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Original research article

Analysis of Chlorophyll-A Distribution And Sea Surface Temperature for Estimation of Skipjack Fishing Grounds (*Katsuwonus Pelamis*) Based on Different Seasons in South Buton Waters

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ABSTRACT

The success of fishing activities is certainly greatly influenced by the conditions of the Fishing Ground (FG). Therefore, information about potential fishing areas is needed by fishermen in fishing activities. Chlorophyll-a is the primary productivity in water. The development of aquatic chlorophyll is influenced by Sea Surface Temperature (SST). The purpose of this study was to analyze the distribution of chlorophyll-a and sea surface temperature (SST) for estimating fish fishing areas based on different seasons in South Buton Waters. This type of research is exploratory research. This study used remote sensing method. The direct interview method with respondents aims to validate data (fishermen) from remote sensing processing. The study used Aqua Modis satellite imagery data to derive parameter values of chlorophyll-a and sea surface temperature. The results of the analysis of the distribution of chlorophyll-a in South Buton waters are the highest with chlorophyll-a concentrations ranging from 0.3-3.0 mg / m³ spread in the waters of Sampolawa and Batauga Districts with surface temperatures ranging from 26°C and 33°C. Eastern and Transitional Season II have high levels of chlorophyll-a concentration. This season will be a potential skipjack fishing area in South Buton Waters.

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Introduction

South Buton Regency is one of the areas that has potential fish resources. These fish resources include large and small pelagic fish species, as well as demersal, spread across seven districts, namely Lapandewa, Kadatua, Sampolawa, Siompu, and West Siompu, Batauga, and Batuatas (Widihastuti 2019; Hamar 2023). The waters of South Buton are also flanked by the Flores Sea and the Banda Sea, so its location becomes very strategic, the potential and economic value of its fish resources are quite high and generally the majority of fishermen as fishing use rumpon as a fishing aid (Hamar, 2023).

The production of capture fisheries in South Buton in 2014 has contributed to the potential of the Fisheries Management Area of the Republic of Indonesia 714 or WPP RI 714, which is 7,308 tons (DKP South Buton, 2015). The largest contributor to capture fisheries production is Batauga District with a total of 1,869 tons, with the highest catch being the type of swordfish. Lapandewa sub-district contributes the lowest production with a total of 7 tons, with the highest catch of skipjack fish species (Marine and Fisheries Service, 2015). According to WPP 714 potential estimation data of 474,200 tons, the average fishery production from South Buton Regency is 35,452 tons/year (Marine and Fisheries Service, 2015).

One of the factors for the success of fishing operations at sea is knowledge about Fishing Grounds (FG) and knowing the effectiveness of catches from the construction of fishing equipment Abdullah (2018) and Vivi *et al*. (2023). A fishing ground (FG) is an area that is a habitat for fish populations and is a potential target to be used to capture fisheries income (Munthe, 2010). However, information on these fishing grounds is still difficult to obtain with certainty, so fishermen are only based on experience in determining fishing areas. As a result, fishing efforts are less efficient because they incur large costs for fuel consumption (BBM) in finding skipjack schooling (Simbolon, 2010).

Several factors affect the distribution and abundance of skipjack fish including Temperature and Chlorophyll-a. Chlorophyll-a is one of the parameters that largely determines primary productivity in the sea. The distribution and high and low concentration of chlorophyll-a is strongly related to the physical oceanographic conditions of an aquatic body. Sea Surface Temperature (SST) is used as a marker in determining fertility because it has an impact on the metabolic processes, breeding and distribution of marine organisms (Yuniarti *et al*. 2013). SPL observations to predict the presence of skipjack fish are very precise because skipjack is a species of fish whose swimming layer is found in the surface layer. Matsumoto (1984), Suhendrata (1986), Anggarini (2003), Simbolon and Halim (2006), and Syahdan *et al*. (2007) reported that SPL affects the distribution of skipjacks, and the range of SPL values varies temporally and spatially (Fajrianti, *et al* 2016).

Fishing ground (FG) can be determined through remote sensing using satellite imagery. One of the satellite images that can detect the distribution of chlorophyll-a and SPL in waters is the Aqua satellite image with the MODIS sensor which can be downloaded on the NASA portal, namely MODIS L3 (https://oceancolor.gsfc.nasa.gov) (Zainuddin, 2017). Aqua MODIS has a mission to collect information about the water cycle on earth which has more spectral wavelengths and a more precise recording area (Bukhari, 2017).

The provision of fishing area information in the waters of South Buton Regency needs to be known by fishermen so that fishing efforts are more efficient in fuel consumption, energy, and fishing

operation time and income, so this research is important to do. The knowledge of this fishing area is known by conducting interviews with fishermen so that it can be known where the skipjack fishing is located. This study aims to analyze the distribution of chlorophyll-a and sea surface temperature (SPL) to estimate fish fishing areas based on different seasons in South Buton Waters.

Materials and Methods

Research Location

This research will be carried out in March-September 2023 located in South Buton Waters. The field survey in the form of interviews was carried out on April 22-24, 2023 in Tira, Bahari, Lande and Lakaliba Villages. The processing of Chlorophyll-a and SPL data will be carried out in May 2023 at the Oceanography Lab of FMIPA UHO. Data used in 2020.

Data Collection

The data collected in this study is in the form of information about fishing grounds through oceanographic parameters including chlorophyll-a and sea surface temperature. The type of data obtained in this study is time series data in 2020 consisting of secondary and primary data. Secondary data in this study are sea surface temperature and chlorophyll-a data obtained from the Aqua MODIS level 3 satellite image approach for a monthly period downloaded from the page (https://oceancolor.gsfc.nasa.gov) in the form of NC files_and then processed *to OpenGrads Software* As for the primary data in this study, namely the fishing area surveyed directly to the field. Fish production data is obtained from the South Buton Fisheries and Marine Service, supporting data is in the form of information about fishing areas obtained through interviews with fishermen, which is asked in the interview in the form of where the fishing location is, what type of fishing gear is used when fishing, what type of fish is caught, Number of catches, fishing area coordinate points, etc. Other supporting data were obtained from interviews and documentation. The variables used in the determination of fishing grounds are temperature and chlorophyll-a. Sea surface temperature information can determine the location where fish are very much gathered. The variable chlorophyll-a can indicate that the area is fertile enough and rich in nutrients so it is suspected that fish will be more concentrated in the area. Fishing grounds in South Buton waters were predetermined using questionnaires and GPS from fishermen in South Buton.

Data Analysis

The data analysis used in this study is spatial analysis, where the data obtained are analyzed using satellite image interpretation analysis based on water characteristics through chlorophyll-a distribution and sea surface temperature.

1. Analysis of chlorophyll-a and SST

Chlorophyll-a and SST distribution uses monthly average analysis by averaging monthly data using scripts in OpenGrads software and produces chlorophyll-a distribution and sea surface temperature. The relationship between chlorophyll-a and SST was analyzed using interpolation analysis. Interpolation analysis is a set of methods to find and describe the level / pattern of a spatial phenomenon so that it can be better understood.

The use of spatial analysis is expected to emerge new information that can be used as a basis for decision making in the field studied (Aswant, 2016). Interpolation is a mathematical method or function that infers values at locations for which data is not available (Anderson, 2001). Interpolation analysis is an analysis used to describe the distribution

of temperature and chlorophyll-a waters of South Buton. Interpolation analysis is sampled based on surrounding data (Purnomo, 2018). From the interpolation process produces a characteristic map of each image. Furthermore, the process of merging images or known as Overlay is carried out. Overlay is done to combine the contour of the sea surface temperature image and the contour of the chlorophyll-a distribution image (Hasyim, 2015).

2. Fishing ground estimation

Fishing ground estimation Geographically can be known using the Descriptive Method with an overlay technique between SST and Chlorophyll-a. The descriptive method aims to describe the current state and relate between existing variables (Bukhari, 2017).

Results and Discussion

Distribution of Seasonal Chlorophyll-A Concentration in South Buton Waters for the 2020 Period

In general, chlorophyll-a concentrations in South Buton waters reached the lowest and highest at 0.5 mg/m³ and 3.0 mg/m³. The distribution map of chlorophyll-a can be presented in Figure 4.1. Based on Figure 1 The concentration of chlorophyll-a distribution in the western season (December, January and February) in the waters of South Buton Regency ranges from 0.11-0.50 mg / m³. According to Prianto (2013), the western season occurs around December-February, where generally strong winds, high rainfall and thick cloud concentrations. The distribution of chlorophyll-a in February is found around the coast of the sub-district. Sampolawa, Batauga and Siompu. In January, chlorophyll-a distribution was found in the waters of Batauga and Siompu sub-districts and in December chlorophyll-a distribution was found around the waters of Batauga sub-district with chlorophyll-a concentrations ranging between 0.15-0.50 mg/m³. Chlorophyll-a concentrations in December are high near coastal areas and fall as they move away from the coast. According to Zulkarnaen 2009 the concentration of chlorophyll-a in coastal and coastal waters is relatively high compared to high seas areas, due to the supply of nutrient supply through river run-off from land while chlorophyll-a is lowest far from the coast and occurs in February. During the western season, chlorophyll-a distribution concentration is found around the waters of Sampolawa, Batauga, and Siompu Districts. The average value of chlorophyll-a distribution that occurs in the western season is still in the good category.

The distribution concentration of chlorophyll-a in the first transition season (March, April, and May) in the waters of South Buton Regency ranged from 0.20-0.1.1 mg/m³. In the first intermediate season, there is a difference in chlorophyll-a concentration compared to the Western Season and there is an increase in chlorophyll-a, namely Bearada in May with a concentration of 0.20-0.1.1 mg / m³ spread in the waters of Batauga District and Siompu District. This is thought to be due to the high rainfall that falls in Indonesia, causing a lot of nutrients to enter sea waters through river flows (Putra, 2013). The highest concentration in May ranged from 0.30-0.32 mg/m³ with chlorophyll-a distribution only in the waters of Batauga District. This is due to the supply of nutrients in large quantities through ground surface flow (run-off) which enters the watershed and empties into the waters of Batauga. The lowest concentration of chlorophyll-a was in March with a value of 0.22-0.28 mg / m³ spread in the waters of Lapandewa District, especially in Lakaliba village. Low chlorophyll-a can be influenced by lack of nutrients due to upwelling on a less significant scale, so that the supply of phytoplankton growth nutrients and

chlorophyll-a production is limited (Rahma, 2023).

The distribution concentration of chlorophyll-a in the Eastern Season (June, July and August) in the waters of South Buton Regency is between 0.3-3.0 mg/m³. In June chlorophyll-a concentrations ranged from 0.3-3.0 mg/m³ spread in the waters of Sampolawa and Batauga sub-districts.

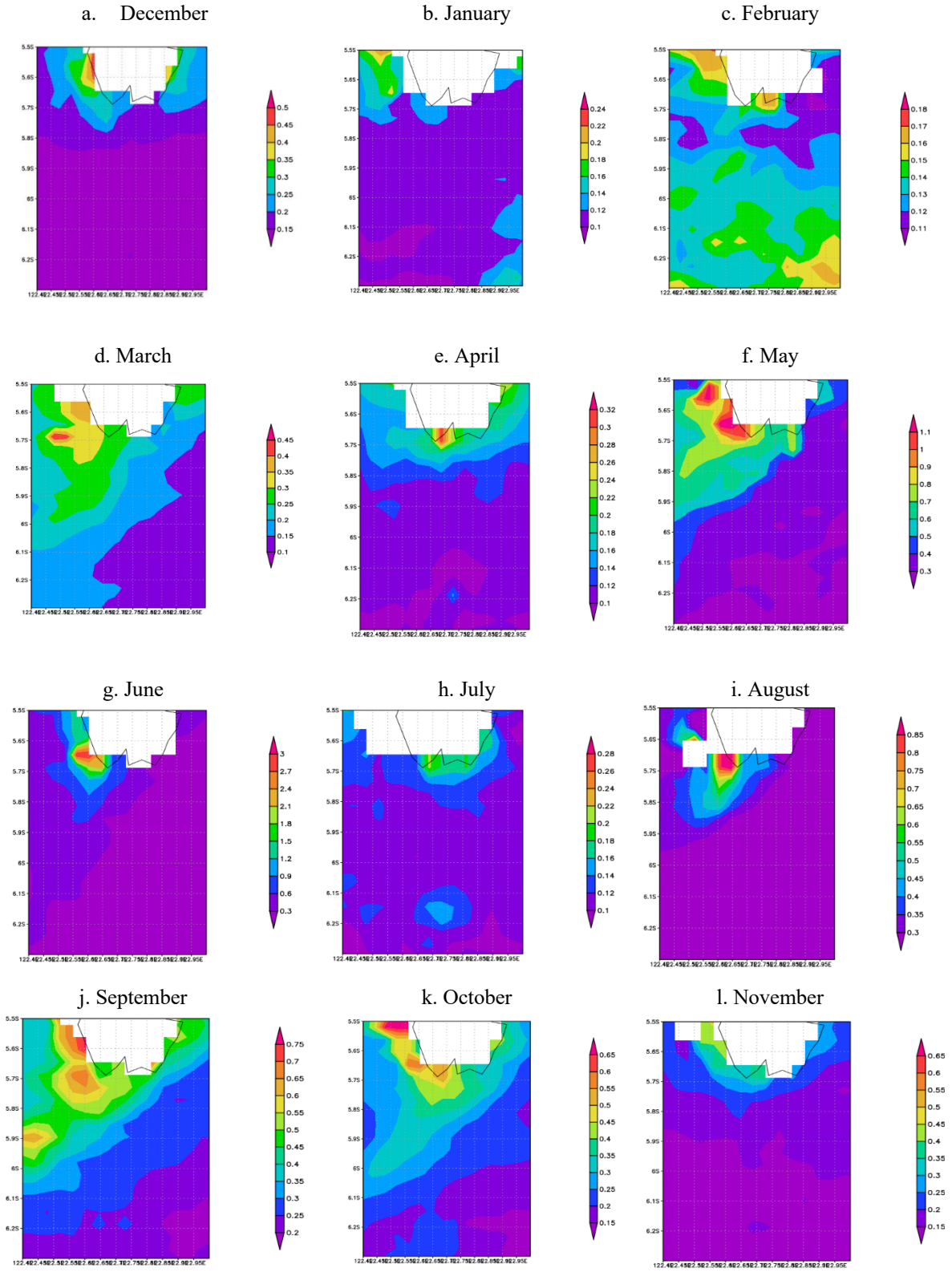

Figure 1. Distribution of Chlorophyll-a Concentration Based on Season 2020 in South Buton Regency Waters

In July the concentration of chlorophyll-a was in the range of 0.4-0.28 mg/m³ spread in the waters of Batauga District. In August chlorophyll-a concentrations ranged from 0.3-0.85 mg/m³ spread in the waters of Siompu and Kadatua sub-districts. The highest chlorophyll-a values in June ranged from 0.3-3.0 mg/m³, this is thought to be due to the presence of high nutrients originating from inland waters. The high and low chlorophyll content of phytoplankton is strongly influenced by the terrestrial environment, namely the entry of nutrients through the flow of rivers that empty along the coast (Printon, 2013). The lowest concentration of chlorophyll-a in July with values of 0.3-0.28 mg/m³. However, judging from the fertility of the waters, July includes fertile waters just like June and August. According to Wouthuyzen (2006) in Prihartato (2009) chlorophyll-a concentrations that exceed 0.2 mg/m³ are classified as fertile waters. The concentration of chlorophyll-a in August ranged from 0.3-0.85 mg/m³ spread in the waters of Batauga and Kadatua Districts.

The distribution of chlorophyll-a in the second transition season (September, October and November) in the waters of South Buton Regency is between 0.15-0.75 mg/m³. In the second transition season, there is a difference in chlorophyll-a concentration compared to the Eastern Season., namely in the second transition season there is an increase in chlorophyll-a. The highest concentration of chlorophyll-a was in September with a value of 0.15-0.75 mg/m³ which began to spread in the waters of Batauga and Siompu Districts. Chlorophyll concentration in October and November is the same value of 0.15-0.65 mg / m³, spread around the waters of Batauga, Siopmu and Kadatua Districts. The spread of chlorophyll-a in October and November is the same pattern.

Seasonal Spread of Sea Surface Temperatures in South Buton District Waters

In general, the distribution of SPL in South Buton waters reaches the lowest and highest at 26°C and 33°C. °The distribution map of Chlorophyll-a can be presented in Figure 4.2. Based on Figure 2 The distribution of sea surface temperatures in the western season (December, January and February) in the waters of South Buton Regency ranges from 28°C-32°C visually shows that warm temperatures in January and February are found in the waters of Siompu, Kadatua, Sampolawa, Batauga and Lapandewa Districts, especially in Lakaliba district with a range of values reaching 29.2°C -31.2°C . According to Zulfikar et al. (2017), near-coastal waters have higher temperatures than offshore waters or far from the coast. The strong influence of land on water temperature causes coastal waters to have higher temperatures than offshore waters. Daily variations occur mainly in the surface layer. Cold temperatures are found in December in all sub-districts. The distribution of Sea Surface Temperatures in Citra during 2020 in January and February looks warmer compared to December. This is reinforced by Effendi et al. (2012), that the distribution of chlorophyll-a concentration is very dependent on sea surface temperature conditions where the colder the sea surface temperature, the more chlorophyll-a contained in it.

Sea Surface Temperature in Transition Season I in South Buton District Waters ranges from 29°C-33 C°. In Transition Season I (March, April and May) visually shows that warm temperatures are dominant in the waters of Sampolawa, Batauga and Lapandewa Districts. The distribution of images during 2020 in March tends to be warmer compared to April and May. In March warm temperatures tend to be in the waters of Kadatua and Siompu with a

value range of 30°C-33°C.While cold temperatures are in the waters of Batauga, Sampolawa and Lapandewa Districts. In April the temperature is warm in the waters of Lapandewa District with a value range of 30.6°C-32.6°C. Cold temperatures are in the waters of Sampolawa and Batauga Districts.

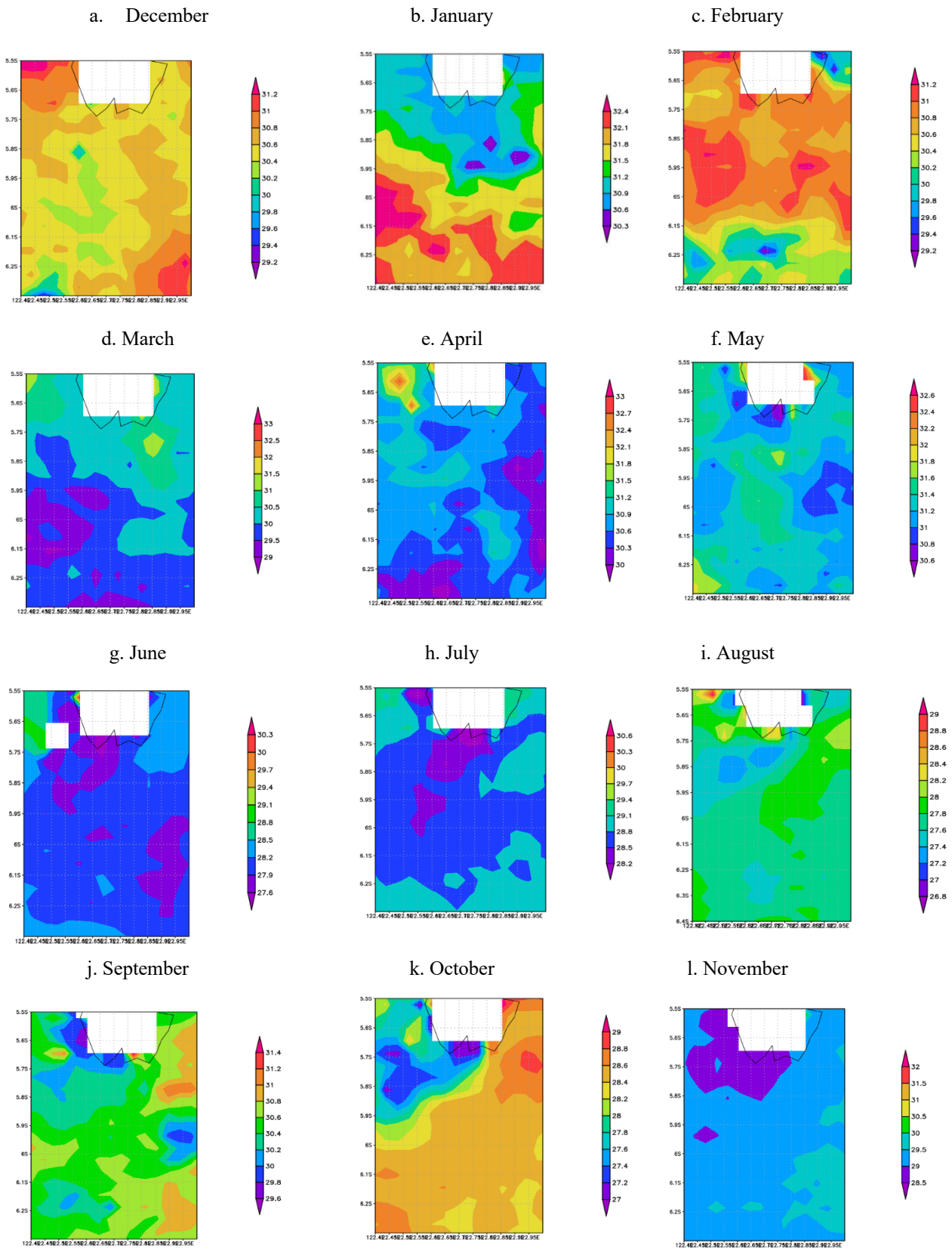

Figure 2. SST Spread Based on Season 2020 in South Buton District Waters

In May warm temperatures were in the waters of Burangasi Village with a range of values reaching 29°C-33°C, cold temperatures were in the waters of Sampolawa, Kadatua, Siompu Barata, Siompu Bataugadan Batuatas Districts. The temperature distribution in the First Transition Season tends to be eastward. This is by the statement of Simbolon and Tajuddah (2008) that in the transition season I is more dominant showing warm temperatures pushed by cold water masses to the east as the West Monsoon comes.

The first transition season sees a difference in sea surface temperature movements with the Western Season. In this season the distribution of sea surface temperatures shows that there has been a slight mix between warm-water masses and cold-water masses. It is suspected that this is due to the influence of the eastern monsoon current system that pushes surface water masses (Tajuddah, 2017).

Sea surface temperatures in the Eastern Season in South Buton waters range from 26-33.3°C. The image of the sea surface temperature of the Eastern season (June, July, and August) for 1 year (2020) tends to be cooler than the Western Season and the Transition Season I. In the Eastern Season, there is a difference in the distribution of sea surface temperature movements, where the mixture of warm water masses and cold water masses in most sea surface temperature images of the First Transition Season is no longer seen changing with cold water masses that dominate in almost all images in the Eastern Season.In this season the distribution of SPL shows that it has been mixed between warm water masses and cold water masses, allegedly due to changes in seasonal wind movement patterns that push surface water masses.

In the Second Transition Season, sea surface temperatures in South Buton waters ranged from 27°C-32°C. Warm temperatures tended to be in Lapandewa waters while cold temperatures tended to be in Sampolawa, Batauga and Siompu. In the Second Transition Season (September, October and November), it spatially shows that sea surface temperatures in November are warmer than in September and October. In September and October, sea surface temperatures are cooler in the waters of Sampolawa and Batauga. In November the warm temperature in the waters of Burangasi and Batuatas while the cold temperature is in the waters of Batauga and Sampolawa because the water area close to the coast has a relatively warmer temperature indicated by the red color near the island, when compared to offshore waters that tend to be cold indicated by gradations of yellow to dark green.

Based on the distribution of chlorophyll-a and sea surface temperature provides information on skipjack fishing grounds. The highest average chlorophyll-a values occur in the eastern season and transition II, while the lowest distribution of chlorophyll-a occurs in the western season and transition I. According to Siregar's (2018) research fertile waters have a high level of chlorophyll-a concentration, because chlorophyll-a is an indicator of fertility in them. The concentration of chlorophyll-a is also influenced by currents in these waters. However, overall chlorophyll-a concentrations often occur in coastal areas. This happens due to the flow of organic matter through rivers that flow into the sea.

Conclusion

The distribution of chlorophyll-a shows good indicators with a value range of 0.5 – 3.0 mg/m³ with an average temperature in the range of SST 29°C - 33°C. South Buton waters are worthy as an estimation of the location of skipjack fish fishing ground with potential categories. The eastern season and the

second intermediate season in the South Buton region tend to be better compared to other seasons. The eastern and intermediate seasons II have high concentrations of chlorophyll-a. This season will be a potential skipjack fishing area in South Buton Waters.

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