P-ISSN: 2355-729X
Jurnal IPTEKS PSP. Vol. 10 (1) April 2023: 28 – 35 E-ISSN: 2614-5014

SPATIAL AND TEMPORAL DISTRIBUTION OF SKIPJACK AND LITTLE TUNA IN FISHERIES MANAGEMENT AREA 713

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Manuscript Recived: 10 October 2022
Revision Accapted: 4 April 2023
DOI: 10.20956/jipsp.v10i1.23774

ABSTRACT

Indonesian Fisheries Management Area (IFMA) 713 is a strategic and potential area for utilizing large pelagic fishery resources. In general, there are no fixed fishing grounds for large pelagic fish, and they are always changing and moving following the movement of environmental conditions, which naturally causes fish to choose a more suitable habitat. This study examines the distribution and abundance of skipjack tuna (Katsuwonus pelamis) and little tuna (Euthynnus sp) in relation to oceanographic conditions such as the distribution of sea surface temperature and sea surface chlorophyll-a concentrations in Indonesian Fisheries Management Area 713, which includes the Makassar Strait, Flores Sea, and Bone Bay. Based on the findings, skipjack tuna tends to be caught at warmer temperatures and higher chlorophyll-a concentrations than little tuna. Skipjack tuna tended to be distributed at a temperature of 29.84°C-30.28°C, which was associated with a chlorophyll-a concentration of 0.3 mg m^{-3}, in contrast to little tuna, which was distributed at a temperature of 27.92°C-28.66°C with the most productive chlorophyll-a concentration (relatively high CPUE) of 0.2 mg m^{-3}. This information on habitat distribution and optimum conditions of oceanographic parameters is very useful for the sustainable management of skipjack tuna and little tuna in the IFMA 713. in contrast to little tuna, which was distributed at a temperature of 27.92°C-28.66°C with the most productive chlorophyll-a concentration (relatively high CPUE) of 0.2 mg m^{-3}. This information on habitat distribution and optimum conditions of oceanographic parameters is very useful for the sustainable management of skipjack tuna and little tuna in the IFMA 713. in contrast to little tuna, which was distributed at a temperature of 27.92°C-28.66°C with the most productive chlorophyll-a concentration (relatively high CPUE) of 0.2 mg m^{-3}. This information on habitat distribution and optimum conditions of oceanographic parameters is very useful for the sustainable management of skipjack tuna and little tuna in the IFMA 713.

Keywords: IFMA 713, Little tuna, Oceanographic factors, Skipjack tuna.

INTRODUCTION

An economically important fishing area is a waters where groups of fish such as skipjack tuna and little tuna and other economically important fish that are the target of catching are expected to be caught maximally, but still within the limits of resource sustainability. This type of fish is also included in the type of fish that has a long migration rate and a fairly deep vertical distribution (Froese and Pauly, 2011).

There is no fixed fishing ground (fishing ground) for large pelagics, it always changes and moves following the movement of environmental conditions, which naturally causes fish to choose a more suitable habitat. The formation of the ideal habitat is strongly

influenced by the conditions or oceanographic parameters of the waters. This affects the dynamics of the movement of water masses horizontally and vertically which in turn will affect the distribution and abundance of fish.

Identification of potential fishing areas using remote sensing technology based on satellite image data (satellite remote sensing) is an indirect method of identification. From oceanographic satellite imagery data, observations were made of oceanographic parameters such as the distribution of sea surface temperatures, and estimates of chlorophyll-a content (Safruddin et al., 2019). The results of these observations are expressed in the form of a contour map, so that it can be estimated the fertility level of a water location or the suitability of water conditions with the habitat favored by a school of fish based on latitude coordinates for tuna.(Zainuddin et. al., 2006; Safruddin et. al., 2020).

This study examines the distribution and abundance of skipjack and tuna in relation to oceanographic conditions in the sea Fishery Management Area 713 which includes Makassar Strait, Flores Sea and Bone Bay. Fishing base in the waters of the Makassar Strait (Barru Regency) and the Flores Sea (Bulkumba Regency)..

MATERIAL AND METHOD

This research was conducted from April to June 2021 in Fisheries Management Area (WPP) 713. Purse seine is a fishing tool used with the main catch targets are skipjack and tuna.

Data collection

There are two types of data collected, namely primary data (observation data or data obtained directly in the field (position and catch data) by following fishing operations. Secondary data consists of oceanographic satellite imagery data in the form of sea surface temperature and chlorophyll -a sea level.

Data analysis

The primary and secondary data collected were analyzed and visualized using ArcGIS 10.4 software and the productivity of the catch was analyzed by Catch per unit effort of fishing effort carried out with purse seine fishing gear with skipjack and tuna fishing targets was calculated by the following equation:

$$U_{t,i,j} = \frac{\sum C_{t,i,j}}{\sum E_{t,i,j}},$$

Where Ut; i; j, Ct; i; j, and Et; i; j was the nominal CPUE, the sum of catches for all of the fishing fleets within a fishing grid, and the sum of all fishing efforts (fishing days) of all fishing vessels within a fishing grid, respectively, at longitude i, latitude j in time t. The nominal CPUEs of different temporal scales were obtained by changing t. For example, if t is month, Ut; i; j represents monthly nominal CPUE; if t is year, Ut; i; j represents yearly nominal CPUE.

P-ISSN: 2355-729X
E-ISSN: 2614-5014

RESULTS AND DISCUSSION

Distribution of skipjack and tuna and distribution of sea surface temperature

The main parameters in identifying skipjack and tuna habitats are SST and SSC, because both are positively correlated with the distribution of marine organisms, especially fish (Andrade, 2003; Zainuddin et. al., 2017).

Temperature is an important variable in influencing the growth of phytoplankton and directly affects the physiological condition of fish (Yuniarti et. al., 2013). While chlorophyll-a is closely related to productivity as indicated by the amount of phytoplankton biomass which is the first food chain of pelagic fish (Kunarso et. al., 2011). The level of water fertility can be estimated by knowing the concentration of chlorophyll-a.

Andrade and Garcia (1999) defined the natural relationship between pelagic fish and sea surface temperature, indicating that biotic and abiotic factors are significant in this relationship (Andrade, 2003). In sub-tropical waters, such as in Japan, the optimal sea surface temperature for skipjack distribution is not less than 18 °C (Kiyofuji et. al., 2019). For tropical waters, the optimal temperature value is between 28.5 °C - 31.5 °C (Zainuddin et. al., 2017). In this study, two types of large pelagic fish were shown, namely skipjack and tuna. Tuna fish looks caught at a cooler temperature when compared to skipjack tuna.

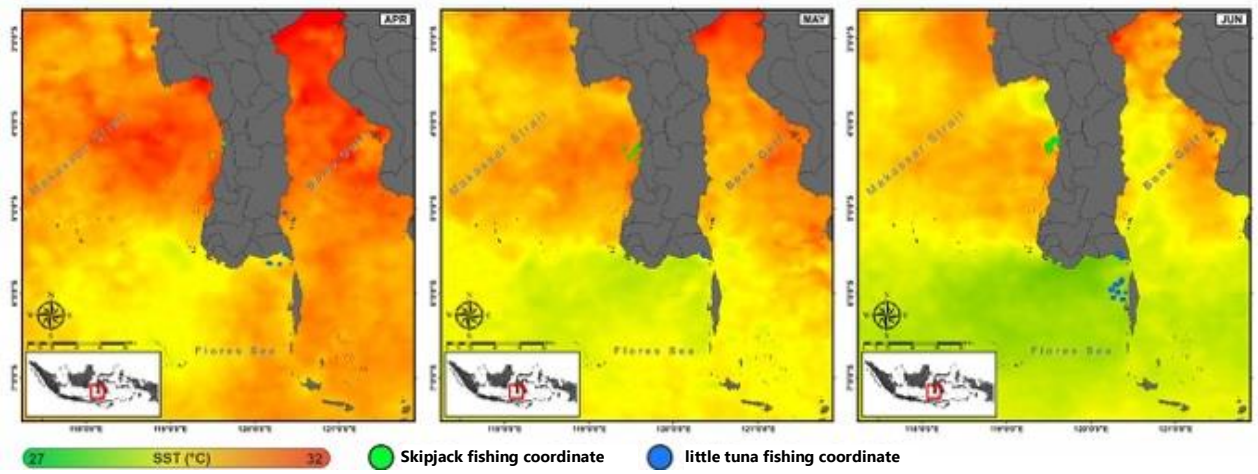

Figure 1. Spatial distribution of skipjack and little tuna based on SST from April to June 2021.

Skipjack tuna is seen to have a fishing temperature range of 29.84 to 30.28°C, the value of the sea surface temperature of skipjack tuna is also described in previous studies in the Makassar Strait with the optimum temperature obtained between 28.78°C to 30.25°C (Hidayat et. al., 2021). Each temperature range for skipjack tuna seems to have almost the same number of catches per unit effort (CPUE), but the highest CPUE value is in the temperature range of 30.63°C with a total of 569 skipjack tuna/catch effort out of a total of 2.376 catches. While for

tuna caught in a temperature range of 27.92°C to 28.66°C where the highest CPUE value is in the temperature range of 28.38°C with a CPUE of 7.560 tuna/catch effort from a total of 11.039 tuna catches.

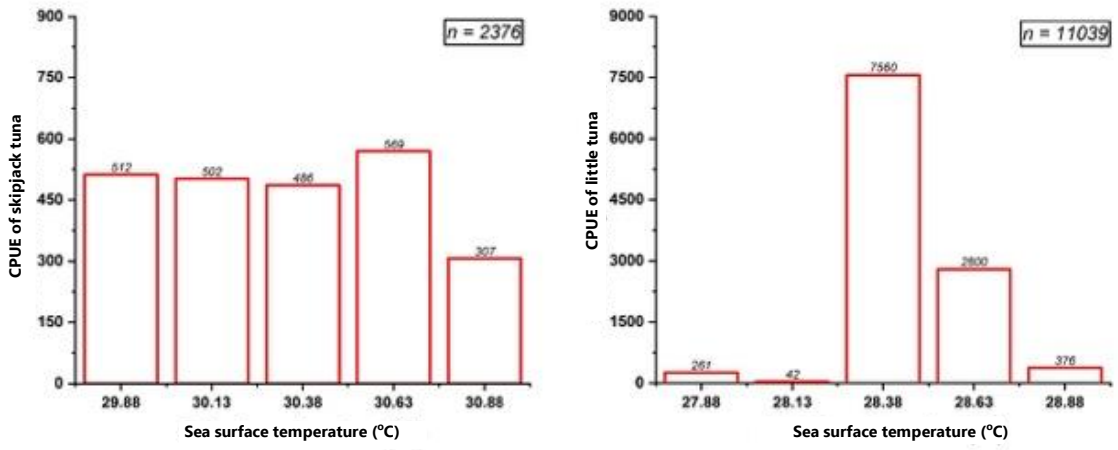

Figure 2. Relationship between sea surface temperature and CPUE of skipjack and tuna in FMA 713

Distribution of skipjack and tuna and chlorophyll-a concentration

Large pelagic fish such as skipjack and tuna are visual opportunistic predators that eat a variety of prey.(Duffy et. al., 2017; Olson et. al., 2016). The role of chlorophyll-a is not directly related to the distribution of large pelagic fish in the waters, chlorophyll-a is used as an indicator of the feeding ground of large pelagic fish.(Safruddin et. al., 2018; Hidayat et. al., 2019;). According to Olson et. al. (2016) the food composition of tropical tuna will depend on body size, location, period, and water depth.

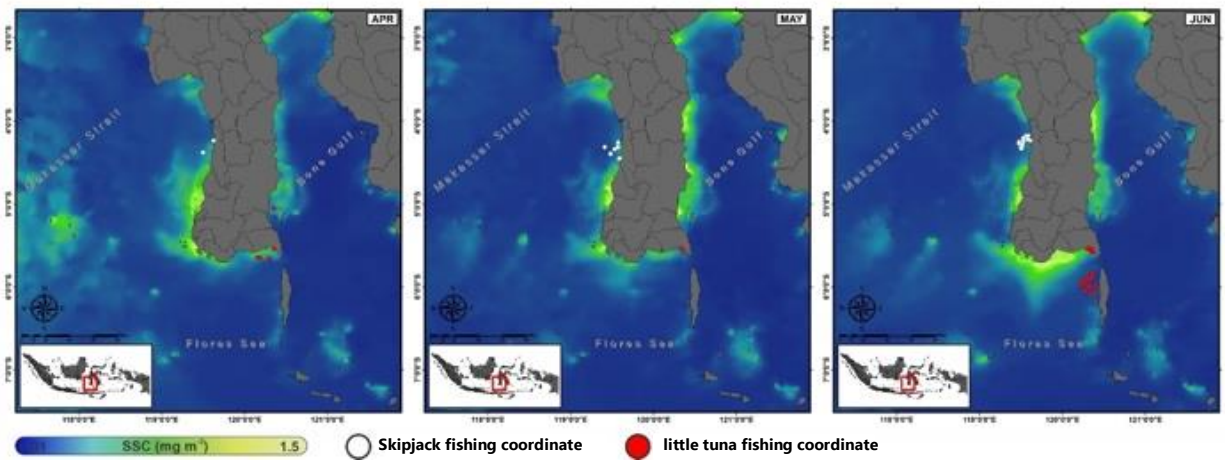

Figure 3. Spatial distribution of skipjack and tuna based on chlorophyll-a concentrations from April to June 2021.

P-ISSN: 2355-729X
E-ISSN: 2614-5014

As an indicator of the presence of fish in the waters, the concentration of chlorophyll-a can certainly be a reference for determining fishing areas and even as basic information for predicting potential zones of economically important fish. In this study found different characteristics of the optimum concentration of chlorophyll-a from skipjack and tuna. Figure 4 shows that skipjack tuna is caught in waters that have a chlorophyll-a concentration of about 0.3 mg m^{-3} with a CPUE of 1.066 fish from a total of 2.376 fish caught. The most productive concentration of chlorophyll-a for tuna was around 0.2 mg m^{-3} with a total CPUE of 7.840 fish out of 11.039 fish in total catch.

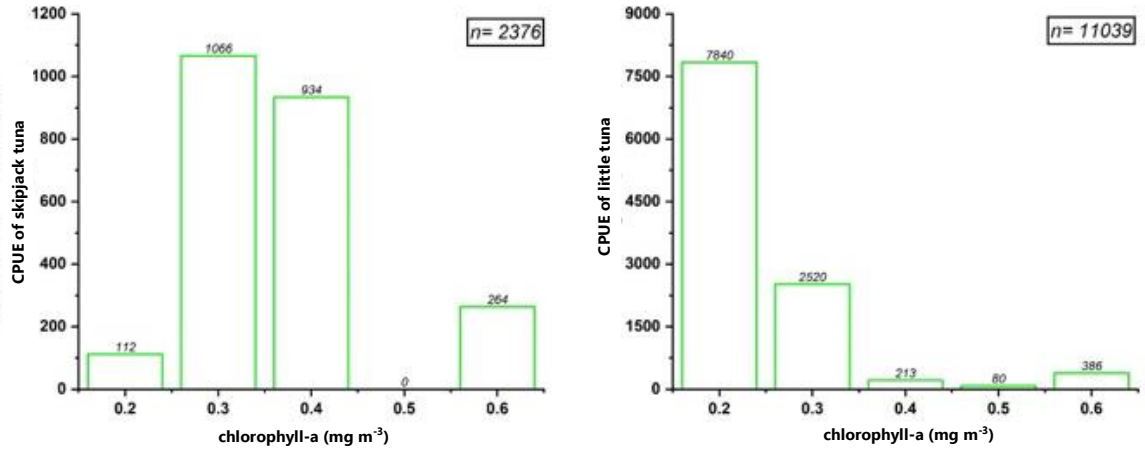

Figure 4. Relationship of chlorophyll-a and CPUE of skipjack and tuna in FMA 713

The dynamics of sea surface temperature and chlorophyll-a are very dynamic in the waters, which can lead to alternate upwelling and downwelling. (Atmadipoera and Widyastuti, 2015; Sari et. al., 2018; Wijaya et. al., 2020) and has the potential to cause a biological response so that it can increase nutrients in the waters(Iskandar et. al., 2017; Takarina et. al., 2019). The distribution of large pelagic fish in the waters also correlates with the location of the occurrence of thermal and chlorophyll-a fronts (Hidayat et. al., 2019 b) . This event is mainly related to sea surface temperature and chlorophyll-a (Zainuddin et. al., 2019) and corroborate previous findings that sea surface temperature and chlorophyll-a are indeed appropriate parameters in predicting the right potential area.

CONCLUSION

In WPP 713, it was found that the relationship between sea surface temperature and chlorophyll-a is a negative relationship where every increase in sea surface temperature causes a decrease in the concentration of chlorophyll-a, and vice versa. There are optimum oceanographic conditions for two types of fish caught using purse seine fishing gear.

Skipjack tuna is caught at warmer temperatures than tuna. Skipjack tuna tended to be distributed at a temperature of 29.84°C - 30.28°C which was associated with a chlorophyll-a concentration of 0.3 mg m^{-3}, in contrast to litle tuna which was distributed at a temperature of 27.92°C - 28.66°C with the most productive concentration of chlorophyll-a (relatively high CPUE) of 0.2 mg m^{-3}.

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