelamis*) fishery resources in the fishery management area (WPP) 572 is very high. One of the fishery areas in Indonesia that are the main producer of the commodity is North Sumatra (Gussasta *et al*., 2021).

Sibolga city is one of the municipalities in North Sumatra province with its natural conditions. The most prominent potential is marine fisheries. The potential of large pelagic fish resources in Sibolga waters is very high and fishing productivity is very potential where the Sibolga Nusantara Fishery Port (PPN) is the main fishery port for landing catches in North Sumatera Province (Limbong, 2019; Simatupang and Lubis, 2012). The Sibolga Nusantara Fishery Port is the landing base for the tuna fishing fleet in the Indian Ocean west of Sumatera (Wijopriyono, 2012).

Oceanographic factors that can be related to the high productivity in the waters are SST (sea surface temperature) and the distribution of chlorophyll concentration. SST is one of the indicators in determining the fertility of water because it has an impact on the metabolic processes, breeding, and, distribution of marine organisms (Yuniarti *et al*., 2013), Chlorophyll in water can be used as an indicator of the fertility of

water because this is because chlorophyll is a primary producer for life in the sea. Where the content of chlorophyll in water is closely related to the food chain. The high content of chlorophyll-a can increase the productivity of zooplankton in water, thus creating a food chain that supports fish productivity in the waters (Putra *et al*., 2012). The concentration of chlorophyll-a can be called a photosynthetic pigment from phytoplankton. In marine water, the chlorophyll-a index can be associated with fish production or more precisely can describe the level of productivity of fishing areas so that knowing the distribution of chlorophyll-a can be used as a parameter in identifying the presence of chlorophyll-a. fish in water. (Syafruddin and Zainuddin, 2008).

One of the technologies to determine the distribution of chlorophyll-a and sea surface temperature is remote sensing, using remote sensing methods (Arleston *et al*., 2016; Pasaribu *et al*., 2021) as one of the solutions in determining fishing areas by looking at the concentration of chlorophyll-a in some water. Sensing is one of the more efficient methods that can be used to see the presence and abundance of phytoplankton through image analysis of the distribution of chlorophyll-a. The image analysis carried out provides an overview of the distribution of chlorophyll-a in waters so that it can be used as information to determine fishing areas.

The Western Coast of Sumatra Island has enormous fishery potential, both in territorial waters and in the waters of the exclusive economic zone up to 200 miles from the coast. This great potential makes the fishing business, especially the fishing business on the western waters of Sumatera, bigger than the East coast (Limbong *et al*., 2019). Sibolga waters are geographically quite strategic because they are located in the Indian Ocean and most of their catches land at the Sibolga Nusantara Fisheries Port. This study aims to understand the trend of fluctuations in fish catches in The w of Sumatera and examine the effect of variations in temperature and abundance of chlorophyll on fish catches in Western Sumatera.

2. Methodology

Sea surface temperatures and monthly chlorophyll-a concentrations were obtained from the results of the Aqua MODIS satellite which were downloaded via the www.modis.gsfc.nasa.gov website for 12 (twelve months) 2021 from the western waters of Sumatera between 98^0 42' 02" – 098^0 51' 00" east longitude and 00^0 00' 05" – 00^0 01' 32" south latitude located in Pini, Pulau Subdistrict, Batu Island, South Nias, which is a fishing ground area on the western coast of Sumatera. Temperature and chlorophyll-a data were extracted from satellite images only from 3 points (stations) namely 098^0 42' 02" east longitude 00^0 00' 54" south longitude (Station 1), 098^0 50' 64" east longitude 00^0 00' 56" south longitude (Station 2) 098^0 51' 78" East Longitude 00^0 01' 32" South Latitude (Station 3) which is the waters of the Indian Ocean west of Sumatera which is included in the WPP (Fisheries Management Area) 572. The time of the study was carried out from May 25th - August 5th, 2022, namely data collection of sea surface temperatures and the concentration of chlorophyll-a was extracted from the Aqua MODIS satellite imagery to obtain monthly data and data on fish catches obtained from the Sibolga Nusantara Fishery Port.

The tools used in this research are data processing tools and software and statistical analysis. The materials and tools used in the research are data on fishing results and vessels making catching which are obtained from the logbook recording of fishing vessels at the Sibolga Nusantara Fisheries Port (PPN) for a period of 12 (twelve months) 2021 which includes fishing areas in the waters. The Indian Ocean western of Sumatra is WPP (Fisheries Management Area) 572, which is a fishing area whose catch is landed at the Sibolga Nusantara Fisheries Port. The main material used in this study consisted of remote sensing data and CPUE data for the dominant fish caught.

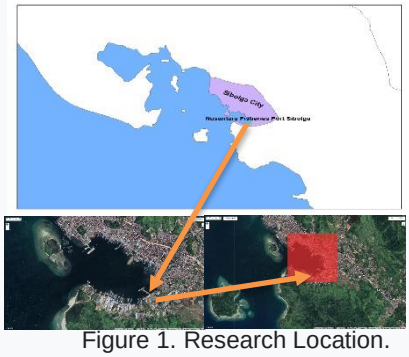

Figure 1. Research Location.

Analysis of fish production caught at the Sibolga Nusantara Fishery Port uses time series graphs and is interpreted based on the highest and lowest monthly CPUE production of fish caught at the Sibolga Nusantara Fishery Port. The calculation of CPUE (catch per unit effort) aims to determine the value of the catch rate of fishing effort based on the distribution of the total catch (catch) to the effort (effort). The formula used is as follows: (Gunawan, 2004).

$$CPUE_i = \frac{C_i}{F_i} \quad \text{..... 1}$$

Explanation :

C_i = i-th Catch (Tons)
F_i = i-th Catch Effort (Trip)
$CPUE_i$ = the number of catches of the i-th catch (kg/trip)

Data standardization analysis is used to standardize all existing data and obtain standard values, making it easier to make graphs of all existing data. Sartimbul *et al*., (2006). The formula used is:

$$S = \sqrt{\frac{\sum_{i=1}^{n}(x_i - \bar{X})^2}{n-1}} \quad \text{..... 2}$$

$$Z = \frac{x_i - \bar{X}}{S} \quad \text{..... 3}$$

Explanation :

z = standardization value
x_i = i-th x value
$\bar{X}$ = average value
s = standard deviation
n = Total number of data

While the SST, Chlorophyll-a, and CPUE analysis using anomaly analysis were carried out to determine the occurrence of data deviations from normal to fluctuating conditions, while seasonal analysis was carried out to determine the characteristics of each data according to the division of seasons (western, transition I, east, and transition II). Statistical analysis was carried out to determine the correlation value and the most related components of the overall data, so that the most dominant factors for variations in SST, Chlorophyll-a, and CPUE of fish caught at the Nusantara Fisheries Port for 12 (twelve) months from January 2021 to December 2021 According to Sartimbul (2006), to calculate the anomaly data used the formula:

$$\text{Anomaly} = X - \bar{X}$$

Explanation:

X = data on the calculated month

$\bar{X}$ = accumulated average data on the whole calculated month year

Time series analysis of sea surface temperature, chlorophyll-a concentration, and fishing effort per trip (CPUE) was carried out using Microsoft Excel 2019 to see the relationship between catch per trip (kg/trip) with sea surface temperature (^{0}C) and chlorophyll-a (mg/m^3) and fish CPUE.

3. Research result

a. Variations in Fish Catches on the Western Coast of Sumatra

Data on catches in the western waters of the Sumatera Indian Ocean in 2021 comes from data from the Log Book of Catches Landed at the Sibolga Nusantara Fisheries Port. Based on these data, fish catches on the western coast of Sumatra are still dominated by large pelagic groups. From the observations, fish from the Scombridae family are the most common types of fish caught in the waters of western Sumatra. Retno *et al*., (2019) also stated that the composition of catches in the western waters of Sumatera, the Indian Ocean, was dominated by large pelagic groups. The making of fish catch diagrams was carried out to determine the variation of the most dominant catch in the western waters of Sumatra so that the highest and lowest catch types of fish in the study area were seen in the Western Sumatran waters. Based on Figure 2, shows that the highest number of fish catches in the waters of Western Sumatera is dominated by 3 (three) types of fish, namely Skipjack tuna (*Katsuwonus pelamis*), Layang (*Decapterus sp*), and Sardinella (*Sardinella sp*). In general, Skipjack tuna *(Katsuwonus pelamis)* is the most dominant type of fish caught in the waters of western Sumatra.

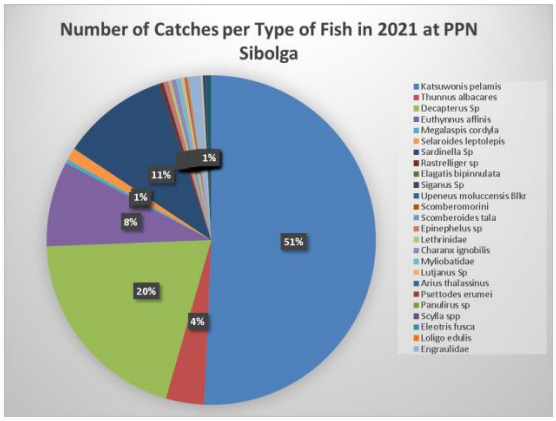

Figure 2. Graph of Catches of Western Sumatran Fish Landed at PPN Sibolga Year 2021.
Source: Fishing Logbook at PPN Sibolga, (Processed 2022).

Skipjack tuna (*Katsuwonus pelamis*) 11,655,768 kg (50.67 %), Layang (*Decapterus sp)* 4,589,147 (19.95 %), Sardinella (*Sardinella sp*) 2,421,523 (10.53 %), Cob (*Euthynnus affinis*) 1,926,158 kg (8,37%) and Yellowfin *(Thunnus albacares)* 865,985 (3,76 %). Other types of fish caught in the waters of the Indian Ocean on the Western Coast of Sumatera were 85,319 kg of hardtail scad (*Megalaspis cordyla*), 84,952 kg of mackerel (*Rastrelliger Spp*), 7,810 kg Rabbit Fish of (*Siganus Sp*.), 278,207 kg of Yellowstripe trevally (*Selaroides leptolepis*), 2,580 kg of Streaked Spanish Mackerel (*Scomberomorus commerson*), 2,250 kg of crab (*Portunus pelagicus*), and other types of fish.

b. Trend of Dominant Catches Caught on the Western Coast of Sumatera

There are three dominant types of fish caught on the western coast of Sumatera which landed at PPN Sibolga in 2021, namely Skipjack tuna (*Katsuwonis pelamis*), Layang (*Decapterus sp*) and Sardinella (*Sardinella sp*). many caught, followed by Layang *(Decapterus sp)* and Sardinella (*Sardinella sp*). Based on the graph below, it can be seen that the types of fish caught monthly on the western coast of Sumatra are very volatile every month. The peak of the dominance of Skipjack tuna (*Katsuwonus Pelamis*) production occurred in July, which was 62%, while for Layang (*Decapterus sp*) the peak of dominance occurred in November, namely 28.47%, and for Sardinella (*Sardinella sp*) the peak of dominance in June, which was 16.73%.

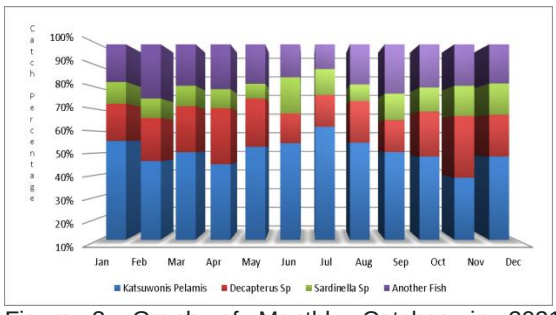

Figure 3. Graph of Monthly Catches in 2021 Western Coast of Sumatera Landed at PPN Sibolga.
Source: Fishing Logbook at PPN Sibolga 2021, (Processed 2022).

The fluctuation of catch on the Western Coast of Sumatra is influenced by several aspects such as the number of vessels, the number of fishing gear, natural conditions, and also the existence of government regulations. The catch of fish landed at PPN Sibolga in 2021 fluctuated every month, the highest fish catch occurred in May at 2,631,780 kg and the lowest catch occurred in June at 1,299,892 kg.

c. Dominant CPUE in Western Coast Sumatera

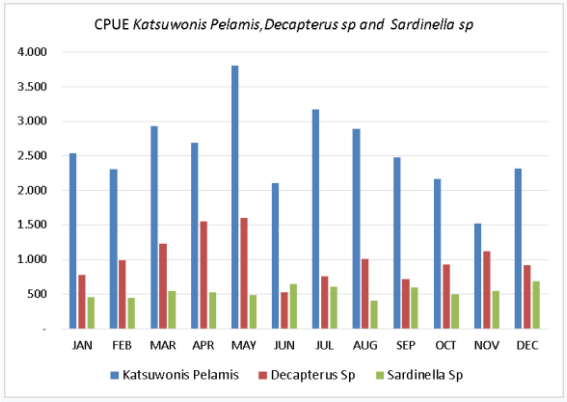

Figure 4. Monthly Fish Catch in Sibolga PPN 2021.
Source: Fishing Logbook at PPN Sibolga, (Processed 2022).

Based on the picture above, there are three dominant types of fish caught on the Western Coast of Sumatera which landed at PPN Sibolga in 2021, namely Skipjack tuna (*Katsuwonus pelamis*), Layang (*Decapterus sp*) and Tembang (*Sardinella sp*). In May 2021 production of Skipjack tuna (*Katsuwonus pelamis*) were caught the most at 3,809 tons compared to other months followed by Layang (*Decapterus sp*) as many as 1,604 tons and Sardinella (*Sardinella sp*) as many as 486 tons and in May 2021 is also the month with the highest catch in 2021. The lowest catch was in November where the total catch of Skipjack tuna (*Katsuwonus pelamis*) was 1,522 tons, followed by Layang (*Decapterus sp*) as much as 1,124 tons and Sardinella (Sardinella sp) as much as 551 tons.

The seasonal pattern of fish often does not match the general pattern of seasons. There is a very close relationship between sharp fluctuations and total production, mainly due to environmental changes. The similarity of the pattern between the seasons in one year with the next year is not yet known, depending on the presence or absence of significant changes in the aquatic environment (Arleston *et al.,* 2016).

d. Sea Surface Temperature (SST) in the waters of Western Coast Sumatera

Time series analysis was carried out to determine the variation, high and low limits of monthly sea surface temperatures for 12 months, namely in 2021 (Figure 5), showing the value of sea surface temperature on the Western Coast of Sumatera fluctuating every month. Based on the figure, the high-temperature phase occurs in February, while the lowest temperature occurs in August. In time series, fluctuations in the SST value on the Western Coast of Sumatera in 2021 ranged from 26.88 ^{0}C - 30.92 ^{0}C, with the lowest temperature value occurring in August, namely 26.88 ^{0}C, while the highest temperature value occurred in February at 30.92 ^{0}C when compared to other months. Under Gaol's statement, (2015) during the western season, air pressure in Indonesian waters weakens, so the wind will move currents that will carry warm water masses from high air pressure waters to Indonesian waters (low air pressure), on the contrary when the east season in the south.

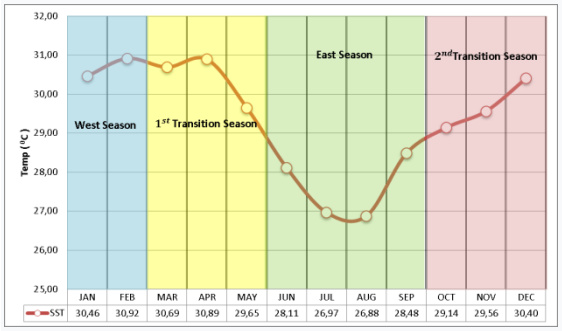

Figure 5. The trend of Sea Surface Temperature in the western waters of Sumatera.

e. Variation of Chlorophyll in the waters of Western Sumatra

Variations in chlorophyll concentration on the Western Coast of Sumatera were studied based on monthly observations of data from the Aqua Modis satellite in 2021. The range of chlorophyll-a concentrations on the Western Coast of Sumatera during the last twelve months was between 0.15 mg/m^3 (March 2021) to 1.56 mg/m^3 (May 2021). Seasonal variations in Indonesia are divided into 4, namely the western season (December, January, February), the transition season I (March, April, May), the east season (June, July, August), and the transition season II (September, October, November). Each season has different characteristics of sea surface temperatures due to variations in atmospheric pressure and fluctuating wind speeds.

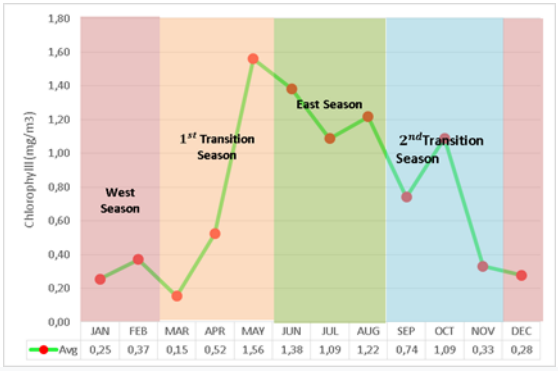

Figure 6. Timeseries of Chlorophyll-a Distribution in Western Sumatra Waters in 2021.

The pattern of chlorophyll concentration is influenced by monsoons. The Western monsoon which occurs in December – February (the beginning and end of the year) blows the wind from the northwestern to the southeast and brings heavy rainfall (Wyrtki, 1961). The east monsoon that occurs in June – August blows stronger and drier winds from the southeast to the northwestern (Wyrtki, 1961). The Western monsoon which occurs in December – February blows the wind from the northwestern to the southeast and brings heavy rainfall. High rainfall reduces the concentration of chlorophyll-a so that in this season the concentration of chlorophyll-a is low. the concentration of chlorophyll-a generally starts to increase in June until it reaches a peak in different months of the year.

f. relation between variations in sea surface temperature and chlorophyll-a

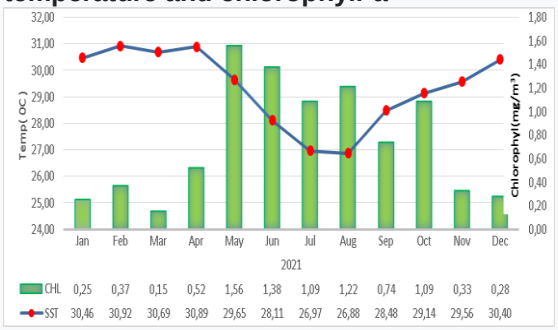

Figure 7. Relation between Temperature and Chlorophyll-a on the Western Coast Of Sumatra Waters in 2021

The results of the analysis of satellite images analysis for the temperature and chlorophyll distribution in December 2021. Based on the picture above, the relationship between temperature and chlorophyll shows that the correlation between temperature and chlorophyll-a can be categorized as a negative linear correlation, that is, it can be illustrated that the value of chlorophyll concentration will be high if the temperature value decreases so vice versa, while the correlation between catches and chlorophyll-a can be categorized as positive linear correlation, namely the catch value will be high if the chlorophyll-a level is also high, and vice versa. Figure 7 shows an increase in the decrease in temperature in mid-2021, namely in May and June followed by an increase in chlorophyll concentration inversely proportional to the sea surface temperature at the end of 2021, an increase in November and December, followed by a decrease in chlorophyll concentration.

g. The relation between chlorophyll-a and catch

Fish will choose habitats whose environmental conditions are by their biological life, where these habitats are strongly influenced by oceanographic conditions such as temperature, chlorophyll, salinity, weather, and others (Indrayani, 2012), according to Indrayani, (2012) the existence of small pelagic fish is more determined by habitat with chlorophyll-a meeting position and optimal temperature, compared to other oceanographic parameters.

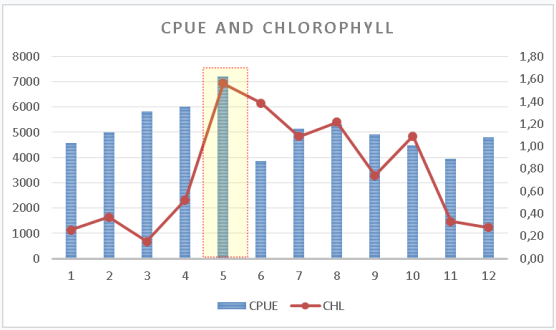

Figure 8. The relationship between chlorophyll and CPUE in the waters of Western Coast Sumatra landed in Sibolga PPN 2021.

The production volume increased considerably in May (Figure 8) can be seen that an increase in fish catches in May was the peak of the highest catch occurred in 2021 where the concentration of chlorophyll also experienced the highest increase compared to other months. At the end of the year, the concentration of chlorophyll in the waters of western Sumatra decreased, which was also followed by a decrease in CPUE landed at PPN Sibolga. The results of previous studies also showed a positive relationship between the concentration of chlorophyll-a and fish production. An increase in the concentration of chlorophyll-a is generally followed by an increase in fish production (Sartimbul, 2016). This indicates that fluctuations in oceanographic parameters have an effect on the presence of fish in the waters.

4. Conclusions And Recommendations

4.1. Conclusions

a. The composition of catches in the western waters of Sumatra which landed at PPN Sibolga in 2021 there are three dominant fish species, namely Skipjack tuna (*Katsuwonus pelamis*) 11,655,768 kg (50.67 %), Layang (*Decapterus sp*) 4,589,147 (19, 95 %), Sardinella *(Sardinella sp*) 2,421,523 (10.53 %), The variation of fish catch per business unit (CPUE) landed at the Sibolga Nusantara Fishery Port in 2021, the highest occurred in May at 3,809 kg/trip and the lowest CPUE occurred in November 1,521.58 kg/trip and the average monthly CPUE in 2021 was 5,105.88 kg/trip.

b. Monthly variations of sea surface temperature and chlorophyll-a in the waters of Western Sumatra for 12 months (2021) obtained the lowest temperature value occurred in August, namely 26.88 ^{0}C while the highest temperature value in February was 30.92 ^{0}C, concentration The highest chlorophyll value was in May at 1.56 mg/m^3 while the lowest value occurred in March at 0.15 mg/m^3.

c. The correlation between sea surface temperature, chlorophyll-a, and CPUE of fish shows that when the sea surface temperature is low, it is followed by a high concentration of chlorophyll which correlates with the increase in fish catches in the Western Coast of Sumatra.

4.2. Recommendations

a. The government is expected to be able to implement conservation policies by setting the maximum limit for fishing, namely by setting the time and zoning for fishing to preserve fish resources.
b. Conducting further research on other environmental parameters of the catch and assessment of other aspects such as socio-economic and environmental to add references to marine management.
c. Thanks to :
We would like to thank the Government officials at the Sibolga Nusantara Fisheries Port agency for data on fish catches, the number of boat trips, and other fishery data. we thank the National Oceanic and Atmospheric Administration (NOAA) for the production and distribution data Aqua Modis for chlorophyll-a, SST data. The author would like to thank the Ministry of Education, Culture, Research and Technology which has contributed through the 2022 Beginner Lecturer Research (PDP) fund.

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