Mapping bullet tuna (*Auxis rochei*) potential fishing grounds in Prigi waters, East Java, Indonesia, using satellite imagery and *in-situ* oceanographic parameters

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Abstract. Prigi waters in East Java, Indonesia have dominant fishing potential, especially bullet tuna (*Auxis rochei*). The capture of *A. rochei* in Prigi generally uses small pelagic purse seine. Overfishing efforts cause *A. rochei* production to fluctuate every year. In addition, this decline in production can be influenced by oceanographic parameters. The purpose of this study was to understand the conditions of oceanographic parameters (SST, chlorophyll-a, salinity) and their relationship to *A. rochei* for determining potential fishing zones. The research was carried out from February to April 2024. The research method was carried out by directly measuring oceanographic parameters and using satellite image data. Data analysis uses satellite image data verification tests and *in-situ* data. The data captured are real-time. A multiple linear regression analysis for determining the optimal parameter combination is carried out to obtain the fishing potential zone. A 1 ppt change in salinity resulted in an increase of 5,276.53 kg in the catch of *A. rochei*. Meanwhile, simultaneous testing obtained a significance result of 0.008 which means that the variables SST, chlorophyll-a, and salinity together influence the catch of *A. rochei*. Testing partially SST, and salinity affects ($p<0.05$) *A. rochei*, but chlorophyll-a alone does not affect *A. rochei*. The value of the determination coefficient was 0.796, which means that the influence of SST, chlorophyll-a, and salinity variables on the variable *A. rochei* was 79.6%, while 20.4% was influenced by other factors that were not included in the regression model. The mapping of the Fishing Potential Zone (ZPPI) can be used as a reference for determining the *A. rochei* fishing area as a prevention of a decline in *A. rochei* production in Prigi. ZPPI is an important process to improve the efficiency and sustainability of the fishing industry.

Key Words: SST, chlorophyll-a, salinity, Purse seine, small pelagic.

Introduction. The potential of marine fisheries resources in East Java consists of pelagic fish and demersal fish (Rosana & Prasita 2015). Prigi waters are a small pelagic fish area of bay waters with a high productivity, located in the northern part of the Indian Ocean and traversed by the South Java current (Muripto & Ripai 2015; Tampubolon et al 2019). Meltyara et al (2023) stated that the potential of small pelagic fish in Prigi waters consists of Indian scad (*Decapterus russelli*), Yellowstripe scad (*Selaroides leptolepis*), Short mackerel (*Rastrelliger brachysoma*), Bonito (*Euthynnus affinis*), and skipjack (*Katsuwonus pelamis*). According to the data of the 2023 Prigi fishing port statistics annual report, Prigi waters have considerable potential for catching bullet tuna (*Auxis rochei*) (Subagya 2023). In 2019, the production of *A. rochei* in Prigi amounted 6,655 tons. In 2020 the production increased by 20%, with a total production of 8,004 tons. Then in 2021, *A. rochei* production decreased by 21%, to 6,350 tons. *A. rochei* production in 2022 increased by 17% from the previous year, to 7,436 tons. The strongest decrease in the total *A. rochei* production was in 2023, by 47%, to 3,926 tons (Subagya 2023).

According to Nagi et al (2023), the decrease in total fish production is probably caused by fish migration due to oceanographic factors, so it is necessary to know the existence and distribution of fish in the sea to increase fish production. The existence and distribution of fish in the sea are dynamic, always changing or moving according to the parameters of sea surface temperature (SST) distribution, salinity, and chlorophyll-a concentration in waters (Tangke & Senen 2020). According to Dewi et al (2023) and Namira et al (2022), these parameters determine the location of fronts, upwelling, potential fish distribution, and temperature changes that occur in the ocean. The catch corresponds to the SST conditions ranging between 29.75 to 30.25°C and to a chlorophyll-a concentration between 0.125 to 0.213 mg m^{-3} (Nugraha et al 2020). Nagi et al (2023) explained that the technology to detect the variability of SST, salinity, and chlorophyll-a parameters is to use satellites. Satellite data is very useful, especially for assessing potential areas for fast, repetitive and systematic fishing in a wide area coverage, by integrating field oceanographic data with satellite image data and cod fishing data (Yunus et al 2019).

The objectives of this study include understanding the conditions of oceanographic parameters in the study area (SST, salinity, and chlorophyll-a), the relationship between *A. rochei* catches and oceanographic factors, and the map of potential *A. rochei* fishing zones in Prigi Waters. This research to produce information on potential fishing areas at the study location, based on oceanographic parameter studies, in order to prevent overfishing, large-scale exploitation of fish resources and horizontal conflicts over fish resources, between traditional and modern fishermen.

Material and Method. The research was carried out on 15 February to 16 May 2024 using small pelagic purse seines in Prigi Waters, Trenggalek Regency, East Java Province, Indonesia (Figure 1).

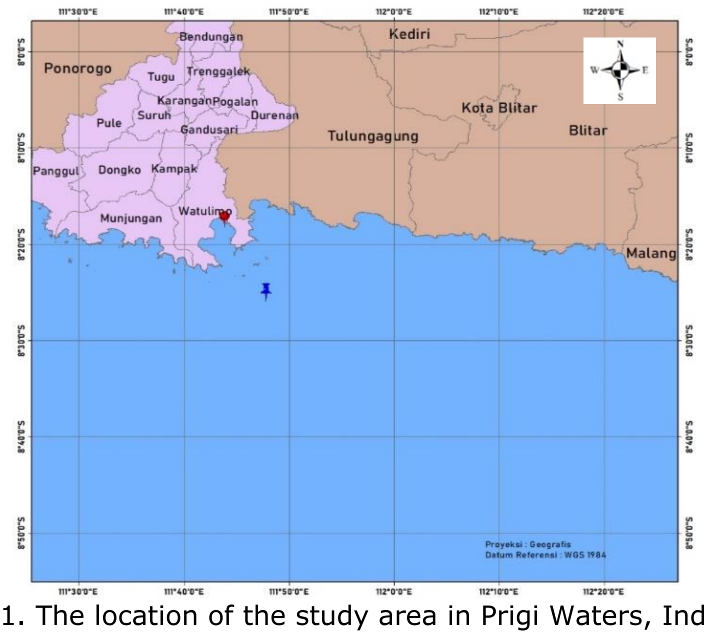


Figure 1. The location of the study area in Prigi Waters, Indonesia.

Method of collecting data. The data collection used a survey method for primary data and database consultation for secondary data (Oktari et al 2019). Primary data is data obtained directly in the field by participating in fishing operations to collect oceanographic parameter data and catch data in Prigi Waters. Secondary data is in the form of satellite images of SST, chlorophyll-a and salinity. The tools used in this research include small pelagic fishing boat, Open CPN & Maverick, ArcGis 10.8.1, SPSS IBM 25, MS. Excel 2021, SeaDas 8.3.0, Meter, Camera, Stationery, Laptop, Refracto-salinometer and digital Thermometer.

Data analysis method

Satellite image data verification test with in situ data. Data verification was carried out to determine the suitability between oceanographic data based on Aqua-MODIS and Marine Copernicus satellite image values with oceanographic data taken *in-situ*. According to Ghufron et al (2019), the relative error correction can be calculated by:

$$RE = \left[\frac{X - C\,x\,100\%}{n}\right]$$

$$MRE = \frac{\sum_{i}^{n} RE}{n}$$

Where:
RE - relative error;
MRE - average relative error (mean relative error);
X - *in-situ* oceanographic data (SST and chlorophyll-a);
C - oceanographic satellite data (SST and chlorophyll-a);
n - number of data records.

Multiple linear regression analysis

Simultaneous test (F_{-test}). This F_{-test} was used to determine the effect of SST, salinity and chlorophyll-a variables on *A. rochei* catches. The formula for the F test is (Suniada & Susilo 2017):

$$Fn = \frac{R^2/K}{(1 - R^2)/(n - k - 1)}$$

Where:
Fn - test value;
R - multiple regression analysis coefficient;
K - number of independent variables;
N - number of sample records.

The hypothesis used in this research is:
H_0: the oceanographic parameter variables do not influence fish variables.
H_a: the oceanographic parameter variables influence small pelagic catch variables.

The decision-making criteria are as follows:
If the significance probability is >0.05, then H_0 is accepted and H_a is rejected.
If the significance probability is <0.05, then H_0 is rejected and H_a is accepted.
H_0 is accepted if $F_{-count} < F_{-table}$ at a = 5%
H_a is accepted if $F_{-count} > F_{-table}$ at a = 5%

To find the F_{-table} value, it is necessary to have degrees of freedom in the numerator and degrees of freedom in the denominator using the following formula:

Df (numerator) = k-1
Df (denominator) = nk

Where:
K - number of independent and dependent variables;
n - number of samples in the study.

Partial test (T_{-Test}). The t_{-test} is used to test how strong the influence of individual independent variables is in partially explaining the dependent variable. According to Suniada & Susilo (2017), the t_{-test} formula is as follows:

$$t = \frac{r\sqrt{n - 2}}{\sqrt{1 - r^2}}$$

Where:
T - significance of the influence of variable X on variable Y;
r - multiple regression coefficient value;
n - number of samples.

The criteria are determined by comparing the value of t_{-count} with t_{-table} using the critical value of t_{-table} with a predetermined significance level of 0.05 (α = 0.05). The criteria for accepting or rejecting the null hypothesis (H_0) used are as follows:
a) H_0 is accepted if t_{-count} is in the acceptance area, where $t_{-count}<t_{-table}$, or sig>α (0.05)
b) H_0 is rejected if it is in the H_0 rejection area, where $t_{-count}>t_{-table}$ or sig<α (0.05).

Coefficient of determination. According to Suniada & Susilo (2017), the analysis of the coefficient of determination is to determine whether the relationship between oceanographic parameters and catch results is strong or not. The coefficient of determination is used to measure variations in the dependent variable. The scale of determination coefficient values is presented in Table 1.

Table 1

Determination coefficient value scale

R	*Data interpretation*
0.00-1.199	Very Low
0.20-0.399	Low
0.40-0.599	Medium
0.60-0.799	Strong
0.80-1.000	Very Strong

Source: Suniada & Susilo (2017)

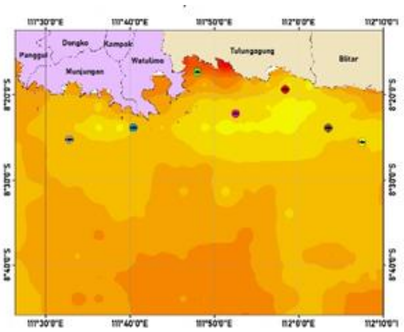
Mapping potential fishing zones. Yunus (2019) explained that based on the values from the analysis results, an overlay was then carried out combining the oceanographic parameters that had been researched to obtain potential zones for catching *A. rochei* in Prigi Waters, East Java.

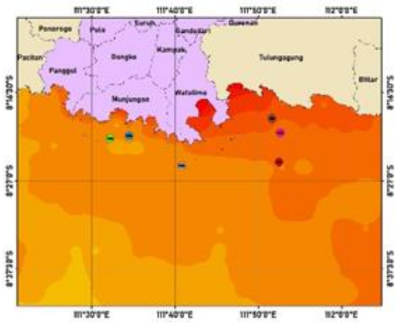
Results and Discussion

Composition of catched fish. During research using small pelagic purse seine, catches were obtained *A. rochei*, *Decapterus macrosoma, Selar crumenophthalmus*, and *Sardinella fimbriata*. In line with the research results of Meltyara et al (2023), the highest number of catches was *A. rochei*.

Oceanographic parameter conditions for A. rochei. According to Hermawan et al (2023) and Yeka et al (2022), the oceanographic parameter conditions such as SST, chlorophyll-a, and salinity are very important factors for the Fishing Potential Zones (ZPPI). In this research, the author measured the oceanographic parameters SST, chlorophyll-a, and salinity in Prigi Waters both directly and using the satellite imagery.

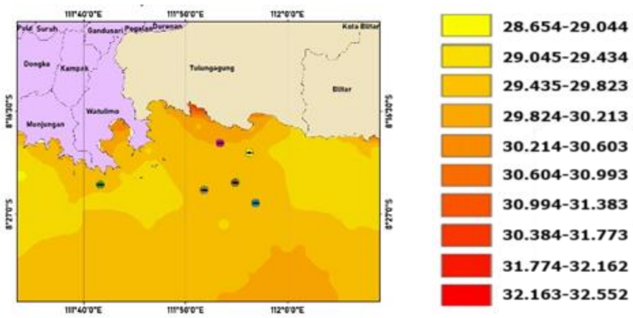
Distribution of sea surface temperature (SST) in Prigi Waters. SST is one of the parameters that determine water quality because it can influence the metabolism and development of marine organisms (Yunus et al 2019). Nagi et al (2023) stated that SST can be used as a way to estimate the presence of organisms in a water body, especially fish. SST significantly influences the behavior and habitat selection of fish species (Freitas et al 2021). According to Weber et al (2021), Siregar et al (2016) fish populations prefer warm sea surface temperatures. This was confirmed by Waileruny et al (2014): SST greatly influences the existence of fish. The distribution of SST in February to April 2024 in Prigi Waters can be seen in Figure 2.





A. SST on February 2024

B. SST on March 2024



C. SST on April 2024

Parameter SST (^{0}C)

Figure 2. Distribution of SST in February-March 2024 in Prigi Waters.

The distribution of SST along with fish catches obtained in the period 21 to 28 February 2024 (Figure 2A) ranges between 30.51 to 31.01°C. The SST distribution tends to decrease per fishing trip by 0.02°C (Figure 3). SST in February tends to warm the waters south of Java. This is in line with the statement of Yoga et al (2014) and Tangke et al (2015): in February, the waters south of Java are will warm, with a SST in the range of 28 to 30.2°C.

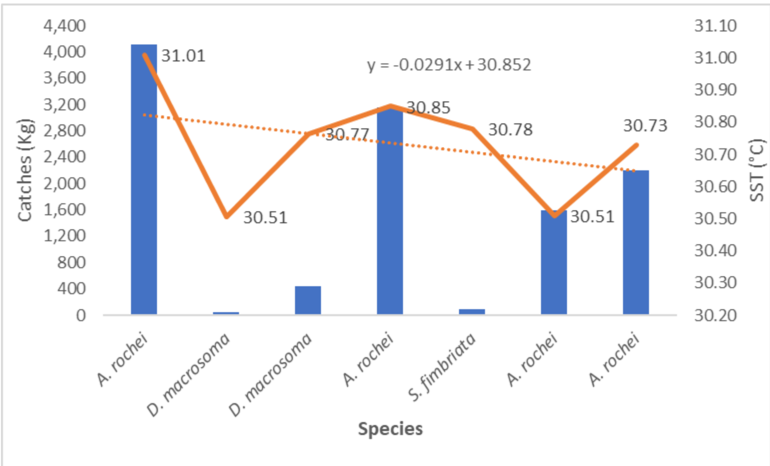


Figure 3. Comparison of SST values with catches in February 2024.

When compared with February 2014 research by Yoga et al (2014), the maximum SST value increased by 0.31°C in February 2024, in the waters south of Java. There has been an increase in SST every year. This increase in SST is thought to be caused by meteorological factors such as an increasing air temperature (Mulyasari et al 2020). With this SST distribution, the dominant catch was *A. rochei*, with the largest catch in February of 4,120 kg at a temperature of 31.01°C, while the lowest catch was at a temperature of 30.51°C, with a total of 1,600 kg. Besides *A. rochei*, *S. fimbriata* and *D. macrosoma* were also caught.

The distribution of SST in the period 17 to 30 March 2024 (Figure 2B) ranged between 29.74 to 30.14°C. The SST distribution tended to increase by 0.03°C per fishing trip during March 2024 (Figure 4). The maximum SST value in March was lower than in February. This is in line with the statement Putra et al (2019) who stated that in March the SST value reaches the minimum value compared to other months. With this SST distribution, the dominant catch is *D. macrosoma*. The highest catch of *A. rochei* was in March, of 1,260 kg, at a temperature of 30.85°C, while the lowest catch was at a temperature of 30.77°C, with a total of 510 kg.

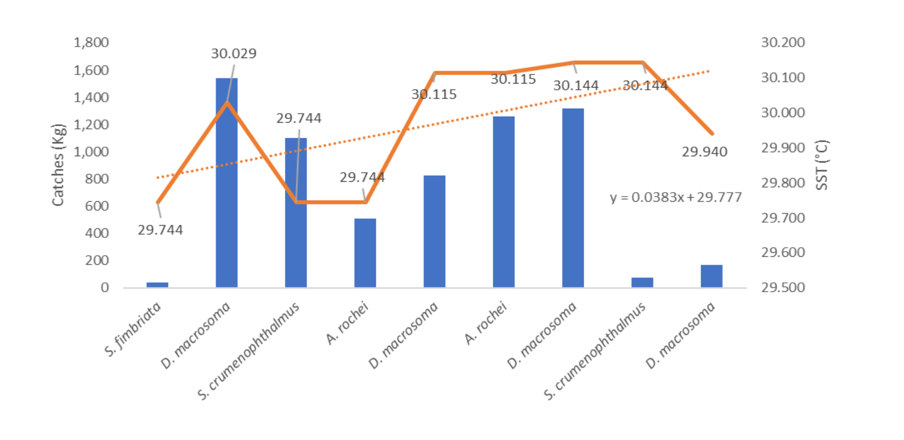


Figure 4. Comparison of SST values with catches in March 2024.

The distribution of SST along with fish catches in April 2024 for the period 18 to 28 April 2024 (Figure 2C) ranged between 29.69 to 30.24°C. The SST distribution tended to decrease by 0.061°C per fishing trip (Figure 5). The maximum SST value in April is lower than in February and March. According to Tangke et al (2015), satellite imagery data for April 2015 showed higher SST values than the previous month, with SST values ranging from 29 to 31.5°C. This was confirmed by Dwiyanti et al (2022) and Putra et al (2019): the average distribution of maximum SST values occurred in April reaching 31.6°C.

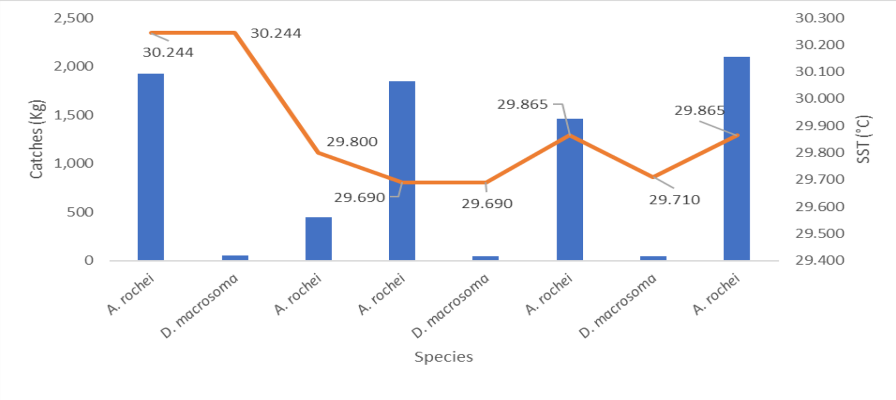
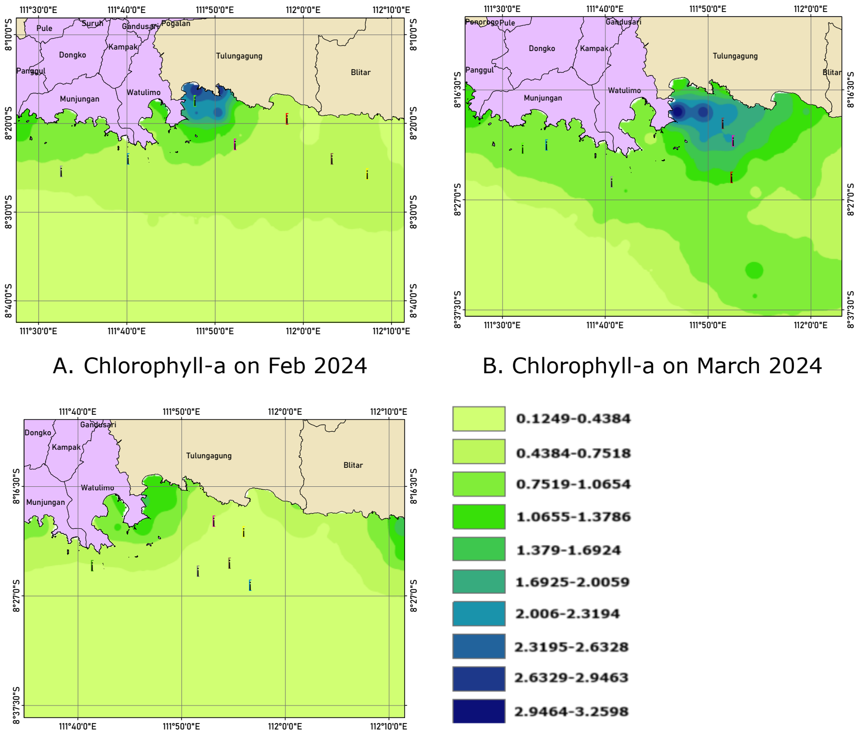


Figure 5. Comparison of SST values with catches in April 2024.

With this SST distribution, the dominant catch was *A. rochei*, with the highest catch in April of 2,100 kg at a temperature of 29.86°C, and the lowest catch was of 444 kg at a temperature of 29.80°C.

Distribution of chlorophyll-a in Prigi Waters. Chlorophyll-a is one of the parameters that determines primary productivity in the sea (Nurdin et al (2020). The distribution and high and low concentrations of chlorophyll-a are closely related to the oceanographic conditions of a body of water. Putri et al (2021) state that chlorophyll-a is not directly eaten by fish, but high concentrations of chlorophyll-a increase feeding opportunities for fish, so that fish gather in that area. The distribution of chlorophyll-a in February to April 2024 in Prigi Waters can be seen in Figure 6.



A. Chlorophyll-a on Feb 2024 B. Chlorophyll-a on March 2024

C. Chlorophyll-a on April 2024 Parameter Chlorophyll-a (mg m^{-3})

Figure 6. Distribution of chlorophyll-a in February-March 2024 in Prigi Waters.

The distribution of chlorophyll-a along with fish catches obtained in the period 21 to 28 February 2024 (Figure 6A) ranged between 0.342 to 0.853 mg m^{-3}. When the data was collected, the concentration of chlorophyll-a tended to decrease by 0.0536 mg m^{-3} per fishing trip during February 2024 (Figure 7). Chlorophyll-a in Prigi waters in February tended to have high concentrations in fishing areas closer to the coast and in coastal waters. With high chlorophyll-a concentrations, the dominant catch was *A. rochei.*

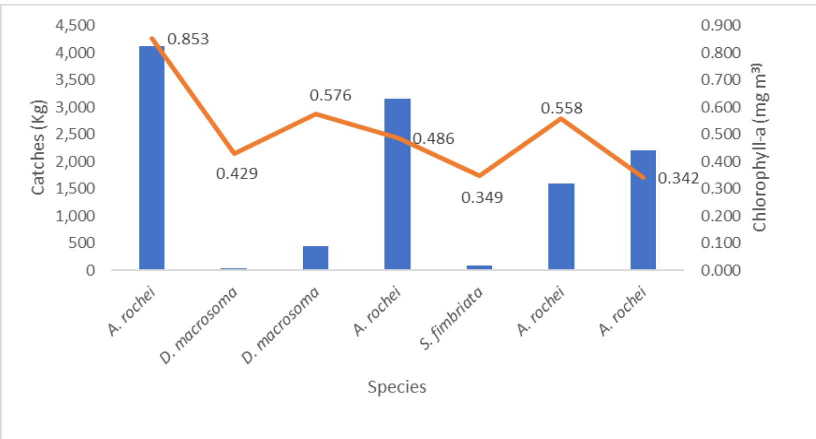


Figure 7. Comparison of chlorophyll-a concentrations with catches in February 2024.

In line with the statement by Nagi et al (2023), the current study found that *A. rochei* uses zooplankton as food in areas that experience high concentrations of chlorophyll-a. The largest catch of *A. rochei* in February was 4,120 kg at a chlorophyll-a concentration of 0.853 mg m^{-3}, while the lowest catch was 1,600 kg at a chlorophyll-a concentration of 0.558 mg m^{-3}.

The distribution of chlorophyll-a along with fish catches obtained in the period 17 to 30 March 2024 (Figure 6B) ranged between 0.430 to 1.059 mg m^{-3}. Chlorophyll-a concentration tended to increase by 0.067 mg m^{-3} per fishing trip during March 2024 (Figure 8). The chlorophyll-a concentration in March 2024 was greater than in February 2024.

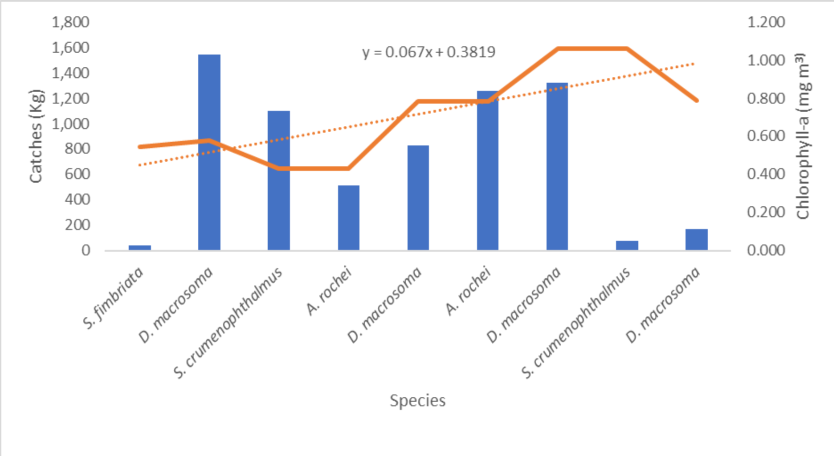


Figure 8. Comparison of chlorophyll-a concentrations with catches in March 2024.

According to Kuswanto et al (2017), chlorophyll-a concentration does not influence the catch results of *A. rochei*. Based on the data obtained, the chlorophyll-a concentration in March 2024 had a higher value than the previous month and the production of *A. rochei* was lower than in the previous month. The dominant catch was *D. macrosoma*, while the highest catch for *A. rochei* was of 1,260 kg in March, at a chlorophyll-a concentration of 0.783 mg m^{-3}, and the lowest catch was at a chlorophyll-a concentration of 0.430 mg m^{-3}, with a total of 510 kg.

The distribution of chlorophyll-a along with fish catches in the period 18 to 28 April 2024 (Figure 6C) ranged between 0.275-0.478 mg m^{-3}. When the data was collected, the concentration of chlorophyll-a tended to decrease with a value of 0.0194 mg m^{-3} per fishing trip during April 2024 (Figure 9). The maximum chlorophyll-a value in April was lower compared to February and March. The highest catch of *A. rochei* was in April at 2,100 kg at a chlorophyll-a concentration of 0.351 mg m^{-3}, while the lowest catch was 444 kg at a chlorophyll-a concentration of 0.302 mg m^{-3}.

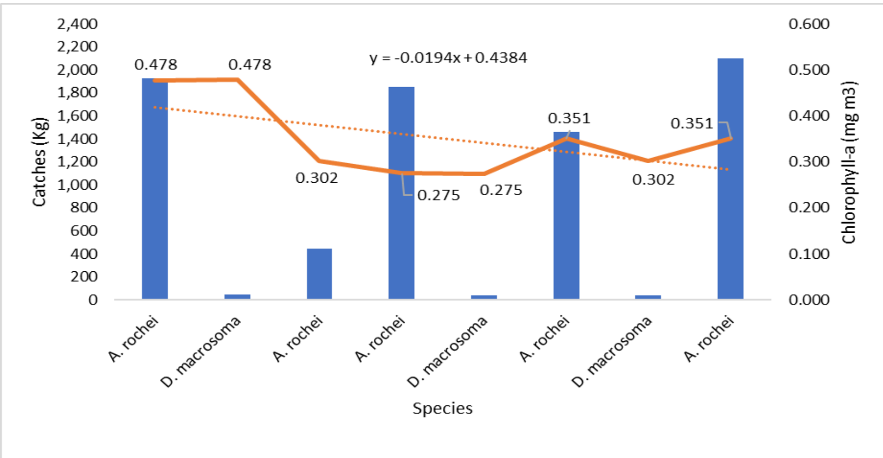
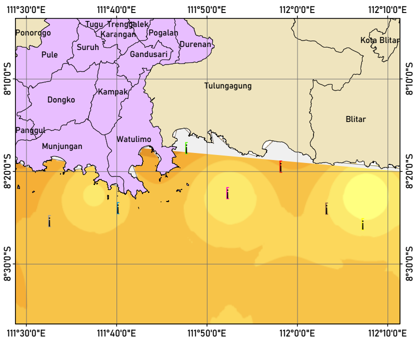
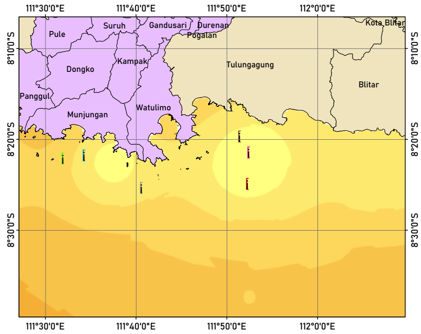


Figure 9. Comparison of chlorophyll-a concentrations with catches in April 2024.

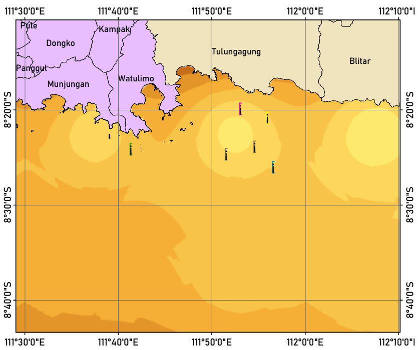
Distribution of salinity in Prigi Waters. Yunus et al (2019) stated that fish migrate to places that have a salinity level that matches their body's osmotic pressure, such as *Selaroides* spp. with a salinity of 19 ppt. *A. rochei* likes areas with a salinity level of 32-35 ppt. Environmental components that have a direct interaction with the abundance of pelagic fish are salinity and oxygen (Ma'mun et al 2019). The distribution of salinity in February to April 2024 in Prigi Waters can be seen in Figure 10.



B. Salinity on February 2024



B. Salinity on March 2024



C. Salinity on April 2024

Parameter salinity in ppt

Figure 10. Distribution of salinity in February to March 2024 in Prigi Waters.

The distribution of salinity in Prigi waters in February 2024 for the period 21 to 28 February 2024 (Figure 10A) ranged from 33.15 to 33.35 ppt. When the data was collected, the distribution of salinity tended to decrease by 0.0282 ppt per fishing trip during February 2024 (Figure 11).

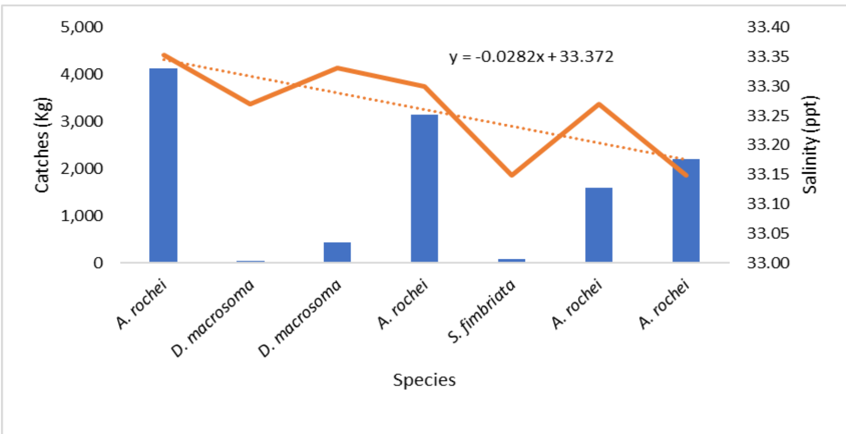


Figure 11. Comparison of salinity distribution with catches in February 2024.

The largest catch of *A. rochei* in February was 4,120 kg at a salinity of 33.35 ppt, while the lowest catch was 1,600 kg at a salinity of 33.27. In line with the statement of Yunus et al (2019), the current study found that *A. rochei* likes areas with salinity levels of 32 to 35 ppt.

The distribution of salinity along with fish catches obtained in Prigi Waters for the period 17 to 30 March 2024 (Figure 10B) ranged from 33.04 to 33.26 ppt. When the data was collected, the distribution of salinity had decreased by 0.0015 ppt per fishing trip during March 2024 (Figure 12). The distribution of salinity in Prigi Waters in March 2024 was lower than in February 2024. Low salinity values affect the *A. rochei* catch results. The total catch of *A. rochei* in February reached 11,070 kg, while in March the total catch was of only 1,770 kg.

In line with Sasmito et al (2022), salinity had a significant effect on the potential zone of *A. rochei*. The dominant catch was *D. macrosoma*. Meanwhile, the largest *A. rochei* in March was 1,260 kg at a salinity of 33.4 ppt, while the lowest catch was at a salinity of 33.10 ppt, with a total of 510 kg.

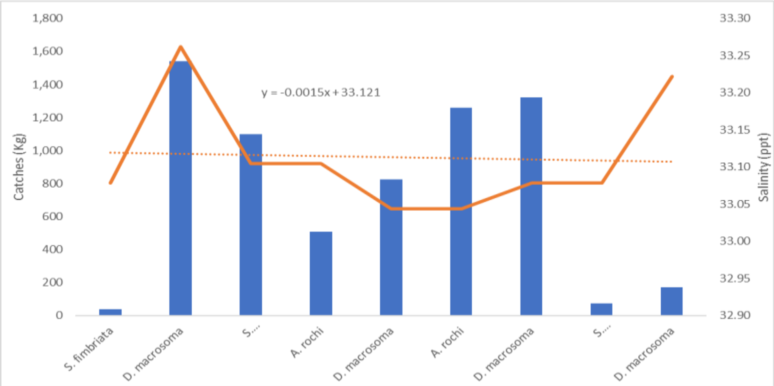


Figure 12. Comparison of salinity distribution with catches in March 2024.

The distribution of salinity along with fish catches in the period 18 to 28 April 2024 (Figure 10C) ranged between 33.17 to 33.27 ppt. At the time when data collection was carried out, the salinity tended to experience a decrease of 0.0097 ppt per fishing trip during April 2024 (Figure 13). According to Erfanda & Widagdo (2020), the salinity of seawater in Southern Java had a value range of 35 to 33 ppt.

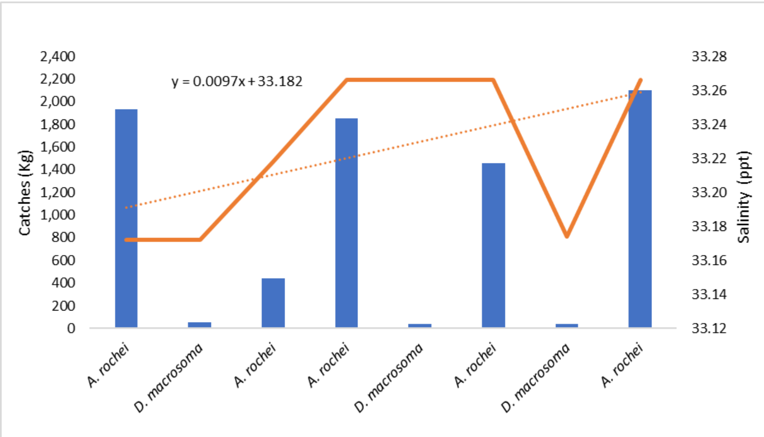


Figure 13. Comparison of salinity distribution with catch results in April 2024.

The highest catch of *A. rochei* was in April at 2,100 kg at a salinity of 33.27 ppt, while the lowest catch was 444 kg at a salinity of 33.22 ppt.

Verification of satellite image data with in-situ data. According to Rifai et al (2020), data verification is carried out by calculating the Mean Relative Error (MRE) value. Verification is carried out by *in-situ* data collection. The verification of *in-situ* SST data against the Aqua-MODIS satellite image data (at 11 *A. rochei* fishing locations) produced an average relative error value of 3.22%. Meanwhile, the verification of *in-situ* salinity data against the Marine Copernicus satellite image data produced an average relative error of 6.82%. Verification of *in-situ* SST and salinity data can be seen in Table 2.

Table 2

In-situ data verification test with satellite imagery

In-situ data		*Satellite imagery data*		*Error value (%)*	
SST (°C)	*Salinity (ppt)*	*SST (°C)*	*Salinity (ppt)*	*SST (°C)*	*Salinity (ppt)*
27.6	28	31.01	33.35	3.10	4.87
28.9	25	30.85	33.30	1.77	7.54
25.4	27	30.51	33.27	4.65	5.70
27.7	25	30.73	33.15	2.75	7.41
26.5	28	29.74	33.11	2.95	4.64
27.8	24	30.12	33.04	2.10	8.22
27.6	26	30.24	33.17	2.40	6.52
25.7	25	29.80	33.22	3.73	7.47
25.8	24	29.69	33.27	3.54	8.42
25.2	27	29.87	33.27	4.24	7.51
25.3	25	29.87	33.27	4.15	6.73
Mean relative error (%)				3.22	6.82

According to Jaelani et al (2015) the average relative error is less than 30% in image data processing can be used for further analysis. Based on the previous statement, it can be concluded that the satellite image SST data can be subjected to further analysis because it has a truth value for the Aqua-MODIS image of 96.78%. Analysis of satellite image salinity data can also be continued because it has a truth value for Marine Copernicus images of 93.18%.

Multiple linear regression analysis. Sepri (2020) stated that the influence of oceanographic parameter conditions on catch data can be analyzed using multiple linear regression analysis. In this study, the analysis used multiple linear regression analysis methods to determine the relationship between *A. rochei* catches as a response variable and several predictor variables such as SST, chlorophyll-a, and salinity.

Simultaneous test (F_{-Test}). This F_{-test} is used to determine the effect of the variables SST (X_1), chlorophyll-a (X_2), and salinity (X_3) on the catch of *A. rochei* (Y) (Suniada & Susilo 2017). In this research, based on the ANOVA output table, a Sig value of 0.008 was determined. Because the Sig value of 0.008<0.05, according to the basis for decision making in the F_{-test}, it can be concluded that H_a is accepted, namely that SST (X_1), chlorophyll-a (X_2), and salinity (X_3) simultaneously influence *A. rochei* (Y). Yani & Susaniati (2018), explained that *A. rochei* is influenced by SST, and chlorophyll-a simultaneously, which is confirmed by the ANOVA output table, since the F_{-count} value is 9.095 and $F_{-count}>F_{-table}$ (=4.35). F_{-table} is obtained using k and n-k-1 (horizontal and vertical degrees of freedom, respectively) from the frequency distribution in the R-statistical table, at a significance of 5% (or 0.05), where "k" is the number of variables (3) and "n" is the number of research samples (11). From this formula, the number (3.11-3-1) = (3.7) is obtained. This number is a reference for obtaining the F_{-table} value of 4.35. The simultaneous test (F_{-test}) of oceanographic parameters can be seen in Table 3 below.

Table 3

Simultaneous test (F_{-test}) of oceanographic parameters

Model	*Sum of squares*	*df*	*Mean square*	*F*	*Sig.*
Regression	9042635,622	3	3014211,874	9.095	0.008^b
Residual	2319975,287	7	331425,041		
Total	11362610,91	10			

a. Dependent variable: *A. rochei* (Y)

b. Predictors: Constant, Salinity (X_3), Chlorophyll-a (X_2), SST (X_1)

T test. Based on Table 4, it can be seen that the calculated value of the SST variable (X_1) is 2.375. Because the value of t_{-count} is 2.375 > t_{-table} 2.228, it can be concluded that Ha is accepted. This means that SST influences the *A. rochei* captures variable, which is in line with Nagi et al (2023), stating that *A. rochei* capture is influenced by SST because mackerels always move to get the optimum temperature. According to Sasmito et al (2022) salinity influences the ZPPI of *A. rochei*. Based on Table 4, it can be seen that the t_{-count} value of the chlorophyll-a variable (X_2) is 0.795. Because the t_{-count} value is 0.795<t_{-table} (=2.228), it can be concluded that H_0 is accepted. The t_{-count} value of the salinity variable (X_3) is 2.401. Because the t_{-count} value is 2.401>t_{-table} 2.228, it can be concluded that Ha is accepted. It means that the salinity influences the *A. rochei* captures variable.

Table 4

T_{test} of oceanographic parameters

Model	*B*	*Std. error*	*Beta*	*t*	*Sig.*
(Constant)	-21,024.9	68,000.4		-3.092	0.018
SST (X_1)	1,204.2	506.989	0.543	2.375	0.049
Chlorophyll-a (X_2)	956.408	1,202.61	0.171	0.795	0.453
Salinity (X_3)	5,276.53	2,197.92	0.454	2.401	0.047
a. Dependent variable: *A. rochei* (Y)					

Based on Table 4, the regression equation is obtained with a constant value of -21,024.9, which can be interpreted as:

1. If the value of the independent variable is 0 then the dependent variable decreases to a value of -21,024.9.
2. If the SST (X_1) variable increases by 1°C, then the variable *A. rochei* increases by 1,204.2 kg.
3. If the chlorophyll variable (X_2) increases by 1 mg m^{-3}, then the variable *A. rochei* increases by 956.4 kg.
4. If the salinity variable (X_3) increases by 1 ppt, then the variable *A. rochei* increased by 5,276.53 kg.

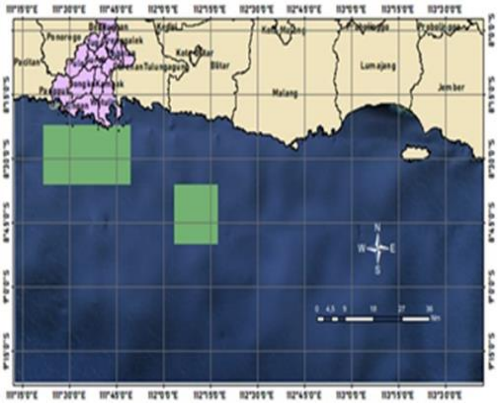
Coefficient of determination. Suniada & Susilo (2017) stated that the coefficient of determination (R^2) indicates whether the relationship between oceanographic parameters and catch results is strong or not. Based on Table 5, it can be seen that the R^2 is 0.796, which means that the influence of the variables sea surface temperature (X_1), chlorophyll-a (X_2), and salinity (X_3) on the *A. rochei* captures variable is 79.6%, while it is 20.4% influenced by other factors not included in the regression model. This means that oceanographic parameters have a strong influence on *A. rochei* (R^2 between 0.60 and 0.799 suggest a strong influence). Several other factors outside the regression model that can influence catch results include water depth, currents and wind (Nagi et al 2023). The coefficient of determination values are presented in Table 5.

Table 5

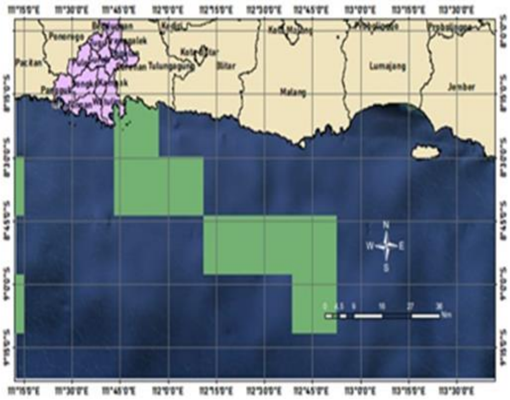
Coefficient of determination

Model summary				
Model	*R*	*R square*	*Adjusted R square*	*Std. error of the estimate*
1	0.892[a]	0.796	0.708	575.695
a. Predictors: (Constant), Salinity (X_3), Chlorophyll-a (X_2), SST (X_1)				

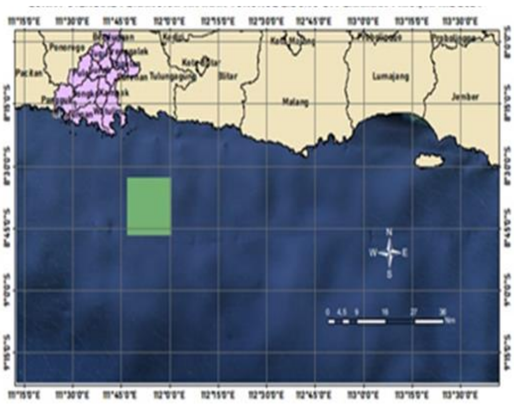
Mapping of potential fishing zones A. rochei in Prigi Waters. ZPPI predictions are useful for determining fishing areas using an oceanographic parameter approach (Farda & Jatisworo 2019). To obtain the ZPPI, an overlay is carried out by combining the optimum oceanographic parameters which influence *A. rochei*. The following are the results of the ZPPI mapping overlay for *A. rochei* fishing in February to April 2024.



A. ZPPI in February 2024



B. ZPPI in March 2024



C. ZPPI in April 2024

Figure 14. ZPPI mapping of *Auxis rochei* in Prigi Waters.

This ZPPI mapping can be used as a reference for determining *A. rochei* fishing areas and preventing a decline in the *A. rochei* production in Prigi. Mapping the potential fishing zones for *A. rochei* is an important process to increase the efficiency and sustainability of the fishing industry, in line with the decreasing trend in *A. rochei* production in Prigi. By using satellite imagery technology, the areas where *A. rochei* is most commonly found can be identified.

The mapping analysis presented in Figure 14 used the data variables and data sources presented in Table 1. Figure 14A shows that the ZPPI for *A. rochei* in February 2024 in Prigi Waters was located at 08°36'14"S-09°04'08"S and 111°31'15"E-112°27'10"E. Figure 14B shows that the ZPPI for *A. rochei* in March 2024 in Prigi Waters was located at 08°29'13"S-08°44'24"S and 111°42'03"E-112°27'39"E. Figure 14C shows that the ZPPI for *A. rochei* in April 2024 in Prigi Waters was located at 08°27'10"S-08° 53'49"S and 112°04'19"E-113°01'30"E.

Conclusions. Oceanographic parameter conditions in February 2024 had a maximum SST value of 31.01°C, chlorophyll-a 0.853 mg m^{-3}, and salinity 33.35 ppt, with a total catch of *A. rochei* of 11,070 kg. Oceanographic parameter conditions in March 2024 had a maximum SST value of 30.14°C, chlorophyll-a 1,059 mg m^{-3}, and salinity33.26 ppt, with a total catch of *A. rochei* of 1,170 kg. Oceanographic parameter conditions in April 2024 had a maximum SST value of 30.24°C, chlorophyll-a 0.478 mg m^{-3}, and salinity 33.17 ppt, with a total catch of A. rochei of 7.784 kg. A 1 ppt change in salinity resulted in an increase of 5,276.53 kg in the catch of *A. rochei*. Meanwhile, if tests were carried out simultaneously, a significance result of 0.008 was obtained, which means that the SST, chlorophyll-a and salinity variables simultaneously influenced the catch of *A. rochei*. In partial testing, SST influenced *A. rochei* fish, chlorophyll-a did not affect *A. rochei* fish, and salinity *A. rochei.* This result is supported by the significance values of SST and salinity <0.05. Meanwhile, chlorophyll-a has a significance value >0.05. The coefficient of determination value is 0.796, which means that the influence of SST, chlorophyll-a, and salinity variables on the *A. rochei* captures variable is 79.6%, while 20.4% is influenced by other factors not included in the regression model. The potential fishing zone of *A. rochei* in February 2024 in Prigi Waters was located at the latitude 08°36'14"S-09°04'08"S and the longitude 111°31'15"E-112°27'10"E. The ZPPI of *A. rochei* in March 2024 in Prigi Waters was located at the latitude 08°29'13"S-08°44'24"S and the longitude 111°42'03"E-112°27'39"E. The ZPPI of *A. rochei* in April 2024 in Prigi Waters was located at the latitude 08°27'10"S-08°53'49"S and the longitude 112°04'19"E-113°01'30" E.

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