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SUITABILITY OF SPATIAL-TEMPORAL HABITAT OF YELLOWFIN TUNA (*Thunnus albacares*) USING MAXIMUM ENTROPY MODEL IN WEST SUMATRA

Kesesuaian Habitat Spasial-Temporal Tuna Sirip Kuning (Thunnus albacares) Menggunakan Model Maximum Entropy di Sumatera Barat

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ABSTRACT

Yellowfin tuna is one of the main catches in West Sumatera waters and has a high economic value. Fishing optimization can be improved through spatial and temporal predictions of fishing areas for effective fisheries management. This research aims to predict fishing areas using an oceanographic data approach through maximum entropy (MaxEnt) modelling. Data collection incorporating sea surface temperature and chlorophyll-a were obtained from the Aqua-Modis satellite in 2022 as well as fishing point data from Ocean Fishing Port (OFP) Bungus. The MaxEnt model shows a good level of accuracy in the West season (AUC 0,860), 1st Transitional season (AUC 0,918), East season (AUC 0,918), and 2nd Transitional season (0,920) The contribution of chlorophyll for one year is more significant, accounted for 75,3%, compared to sea surface temperature, constituted 24,7%. The Sea Surface Temperature (SST) values in West Sumatera waters vary on each season, ranging from 26,4 to 34.5 ℃ and the chlorophyll-a fluctuate between 0,03 and 5,45 mg/m3. The distribution of yellowfin tuna habitat on the map shows that most fishing vessel coordinates are in the Habitat Suitability Index (HSI) HSI value of 0,6 – 0,9. Potential areas for catching yellowfin tuna are around the Mentawai Islands.

Keywords: *Chlorophyll-a, HSI, Maximum Entropy Model, Sea Surface Temperature, Yellowfin Tuna*

ABSTRAK

Tuna sirip kuning merupakan salah satu hasil tangkapan utama di Perairan Sumatera Barat yang memiliki nilai ekonomis tinggi. Optimalisasi penangkapan ikan masih dapat terus ditingkatkan melalui prediksi spasial dan temporal daerah penangkapan ikan untuk pengelolaan perikanan yang efektif. Penelitian ini bertujuan untuk memprediksi daerah penangkapan ikan menggunakan pendekatan data oseanografi melalui pemodelan Maximum Entropy (MaxEnt). Data yang digunakan yaitu suhu permukaan laut dan klorofil-a yang diperoleh dari satelit Aqua-Modis tahun 2022 serta data titik penangkapan ikan dari Ocean Fishing Port (OFP) Bungus. Model MaxEnt menunjukan tingkat akurasi yang baik yaitu musim Barat (AUC 0,860), musim Peralihan 1 (AUC 0,918), musim Timur (AUC 0,918), dan musim Peralihan 2 (0,920). Kontribusi dari klorofil selama satu tahun lebih besar yaitu 75,3 % dibandingkan dengan suhu permukaan laut yaitu 24,7 %. Rentang nilai suhu permukaan laut (SPL) di Perairan Sumatera Barat bervariasi setiap musimnya yaitu pada rentang 26,4 – 34,5 ℃ dan klorofil-a 0,03 – 5,45 mg/m^3. Peta kesesuaian habitat ikan tuna sirip kuning menunjukkan bahwa mayoritas koordinat kapal penangkapan berada pada nilai Habitat Suitability Index (HSI) HSI 0,6 – 0,9. Daerah penangkapan tuna sirip kuning potensial berada di sekitar Kepulauan Mentawai.

Kata kunci: HSI, Klorofil-a, Model Maximum Entropy, Suhu Permukaan Laut, Tuna Sirip Kuning

INTRODUCTION

Fisheries Management Area (FMA) 572 based on the regulation of Minister of Marine Fisheries No. 18 of 2014, is in the Indian Ocean, which stretches from the west of Sumatra to the Sunda Strait and includes six provinces: Aceh, North Sumatra, West Sumatra, Bengkulu, Lampung, and Banten, with an area of 94,368,838.04 hectares. Fishing production from 2016 to 2019 fluctuated, with an average catch of 754.567 tonnes/year. The potential of fisheries in FMA 572 is 1.240.976 tonnes/year (DJPT 2021). The potential of capture fisheries in FMA 572 is quite significant, which is dominated by pelagic fish groups such as skipjack (Katsuwonus pelamis), big eye tuna (Thunnus obesus), layang (Decapterus macarellus), madidihang (Thunnus albacares), mackerel (Rastrelliger spp), and tuna (Euthynnus affinis) (Bramana *et al.* 2020; Kusdiantoro *et al.* 2019).

Fishing production in FMA 572 productively takes place in West Sumatera, which has an Ocean Fishing Port (OFP), namely Bungus Fishing Port. Based on the recapitulation of fishing data at Bungus Fishing Port, the number of tuna longliner anchored has increased from year to year, with a production value in 2021 of 595.73 kg and in 2022 of 642,107 kg (DJPT 2022). Tuna is one of the most widely caught fish species, especially yellowfin tuna (Thunnus albacares), one of the superior fish resources found in West Sumatra Province waters. Yellowfin tuna (Thunnus albacares) is classified as a large pelagic fish that fishermen widely catch in Indonesia. This type of tuna has a high export value that can support economic growth and foreign exchange for the state, with the national production of all tuna fish amounting to 203,249 tons. (Kantun & Mallawa 2015). Yellowfin tuna fishing has the potential to improve the welfare of fishermen in Bungus Fishing Port. Further exploration can be done to increase the maximum productivity of fishing. Therefore, it is necessary to analyze the yellowfin tuna fishing grounds. Oceanographic data that show water conditions are the basis for estimating potential fishing areas, namely Sea Surface Temperature (SST) and Chlorophyll-a (Susilo 2015; Junaidi *et al.* 2021). The relationship between oceanographic parameters, Sea Surface Temperature (SST) and Chlorophyll-a with the presence of fish, can be used for spatial modelling of fishing area maps (Akita *et al.* 2022). Furthermore, fishing areas have also been temporally identified by modeling using data collected in August – December during 2005–2013 (Syah *et al*. 2016).

Sea surface temperature (SST) can affect dissolved oxygen (O2) in the waters and greatly determine the distribution pattern and abundance of fish in the waters (Andriyeni 2013). According to Harahap *et al*. (2019) SST distribution in West Sumatra waters is 28.9-30.4°C. The distribution and variability concentrations of chlorophyll-a are directly related to the oceanographic conditions of the waters in determining the fishing grounds in a body of water (Nababan & Simamora 2012). SST and chlorophyll-a in waters can be detected using satellite imagery, one of which is Aqua MODIS satellite imagery, with the validation value of Aqua MODIS satellite imagery against SST and chlorophyll-a field data is 77.75% (Wardhani *et al*. 2012).

The Maximum Entropy (MaxEnt) model is one of the spatial models for fishing ground prediction. Another method uses an overlay between SST and chlorophyll-a with a particular threshold value (Aufar *et al*. 2021). It uses a GIS approach combined with direct catch data in the field (Zainuddin & Farhum 2017). The model estimates the maximum entropy probability distribution by estimating the most diffuse, uniform, and closest data (Phillips & Dudik 2008). The model can be used to predict fish catches using temporal data using the Fuzzy Time Series method (Mubarak *et al.* 2020). The maximum entropy model has been applied to fish habitat suitability. Akita *et al.* (2022) conducted a study on the prediction of small pelagic fishing grounds in the Java Sea using the MaxEnt model, showing good performance with an AUC value of 0.849, with the salinity parameter being the most dominant influence on habitat suitability. Prediction of yellowfin tuna (Tunnus albacares) fishing grounds using the MaxEnt model in Aceh Province waters has been done by Siregar *et al.* (2019) showed an AUC value of 0.961. Gustantia *et al.* (2021) conducted a study on the prediction of Lemuru fishing areas using the MaxEnt model, showing an excellent model evaluation with a correlation value of more than 0.80.

However, no one has currently implemented a method to predict fishing catch areas, especially for yellowfin tuna, using the MaxEnt model combined SST and chlorophyll-a data approaches, especially in the waters of West Sumatra. Seasonal changes also affect the distribution and abundance of fish, so information about fishing areas in different seasons will produce better-predicted fishing area models. The availability of near real-time satellite oceanographic data has great potential to be used as a data source to predict yellowfin tuna fishing areas in the waters of West Sumatra. Previous research shows that the MaxEnt model results for predicting fishing areas are quite accurate (Siregar *et al*. 2019; Gustantia *et al*. 2021; Akita *et al.* 2022). Yellowfin tuna fishing production can maximized by knowing the fishing ground areas. Therefore, it is necessary to develop an accurate fishing ground prediction map to help fishermen in the fishing seasons, namely the west season, transition season 1, east season, and transition season 2. This research aims to predict yellowfin tuna fishing areas in the waters of West Sumatra to optimize catch production.

METHODS

Study Area

Research and data analysis were carried out from July to September 2023. The research object is located in West Sumatra waters, which are included in the Fisheries Management Area (FMA) 572, as shown in Figure 1.

Materials and Tools

The material used in this research is oceanography data obtained from Terra-Modis satellite images. Terra-Modis satellite data are level 3 and 4 data that have been corrected radiometrically and geometrically, namely sea surface temperature data and chlorophyll data with a resolution of 4 km. Fisheries data consists of fishing ground positions in the form of longitude and latitude. The Yellowfin Tuna data was obtained from the Bungus Ocean Fishing Port.

The data processing tool is a personal computer with a Windows 10 Pro 64-bit operating system, 8192 MB of RAM, and an Intel (R) Core (TM) i5-3317U CPU 1.70 GHz (4CPUs) processor. The software used to analyze and process data in the study is Microsoft Excel 365 and Maximum Entropy Species Distribution Modeling (MaxEnt) 3.4.4. Arc Gis 10.8 software was used to create maps of the research area and the spatial distribution of oceanographic parameters and fishing points.

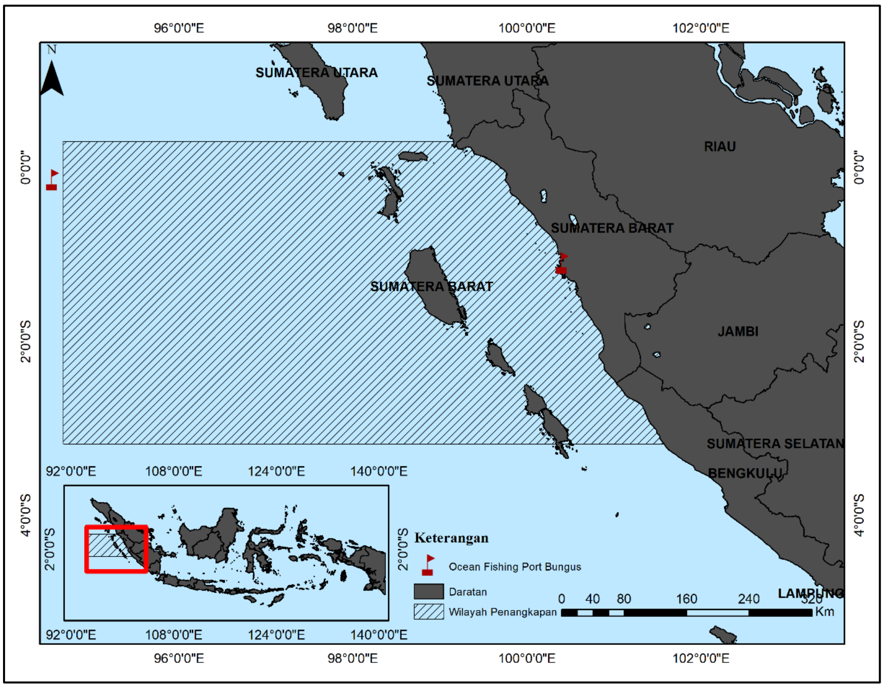

Figure 1 Research location in the waters of West Sumatra, Indonesia

The data processing stage begins with the oceanographic data extraction in Arc Gis 10.8. Then, Inverse Distance Weighted (IDW) interpolation was carried out to obtain values for empty areas (empty pixels) that were not recorded due to cloud interference to see spatial variations in SST and chlorophyll-a. Next, the environmental data is converted from (.tiff) to (.asc) to be used as an environmental variable, and yellowfin tuna fishing coordinates in (.csv) format. Oceanographic data and fishing coordinates will be used to create a prediction map of yellowfin tuna fishing locations using Maxent 3.4.4 software.

Environmental Parameter Data

The environmental parameter data used are SST and chlorophyll-a data obtained on the website https://oceancolor.gsfc.nasa.gov/. The SST and chlorophyll-a data are downloaded on a monthly basis, January-December 2022. The results of the downloaded data are in .nc format. Furthermore, the SST and chlorophyll-a data were converted from .nc to .asc format using Arc Gis 10.8 software. Data in .asc format was then used as environment data in MaxEnt modeling.

Maximum Entropy Model

The Maximum Entropy (MaxEnt) model estimates the maximum entropy probability distribution by estimating the data (most spread, uniform, and closest). The MaxEnt model is one of the species data modeling methods that can be used to predict the presence of yellowfin tuna. The MaxEnt model will examine at the relationship between the spatial data of yellowfin tuna associated with SST and Chlorophyll-a data.

The MaxEnt model describes the density estimation represented by the probability of presence distribution over the environmental data variables. Thus, P(x | y = 1) gives a non-negative value for each SST value (x), and the sum of P(x | y=1) values is 1. If skipjack is assumed to be y, then P(y=1 | x) is the probability of presence. According to Bayes, the probability of presence equation is as follows (Phillips & Dudik 2008):

$$P\,(y=1 \mid x) = \frac{P(x \mid y = 1)P(y=1)}{P(x)} \quad \ldots\ldots\ldots\ldots\ldots\ldots.. \ (1)$$

With:

P(x|y=1) = Probability of occurrence of an event

P(y=1|x) = Probability of presence (chance estimate)

P(x) = Probability of comparison

P(y=1) = Probability of previous event

The next step is to use the Gibbs distribution theorem to analyze the probability of a species being present at point x with a probability of 0 to 1 for scattered organisms. The Gibbs distribution is an exponential distribution determined by the feature weight vector with the following formula:

$$q(x) = \frac{\exp\,(\sum_{j=1}^{n} \lambda_j f_j\,(x))}{z_\lambda} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots...... \ (2)$$

With:

λ_j is the weight of x in the j^{th} variable,

f_j is the value of x in the j^{th} variable,

z_λ is the exponential feature weights vector of the x

q(x) is the estimate of P(x | y=1).

After obtaining the estimate of P (x|y=1), then calculate the entropy of q(x), the formula is as follows (Phillips and Dudik 2008).

$$H(x) = \sum x = 1\ n\ q_{(x)}\ \ln q_{(x)} \ldots\ldots\ldots\ldots\ldots\ldots..(3)$$

Furthermore, to obtain the probability of presence distribution, as follows:

$$P(y=1|x) = e\,H\,q_{(x)}1 + e\,H\,q_{(x)} \ldots\ldots\ldots\ldots \ (4)$$

With:

q(x) is the estimate of P(x | y=1)

H is the entropi of q(x).

RESULT

Distribution of SST and Chlorophyll-a

The range of sea surface temperature (SST) values in 2022 (Figure 2) in West Sumatra waters varies seasonally, namely 26.4 - 34.5℃. Variations in SST values in West Sumatra waters are influenced by monsoon winds caused by differences in air pressure between the Australian continent and the Asian continent (Dida *et al.* 2016; Safitri *et al.* 2012). In addition, the Indian Ocean Dipole (IOD) phenomenon also plays a role in influencing sea surface temperature variability on the west coast of Sumatra (Dipo *et al.* 2011; Damanik *et al*. 2017). The distribution of SPL in the four observed seasons shows that coastal areas have warmer temperatures than marine areas. Ramadani *et al.* (2022) and Sinaga *et al*. (2021) stated that the sea surface temperature in coastal areas is higher allegedly due to the influence of warm land.

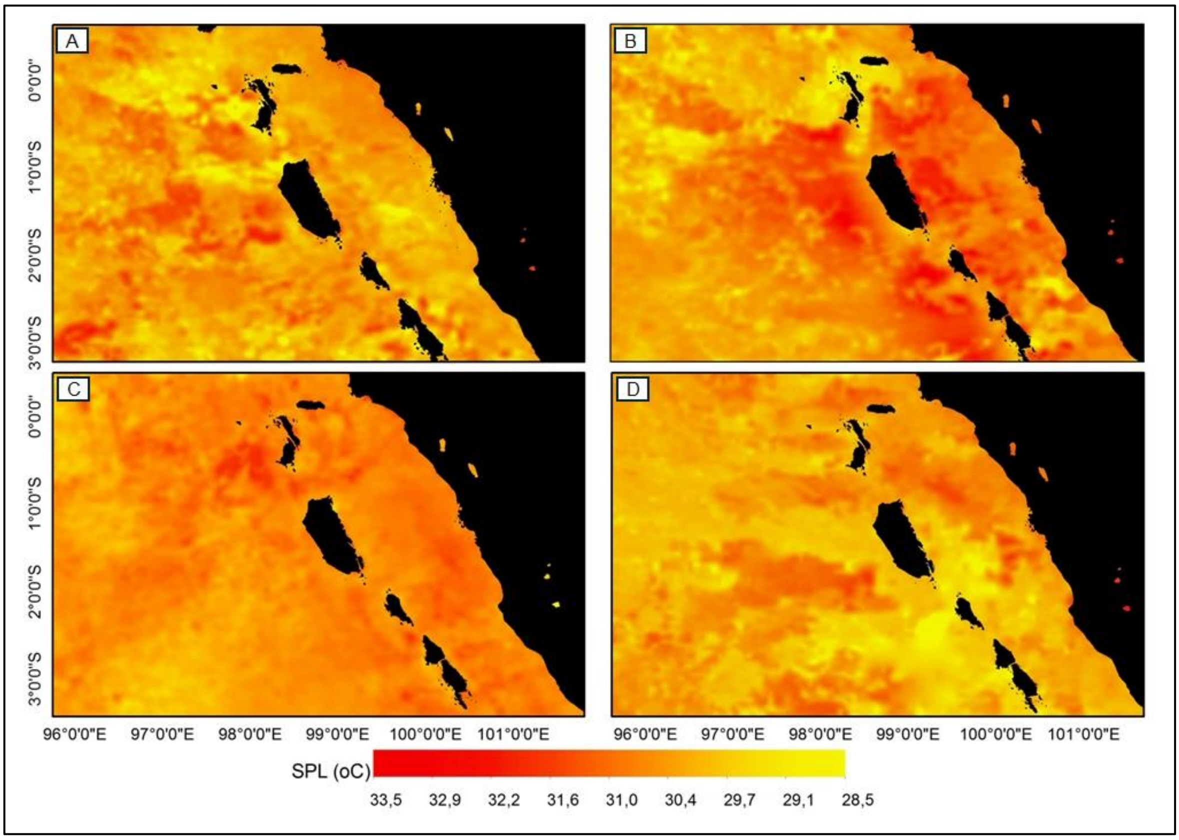

Figure 2 Sea surface temperature distribution in West Sumatra Waters (Indonesia) during (A) West Season, (B) 1st Transitional Season (C) East Season and (D) 2nd Transitional Season 2022

The average sea surface temperature in the West Season (December-February) is lower at 31.15℃ compared to 1st Transitional season (March-May) at 31.3℃. This phenomenon occurs because in 1st Transitional season, the position of the sun is close to the equator, so the intensity of sunlight is more than during the west season (Nontji 2005). In the east season (June-August), the sea surface temperature decreased to 31℃. The decrease in temperature in the east season in generally sunny weather conditions is related to the sun’s position towards the earth's equator line, which is in the northern hemisphere (Wyrtki 1961). The 2nd transitional season (September-November) shows an increase in temperature compared to the east season of 30.45℃. The increase in temperature in the 2nd transitional season in West Sumatra waters has also been analyzed by Zahara *et al.* (2022), which state that the increase in sea surface temperature is because the fact that in this season the sun begins to head back to the southern part of the earth, which means that the sea surface temperature gradually gets sunlight compared to the east season.

Based on the monthly average of chlorophyll-a in West Sumatra waters in 2022 (Figure 3), the range of chlorophyll-a concentrations is 0.03 - 5.45 mg/m^3. Chlorophyll-a concentration in the West Season has a range of 0.03 - 5.45 mg/m^3, 1st Transitional Season 0.05 - 3.63 mg/m^3, east season 0.07 - 3.84 mg/m^3, and 2nd Transitional Season 0.03 - 4.48 mg/m^3. In general, lower chlorophyll-a concentration values occur during 1st Transitional Season, March - May. In the West Season, December - February, the chlorophyll-a concentration is higher than the other seasons with a maximum concentration of 5.45 mg/m^3.

High chlorophyll concentrations are found in coastal areas, especially those close to river estuaries. The increased chlorophyll-a concentration in the coastal and estuary regions is influenced by inputs from the river (Auricht *et al.* 2022). Chlorophyll-a concentrations in the waters of west Sumatra are influenced by the IOD (Indian Ocean Dipole) phenomenon, which causes upwelling due to negative SST anomalies (Dipo *et al*. 2011). Indications of an upwelling phenomenon are marked by a decreased in SST values and increase water fertility based on chlorophyll-a concentrations (Natalia *et al.* 2015).

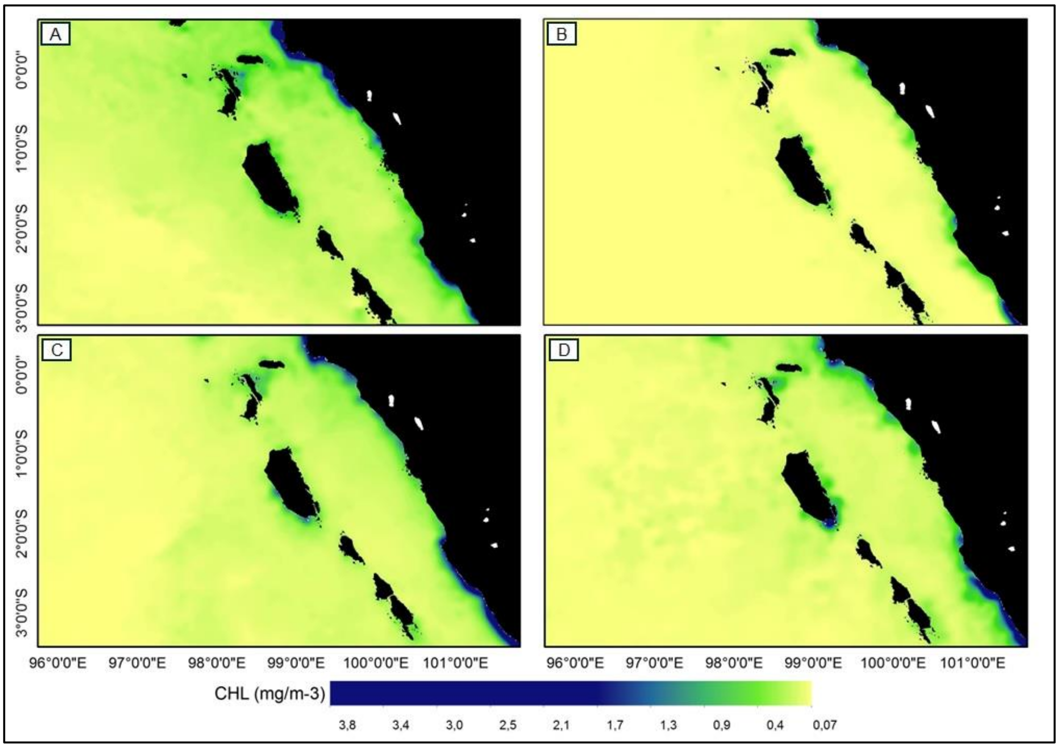

Figure 3 Chlorophyll-a distribution in West Sumatra Waters (Indonesia) during (A) West Season, (B) 1st Transitional Season (C) East Season and (D) 2nd Transitional Season 2022

Model Evaluation

The jackknife test in Figure 4 shows environmental parameters and their influence on the model-building process. In Figure 4, the jackknife test value of contribution from chlorophyll is greater than the SST. The maximum contribution value of chlorophyll about 96.6% in the West season, and a minimum of 56% in the 2nd transitional season. The significant contribution of chlorophyll-a in the West season is caused by the high rainfall which is influenced by the west monsoon winds and the negative IOD phenomenon (Hermawan dan Komalaningsih 2008). Rainfall can cause an overflow of river water which carries distributed nutrients resulting in an increase in water fertility which triggers high development of primary productivity (Kunarso *et al.* 2019). The maximum contribution from SST (44%) in the 2nd transition season and the minimum in the West Season is 3.4%. The average contribution of chlorophyll during one year is 75.3% and 24.7% for SST, thus showing that the contribution of chlorophyll-a is more significatnt than SST to yellowfin tuna fishing.

The evaluation results of the maximum entropy model show the level of accuracy in predicting potential fishing areas from the test data model. This can be seen in Figure 5. From the model performance based on the AUC (area under the curve) value, namely AUC 0.6 – 0.7 is considered to have poor accuracy, AUC 0.7 – 0.8 is considered good and AUC more than 0.9 indicates an excellentlevel of accuracy regarding the presence and absence of a species (Araujo & Guisan 2006). The model evaluation results show an outstanding level of model performance accuracy in 1st Transitional season (0.918), east season (0.918), and transition season 2 (0.920). Meanwhile, the level of accuracy in the West Season is classified as good with a value of 0.860.

Habitat Suitability Prediction

The distribution of yellowfin tuna habitat on the map shown in Table 1. In the west season, it shows that the yellowfin tuna fishing area is in the Habitat Suitability Index (HSI) value range 0 – 0.9 and 195 catches were recorded with dominant fishing coordinates in the HSI range 0.6 – 0.9. In the first transitional season, the HSI value range was 0 – 1 and 183 catches were recorded with the dominant catch coordinates being 0.5 – 1. Catches in the east season showed HSI values in the range 0.1 – 0.9, with 182 catches and the dominant HSI coordinates in the range. 0.6 – 0.9. 2nd Transitional season II had the greatest number of catches, namely 199, compared to other seasons and the HSI was in the range 0 – 1. The most dominant coordinates of the fishing area were in the HIS range 0.7 – 1.

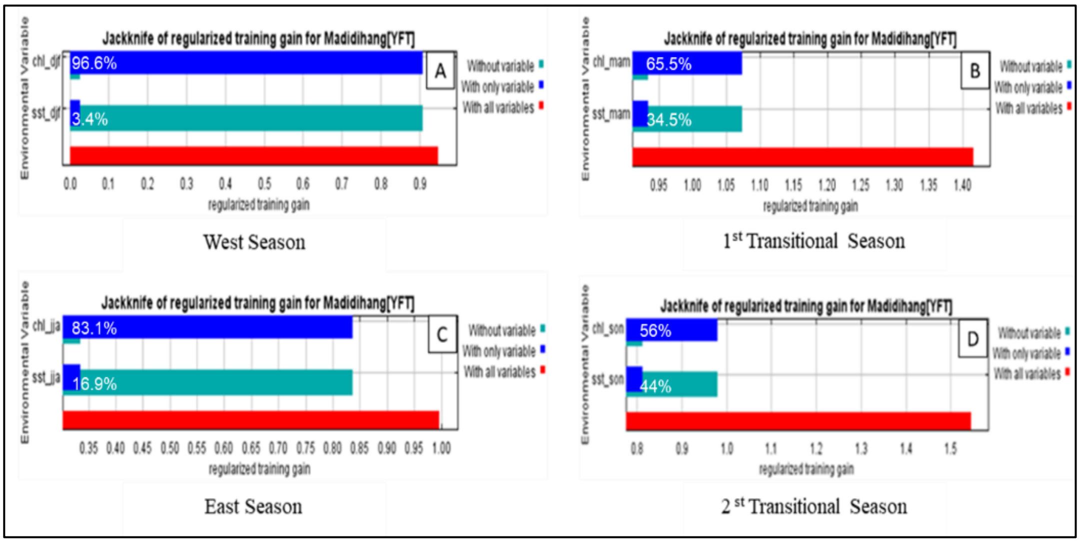

Figure 4 Contribution diagram of Chlorophyll-a (chl) and SST (sst) in (A) West Season, (B) 1st Transitional Season (C) East Season and (D) 2nd Transitional Season 2022

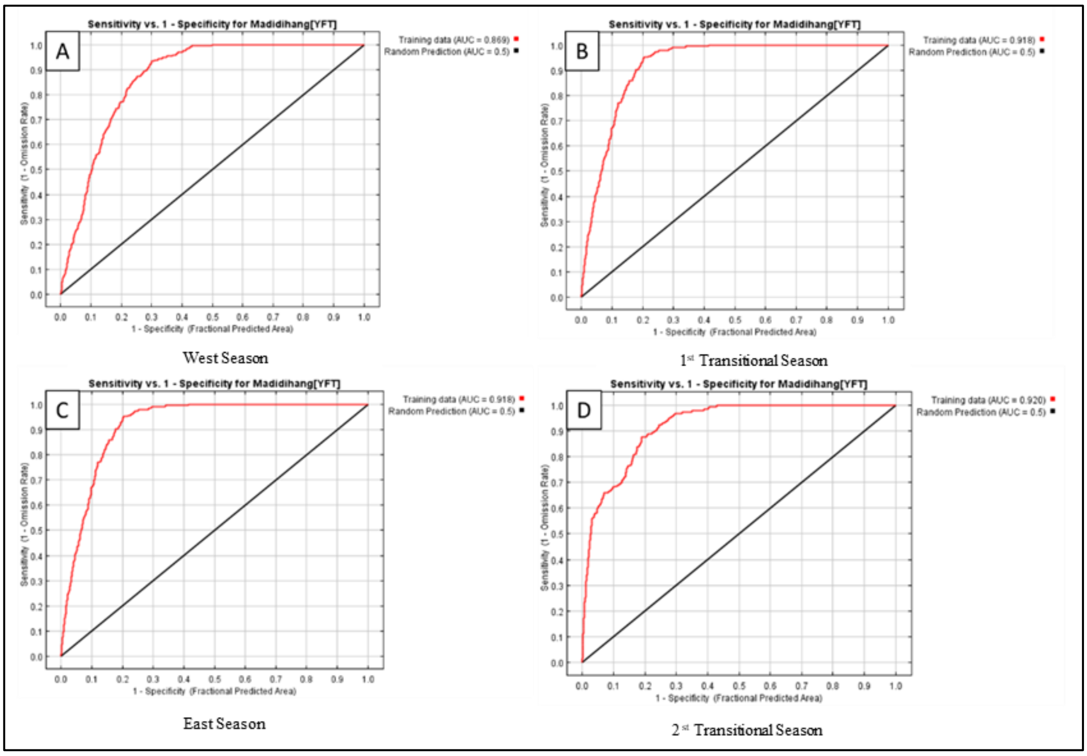

Figure 5 Area Under the Curve (AUC) model evaluation in (A) West Season, (B) 1st Transitional Season (C) East Season and (D) 2nd Transitional Season 2022

The suitability map/HSI in Figure 6 is obtained from overlaying fishing data against environmental data as validation to see the accuracy of the model. Red colour gradation (close to 1) indicates suitable habitat, while blue colour gradation (close to 0) indicates unsuitable habitat (Syah *et al.* 2016). Based on the HSI map in Figure 6 the potential fishing grounds for yellowfin tuna are around the Mentawai islands, indicated by red colour gradations around the islands.

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Table 1 Total fishing points data for each HSI in 2022

HSI	West Season	1st Transitional Season	East Season	2nd Transitional Season	Total
0 - 0.1	1	3	0	6	10
0.1 - 0.2	9	5	6	17	37
0.2 - 0.3	6	8	6	30	50
0.3 - 0.4	9	10	15	6	40
0.4 - 0.5	9	13	12	2	36
0.5 - 0.6	18	21	14	10	63
0.6 - 0.7	21	28	26	5	80
0.7 - 0.8	58	36	37	28	159
0.8 - 0.9	64	34	66	29	193
0.9 - 1	0	25	0	66	91

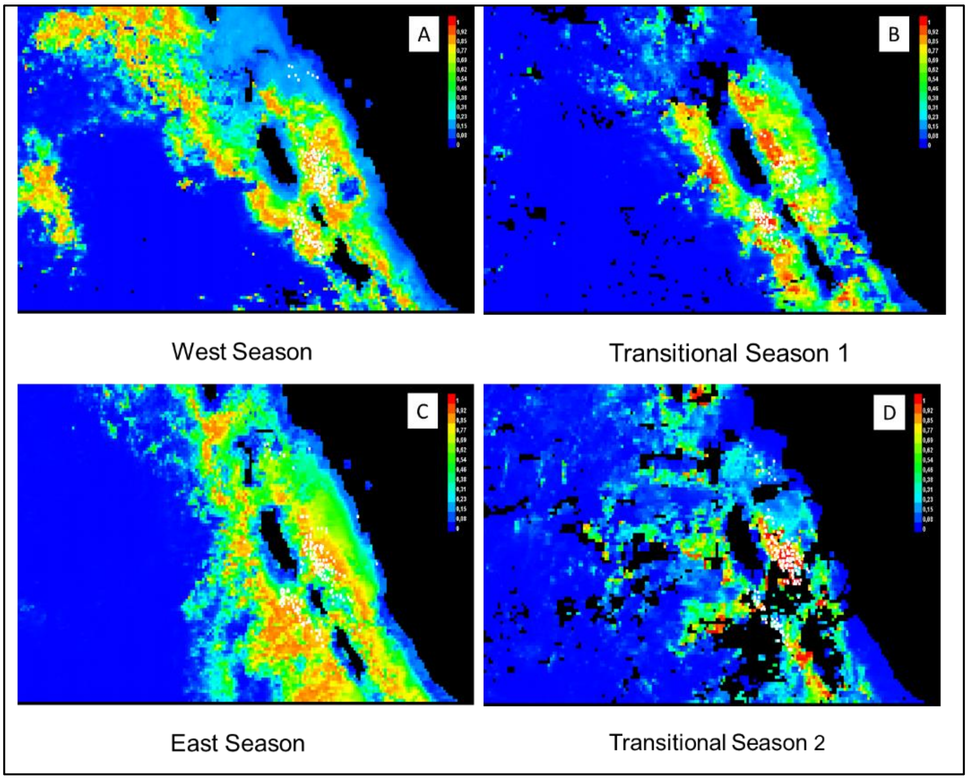

Figure 6 Habitat suitability map of Yellowfin Tuna in West Sumatra Waters (Indonesia) during (A) West Season, (B) 1st Transitional Season (C) East Season and (D) 2nd Transitional Season 2022

DISCUSSION

SST parameters in the ocean vary and fluctuate, significantly affecting fishing productivity. This relates to certain types of fish which have different SST value ranges according to their survival habitat in the waters. Previous research showed that the highest catches of Thunnus albacares were achieved when SST values were low and chlorophyll-a was high. The catch of yellowfin tuna has a positive effect on the variability of sea surface temperature and chlorophyll-a (Wiryawan *et al.* 2020). Research by Syamsunnisak *et al.* (2016) explained that the temperature distribution associated with pelagic fish habitat in free waters tends to have relatively different values. Related to fish habitat parameters, further explained by Wang *et al.* (2016) that several physical, chemical and biological oceanographic parameters, such as currents, SST, salinity, and hlorophyll-a influence the migration process, distribution, and abundance of a fish species. In addition, the waters of West Sumatra which are directly adjacent to the Indian Ocean are also influenced by climate variability such as IOD and ENSO which affect the dynamics of water masses which in turn can have an impact on the distribution and catch of fish in these waters (Setyadji & Amri 2017). ENSO and IOD variability can influence oceanographic conditions including SST. During La Nina, SST and rainfall increases, whereas during El Nino, SST and rainfall decreases (Dewi *et al*. 2020).

Chlorophyll-a is one of the important parameters for determining the level of primary productivity in waters. Yellowfin tuna catches increase with increasing Chlorophyll-a which is quite well correlated (Habibullah & Galib 2020). This is related to the role of chlorophyll-a as a pigment owned by phytoplankton as primary producers in water. The high and low levels of chlorophyll-a concentration distribution are very significantly related to the condition of the aquatic environment (Nurmala *et al*. 2017). This study found that chlorophyll-a concentrations were generally detected throughout the year but reached the highest values in the west monsoon and were mainly concentrated in coastal areas. Research by Gaol & Sadhotomo (2007) found similar results, namely chlorophyll-a concentrations near the coast or land have higher concentration values than those in open waters. The distribution of chlorophyll-a concentration can reach a certain point due to surface currents. The chlorophyll-a parameter is one of the key indicators contributing to water quality assessment. This is related to the carbon cycle and food chain for heterotrophic organisms, so that the primary productivity of a water body can be estimated (Nuzapril *et al.* 2017). Research by Tangke *et al*. (2024) using experimental fishing methods shows that fluctuations in chlorophyll-a have a significant effect on yellowfin tuna catches. Based on analysis using the General Additive Model (GAM), the chlorophyll-a concentration was >0.01 mg m-3 with a time leg at week 15.

Chlorophyll-a and SST parameters in West Sumatra waters are important parameters in determining and building habitat models. Habitat model building requires parameters that are considered important and contribute to the resulting model (Latifiana 2018). Research by Siregar *et al.* (2019) used one of the SST parameters to research the prediction of yellowfin tuna (*Tunnus albacares*) fishing areas using the MaxEnt model in the waters of Aceh Province. In this study using SST and Chlorophyll-a parameters, it was found that the chlorophyll-a parameter contributed more significantly. The Jackknife test conducted in this study analyses environmental parameters and their influence on the model-building process. The graph of the Jackknife test results provides information about the contribution of the chlorophyll-a and SST parameters to predicting of yellowfin tuna (*Thunnus albacares*) habitat in 2022. Chlorophyll-a concentration has more significant percentage contribution than the SST parameter, with the most considerable contribution in the west season. Under normal circumstances the influence of SST will be lower because water conditions tend to be stable and it is possible that when an anomaly occurs it will make a significant difference due to variability, especially global climate. The SST parameter has minor influence on the resulting model, with no difference in each season. This is due to the waters of West Sumatra being in an area that receives much radiation from sunlight and a relatively more evenly stable temperature range (Suhana 2018).

The probability of yellowfin tuna fishing ground area based on the MaxEnt model is around the Mentawai island and its northwest region, as indicated by the range of HSI values close to 1. The potential habitat index is more suitable, marked by the more reddish orange on the map, while the value is close to 0, the potential habitat index is lower or less suitable with a sign of increasingly blue colour. Fishing points in each season are distributed in a fairly varied HSI. The MaxEnt model can see the influence of the environment on the abundance of species to be used as productive fishing grounds. In addition, it can also see the movement of fish in a particular season and time. This is based on locations with high chlorophyll concentrations, low SST and time lags in the food chain. This model can also evaluate the fishing grounds that have been presented in order to improve the accuracy of fishing grounds (Alabia *et al.* 2015).

CONCLUSIONS

The MaxEnt model shows the sensivity of maximum entropy model in a very good level of accuracy in predicting the presence of yellowfin tuna with AUC >0.9 in the 1st Transitional season, 2nd Transitional season and East season. The contribution of chlorophyll-a more outstanding compared to

SST in all season. The range of SST values in West Sumatra waters vary seasonally in the range of 26.4 - 34.5 ℃ and chlorophyll-a 0.03 - 5.45 mg/m^3. The distribution of yellowfin tuna habitat on the map shows that the majority of fishing vessel coordinates are at the Habitat Suitability Index (HSI) value of HSI 0.7 - 0.9. Potential areas for yellowfin tuna fishing are around the Mentawai Islands.

SUGGESTION

Based on the results obtained, we recommend using data with a longer period and adding other oceanographic parameters for better model results.

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