← Kembali   Arsipkan   Pindahkan   Hapus   Spam   •••

Eni Kovacs <ek.bioflux@gmail.com>
Kepada: erick nugraha

Sen, 26 Des 2022 jam 18.10

Dear Dr. Nugaraha,

Regarding your manuscript submitted to AACL Bioflux, the editorial team has some requests prior to acceptance (please see the attachment).

Please note: Always operate corrections/additions (or deletions) in the manuscript we are sending you, by **highlighting with a bright color** (for an easy identification). We never work on the manuscript you send back, just identify the corrections and operate them on our document (to avoid any undesirable accidental operations like changed page set up, otherwise the editors have to start all the work from the beginning, and we cannot ask them to re-check every manuscript word by word to identify unmarked modifications).

Thank you for understanding!

> Tampilkan pesan asli

--
Kind regards,
Editor AACL Bioflux
Eniko Kovacs

Nugraha_S... .docx
1.3MB

Study of sea surface temperature and chlorophyll-a ~~to~~ influence on the number of fish caught in the waters of Sadeng, Yogyakarta, Indonesia

[1]Priyantini Dewi, [2]Sutarjo, [1]Maman Hermawan, [1]Yusrizal, [3]Mira Maulita, [1]Bongbongan Kusmedy, [1]Eli Nurlaela, [4]Sopiyan Danapraja, [1]Erick Nugraha

[1] Faculty of Fishing Technology, Jakarta Technical University of Fisheries, South Jakarta, Indonesia; [2] Fleet Monitoring and Operation, Directorate General of Marine and Fisheries Resources Surveillance, Jakarta, Indonesia; [3] Faculty of Aquatic Resources Management, Jakarta Technical University of Fisheries, South Jakarta, Indonesia; [4] Faculty of Fisheries Extension, Jakarta Technical University of Fisheries, South Jakarta, Indonesia; Corresponding author: E. Nugraha, nugraha_eriq1@yahoo.co.id

Commented [WU1]: In the whole manuscript (title, text, tables and figures), replace "number" by "quantity", when it is about catches, because a mass is expressed, in kg, which is a quantity, not a number. Also, please use the correct unit of measure and format for the concentration (mg m^{-3}), everywhere in the manuscript.

Abstract. Oceanographic factors can be an indicator in determining the potential of fishing areas. The sampling technique of SST and chlorophyll-a data in this study was carried out directly (in-situ) and using satellite image data that can be downloaded from NASA Ocean Color to obtain SST and chlorophyll-a data. The purpose of this study was to analyze the effect of SST and chlorophyll-a on the ~~number~~ quantity of purse seine catches~~. The data analysis method used descriptive analysis, analysis of the relationship between SST and chlorophyll-a variables and catches~~, based on~~used~~ multiple correlation tests~~,~~ and ~~analysis of the effect of SST and chlorophyll-a on catches using~~ multiple linear regression analysis. Species of fish caught during the study included: yellowfin tuna *(Thunnus albacares)*, skipjack tuna *(Katsuwonus pelamis)*, dolphin fish *(Coryphaena hippurus)*, starry triggerfish *(Abalistes stellaris)*, rainbow runner *(Elagatis bipinnulata)*, scad mackerel *(Decapterus russelli)* and squid *(Loligo)*. The SST was measured ~~i~~In-situ. ~~measurement of SST is known that the SST I~~in the waters of Sadeng, Yogyakarta, the SST is relatively homogeneous, ranging from 27° to 30.3°C. ~~SST data that has been obtained in-situ or *ex-situ*~~D~~-d~~ata verification is carried out ex-situ, with the aim of testing the level of accuracy. ~~of data taken directly and S~~satellite image data was processed for as many as 26 sampling points~~, and obtained a~~. The relative error was of 5.63%~~ which means that both data further processing can be carried out~~. Correlation test results between SST variables, chlorophyll-a and catches in the waters of Sadeng, Yogyakarta were performed for~~in~~ the period April to May 2022. ~~Analysis~~ The analysis of the effect of SST and chlorophyll-a showed that ~~partially (X$_1$)~~ SST had ~~an~~ a weak effect~~, on catches~~ while chlorophyll-a ~~a (X$_2$) has~~ had a significant effect on the catches ~~(Y).),~~ ~~These results can be seen from~~as indicated by their level of significance of ~~each of them~~ 0.556 (>0.05) and 0.041 (<0.05), respectively. Meanwhile, if the test was carried out on the ~~simultaneously~~combination of SST and chlorophyll-a, the results ~~obtained~~ would have a significance of 0.056, which means that the SST and chlorophyll variables together ~~have an~~ strongly influence ~~on~~ the catch. ~~The data obtained from *in-situ* or *ex-situ* or can be used to determine the distribution of SST and the concentration of chlorophyll-a in a waters which will later be linked by the catch number.~~

Commented [WU2]: Full denomination when first mentioned.

Key Words: Geographic Information System (GIS), satellite imagery, oceanography, MODIS.

Formatted: Font: Not Italic

Introduction. Sadeng waters which are included in FMA 573 have the potential as habitat for economically important fish such as skipjack tuna *(Katsuwonus pelamis)*, bigeye tuna *(Thunnus obesus)*, yellowfin tuna *(Thunnus albacares)*, mackerel tuna *(Euthynnus affinis)*, mackerel scad *(Decapterus russelli)* and sardin *(Sardinella lemuru)* (Nikijuluw 2008; Wijopriono 2012; Wahyuningrum et al 2012; Jayawiguna et al 2019). ~~and~~ Skipjack tuna *(Katsuwonus pelamis)* is the second largest commodity in the area (Anggraeni et al 2015; Ma et al 2017). ~~This~~ Its geographical condition ~~causes~~ favors Indonesia's ~~to become a mega~~ biodiversity ~~country~~ (Kusmana & Hikmat 2015). Hendiarti et al 2004 explained that Sea Surface Temperature (SST) can affect the metabolism and reproduction of organisms in the sea. The distribution of SST is very important to know because it can provide information about the front, upwelling, currents, weather/climate and fishing ground

(Abidin et al 2020). Sidik et al (2015~~); ~~) and Azizah et al (2020) explained that the influence of SST on the growth of phytoplankton will indirectly affect the concentration of chlorophyll-a in waters. According to Alfajri et al (2017), the ~~fashionable~~ Aqua satellite ~~is one of the satellites~~ created by NASA ~~that~~ functions as an observation satellite in the marine field. The Aqua-~~modis~~ Modis satellite can measure various types of water parameters, one of which is SST in the waters. Oceanographic factors that are often associated with catches are SST and chlorophyll-a (Hastuti et al 2021).

Based on the discussion above and given the lack of research on SST and chlorophyll-a influence on the catch number in Sadeng waters, we researched ~~the study of SST and chlorophyll-a to the total catches~~if there is a relationship between these variables. T~~It is hoped that t~~he results of this study are expected to~~can~~ help fishermen to determin~~e~~ing fishing areas, based on oceanographic parameters.

Material and Method

Description of the study sites. The research was conducted from 18 March to 30 May 2022, by participating in activities of fishing ~~activities~~ by~~on~~ purse seine~~r~~ operating in the Indian Ocean. The research locations are as shown in Figure 1 below:

Figure 1. Map of fishing ~~Ground~~ground.

Method of collecting data. Data collection is done by collecting primary data and secondary data. Primary data ~~in the form of~~concerned the fishing area position, the *in-situ* SST ~~taken~~ measured directly and the number of catches calculated for each trip. ~~and~~ The secondary data ~~in the form of~~were ~~MODIS level 3 aqua satellite imagery, namely~~ chlorophyll-a and SST images obtained by level 3 Aqua MODIS satellite imagery. Materials and tools used include: purse seine~~r~~, GPS, compass, digital thermometer, software (~~Ms~~. Excel, Seadas 7.5.3, Arcmap 10.8, SPSS), Camera, Chlorophyll-a Image, SST Image.

Data processing method. In processing MODIS data, SeaDas software is used. The results obtained are ~~aqua~~ Aqua MODIS images at level 3, which produce SST values in degrees Celsius (°C) and chlorophyll-a (mg m^{-3}~~3~~). Due to the relatively wider area, the projection system used is the GCS *(Geographic Coordinate System)* with the WGS84 datum. The ~~taking~~ processing of chlorophyll-a and SST values contained in the Aqua MODIS ~~aqua~~ image map was carried out using the SeaDAS software. ~~then filtered the Nan d~~Data were filtered with Microsoft Excel, and ~~made~~ a map of the distribution of chlorophyll-a and SST was made, using the ~~IDW~~ IDW (Inverse Distance Weighted) analysis & the contouring menu, ~~namely~~ by interpolation ~~using~~, ~~IDW *(Inverse Distance Weighted)*. is~~ a simple deterministic method ~~by~~ based on~~considering~~ the surrounding points (Nurman 2010).

Commented [WU3]: ?

Formatted: Font: Not Italic

Data analysis method. The method used to observe the data ~~uses~~ used associative research methods with a quantitative approach ~~used~~ to observe certain populations or samples (Sugiyono 2010). Analysis of the effect of SST and chlorophyll-a on the catch was tested by several methods including a verification test of satellite imagery data (ex-situ) and direct measuring (in-situ) data, a classical assumption test, and multiple linear regression analysis.

Results and Discussion

Commented [A4]: Carefully correct the concentration unit of measure, in the whole document: it is mg m-3 (negative exponent; mass per volume), including the tables and figures

Catch production.

1. Catches number on the 1st trip.

The 1st trip was held on 1 to 8 April 2022 by setting 9 times the gear, with the overall catch ~~were~~ consisting of *T. albacares* (2,552 kg), *K. pelamis* (3,023 kg), *D. russelli* (2,837 kg), *C. hippurus* (105 kg), *E. affinis* (337 kg) and *A. stellaris* (2,332 kg), with a total ~~catches~~ of 11,186 kg. The ~~most~~ catches were dominated by *K. pelamis* ~~and the least was *C. hippurus*~~.

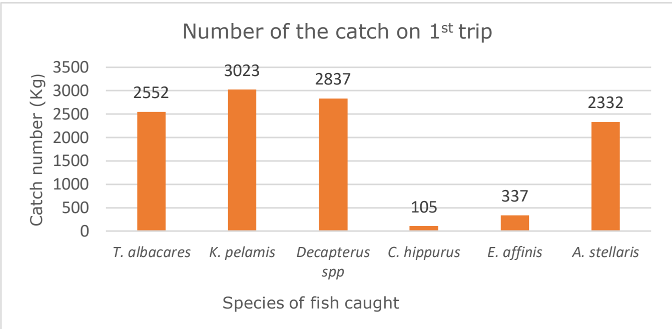
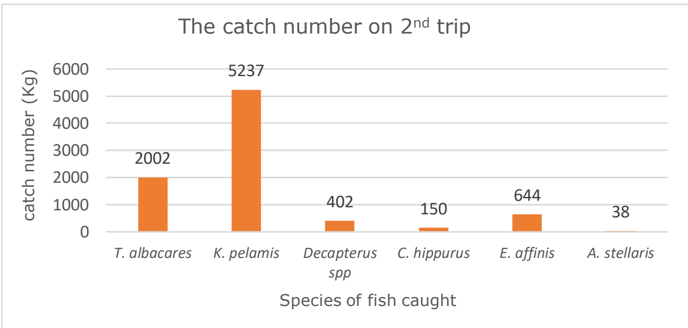


Figure 2. ~~Graph of the~~ The number of catches on the 1st trip.

2. The number of catches of the 2nd trip.

The 2nd trip ~~will be~~was held on 10 to 16 April 2022 with 7 days of fishing operations or 7 settings. The catches of the 2nd trip ~~were~~ consisted of *T. albacares* (2,002 kg), *K. pelamis* (5,237 kg), *D. russelli* (402 kg), *C. hippurus* (150 kg), *E. affinis* (644 kg), *A. stellaris* (38 kg), with a total ~~catches~~ of 8,473 kg. The catches ~~number~~ on the 2nd trip wereas ~~still~~ dominated by *T. albacares, K. pelamis,* and *D. russelli.*

Formatted: Indent: First line: 0 cm



Gambar 3. ~~Graph of the~~ The number of catches on the 2nd trip.

3. The number of catches of the 3rd trip.

The 3rd trip ~~will be~~was held on 09 to 18 May 2022 with 10 days of catching and 10 settings. T~~Most of t~~he catches on this trip were ~~found in~~dominated by *K. pelamis*~~ and the least catches were *C. hippurus*~~. The composition of the catch was: *T. albacares* (3,503 kg), *K. pelamis* (10,378 kg), *D. russelli* (5,866 kg), *C. hippurus* (143 kg), *Loligo* (497 kg), *E. bipinnulata* (154 kg), with a total of 20,541 kg.

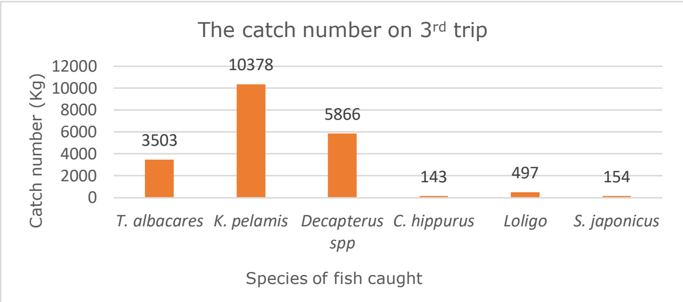


Figure 4. ~~Graph of the~~ The catch of the 3rd trip.

Catch composition. In 3 trips with 26 catches, the catch was 40,200 kg. ~~The highest of catch number was~~ *K. pelamis* dominated with as much as 18,638 kg and ~~with~~ an average of 716 kg per setting, the 2nd highest catch was *D. russelli* with as much as 9,105 kg ~~with~~ and an average of 350 kg per setting, and the 3rd was *T. albacares* with as much as 8,057 kg ~~with~~ and ~~the~~ an average per setting ~~is~~ of 309 kg. Meanwhile, the lowest catches were C. hippurus ~~at~~ with 398 kg and E. bipinnulata ~~at~~ with 154 kg ~~with~~ and an average of 15.3 kg and 5.9 kg, respectively, for each setting. Table 1 shows~~he following is~~ the composition ~~table for the 3rd~~ of the catching trips:

Table 1

Fish ~~Composition~~ composition and catch number

Species	*Catch number (Kg)*			Total	*Average*	*Percentage (%)*
	Trip 1	*Trip 2*	*Trip 3*			
T. albacares	2.552	2.002	3.503	8.057	309	20
K. pelamis	3.023	5.237	10.378	18.638	716	46,3
D. russelli	2.837	402	5.866	9.105	350	22,6
C. hippurus	105	150	143	398	15,30	1
A. stellaris	2.332	38	0	2.370	91,15	5,9
E. affinis	337	644	0	981	37,73	2,5
E. bipinnulata	0	0	154	154	5,92	0,4
Loligo	0	0	497	497	19,11	1,3

T~~in graphical form can be seen in t~~he diagram in Figure 6~~following~~ ~~image~~synthesizes this information: :

Formatted: Justified

Formatted: Font: Italic

Formatted: Centered

Commented [WU5]: According to the format requirements, the decimals separator is ".", not ",". Please make the necessary corrections in the whole manuscript.

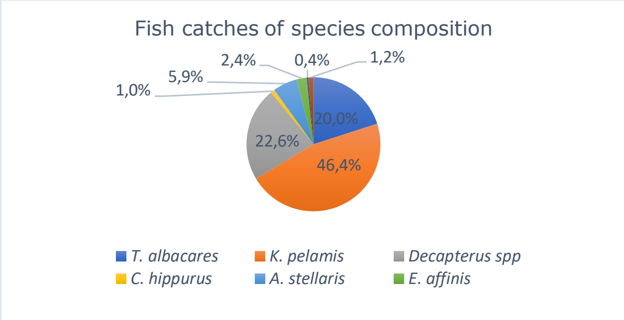


Figure 6. Diagram of the The composition of the caught fish species.

Distribution of Sea Surface Temperature (SST).

1. Distribution of SST in April 2022 for the 1st trip.

The distribution of SST was observed to be stable, this can be seen from the 9 sampling points that were obtained during the 1st trip in April. Table 2The following is a table of shows in-situ and ex-situ SST distribution values taken onmeasured from 01 to 08 April 2022:

Formatted: Indent: First line: 0 cm

Table 2

The distribution of SST in Sadeng waters in April 2022, on the 1st trip

Date	*Position*		*SST (°C)*	
	Latitude (S)	*Longitude (T)*	*In-situ*	*ex-situ*
01/04/2022	08°42'14''	110°31'22''	27,0	31,7
02/04/2022	08°46'05''	110°33'36''	28,1	31,3
03/04/2022	08°51'00''	110°35'12''	28,0	31,3
03/04/2022	08°49'07''	110°36'05''	28,5	31,4
04/04/2022	08°52'07''	110°36'10''	29,0	31,5
05/04/2022	08°41'47''	110°33'00''	27,1	31,5
06/04/2022	08°38'05''	110°51'51''	26,7	31,2
07/04/2022	08°47'00''	110°34'00''	29,2	31,1
08/04/2022	08°43'12''	110°33'26''	30,1	31,7
	Average		28,1	31,4

Commented [WU6]: According to the format requirements, the decimals separator is ".", not ",". Please make the necessary corrections in the whole manuscript.

According to Zulkhasyni (2015) stated that in general high SST occurs in the west season to the transition season, where the west season starts from in September to and ends in February, every year. The *K. pelamis* was caught at a temperature range of 29 to 30°C from November to March (Nugraha et al 2020). And according to Yeka et al (2022), the potential area for catching *K. pelamis* has a close relationship with the environmental parameters, especially the chlorophyll-a, whose optimum ranges from 0.12 to 0.22 mg m-3. SST in-situ of Sadeng waters in April 2022 ranged from 26.7 to 30.1°C. The highest SST occurred ion April 8, 2022, which reached reaching 30.1°C, while the lowest temperature occurred on April 6, 2022, reaching which reached 26.7°C. The average *in-situ* SST in April 2022 on the first trip of the fishing operation was 28.1°C and the average *ex-situ* temperature was 31.4°C, as illustrated in Figure 6..

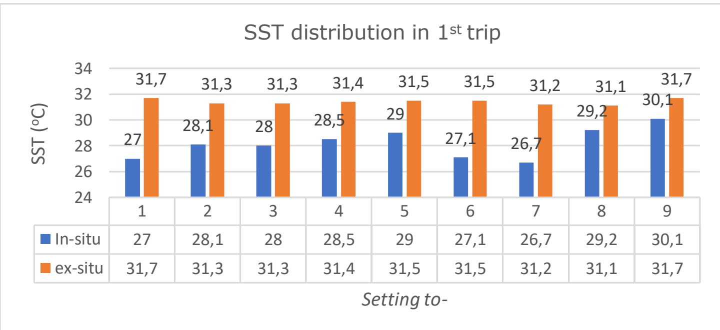


Figure 6. ~~Graph of~~ SST distribution in the 1st trip.

The highest number of catches occurred at the setting 9, with a total of 2,121 kg~~.~~ ~~This is also followed by~~, at a high SST, reaching 30.1°C, ~~-~~ w~~W~~hile the least catch occurred ~~in~~ at the setting 1, with a total catch of 345 kg, at a lower ~~where there was an~~ SST, of 27°C. This shows that in April 2022 if the SST value is high, the number of catches will be high and vice versa if the SST is low, the number of catches will also be low. The comparison of SST with the number of catches in April 2022 can be seen in Figure 7 below:

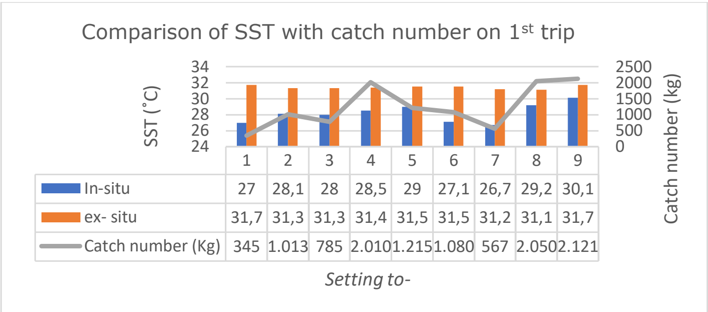


Figure 7. Comparison of SST with catch number in April 2022 on the 1st trip.

2. Distribution of the SST in April 2022 for the 2nd trip.
This month, the SST data collection method was carried out in-situ and ex-situ at 7 points ~~in~~ of the fishing ground~~.~~, as observed in Table 3.~~The following is a table of SST values:~~

Table 3

The distribution of SST in Sadeng waters in April 2022 on the 2nd trip

Date	*Position*		*SST (°C)*	
	Latitude (S)	*Longitude (E)*	*in-situ*	*ex-situ*
10/04/2022	08°36'38"	110°38'20"	30,2	31,7
11/04/2022	08°37'44"	110°29'54"	29,7	29,9
12/04/2022	08°35'20"	110°34'19"	27,5	30,1
13/04/2022	09°05'52"	110°09'27"	29,8	30,1
14/04/2022	08°32'25"	110°35'24"	28,5	30,1
15/04/2022	08°30'37"	110°38'14"	30,1	30,3
16/04/2022	08°30'25"	110°32'43"	28,3	29,4
	Average		29,1	30,2

Based on the data above, it can be seen that ~~from~~ for all 7 sampling points ~~taken~~, the SST distribution in April 2022 looks stable, ranging from 27.5 to 30.2°C. The highest temperature increase occurred on 10th of April 2022, reaching 30.2°C, while the lowest temperature occurred on April 12th of~~,~~ 2022, with a temperature reaching 27.5°C. The *in-situ* average in April 2022, on the 2nd trip, was 29.1°C and the *ex-situ* average was 30.2°C.

Commented [WU7]: Setting to - ????

Commented [WU8]: According to the format requirements, the decimals separator is ".", not ",". Please make the necessary corrections in the whole manuscript.

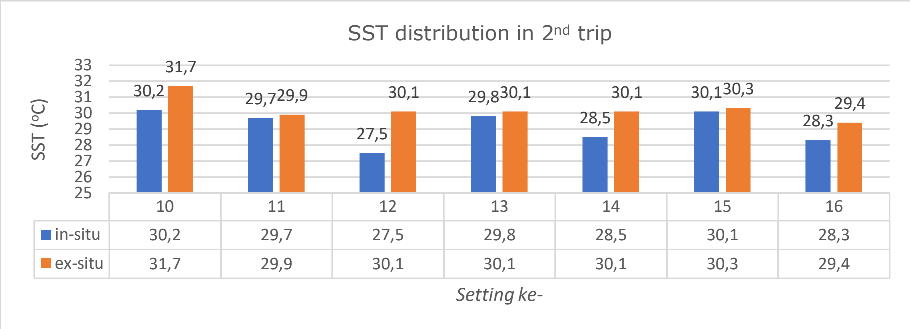


Figure 8. ~~Graph of~~ SST distribution ~~in~~on the 2nd trip.

In Figure 9, the comparison of the SST value with the catch in April 2022 shows that the highest of catch number occurred in the 12th setting, with as much as 2,053 kg,~~.~~ ~~This is also followed at~~by ~~a sufficient SST value with~~ an SST value reaching 27.5°C. Meanwhile, the smallest number of catches occurred in the 11th setting, with as much as 566 kg ~~with~~ and an SST reaching 29.7°C. This shows that in April 2022, if the SST is high then the catch decreases and ~~capsized~~ conversely, if the SST is low then the catch number is high, inversely proportional to the 1st trip.

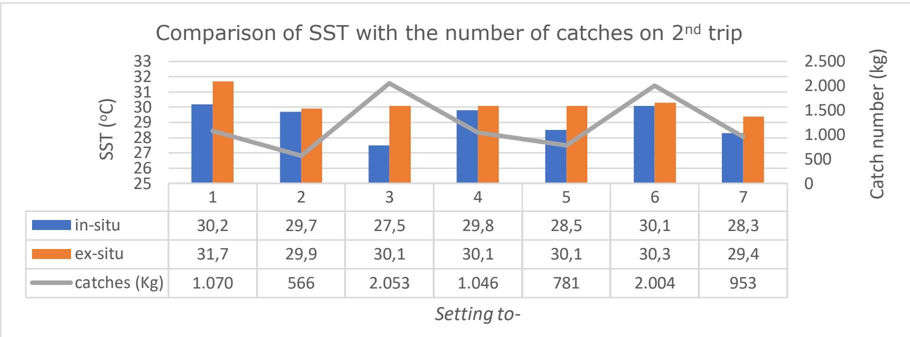


Figure 9. Comparison of the SST Value and the catch ~~number~~ quantity in April 2022, on the 2nd trip.

Commented [WU9]: Correct the figure by replacing catch number by catch quantity

3. Distribution of the SST in May 2022, for the 3rd trip.

In May 2022 the sampling point method was carried out directly ~~and~~ on the satellite imagery, 10 times, as shown in ~~the following~~ ~~T~~table 4:

Table 4

The distribution of SST in Sadeng waters in May 2022, ~~is~~ on the 3rd trip

Date	Position		SST (°C)	
	Latitude (S)	*Longitude (E)*	*in-situ*	*ex-situ*
09/05/2022	08°28'50''	110°08'51''	28,2	30,3
10/05/2022	08°44'19''	110°25'58''	29,1	29,7
11/05/2022	08°46'04''	110°54'56''	30,2	29,6
12/05/2022	09°09'10''	110°16'09''	30,3	30,3
13/05/2022	09°41'15''	109°59'03''	28,6	29,5
14/05/2022	09°27'33''	109°54'56''	27,7	28,8

Commented [WU10]: According to the format requirements, the decimals separator is ".", not ",". Please make the necessary corrections in the whole manuscript.

15/05/2022	08°57'29''	110°06'22''	28,3	29,1
16/05/2022	08°46'14''	110°37'47''	27,7	30,1
17/05/2022	08°43'39''	110°46'36''	27,6	30,2
18/05/2022	08°33'23''	110°34'50''	28,3	28,5
	Average		28,6	29,6

Based on ~~table~~ Table 4 and F~~f~~igure 10, SST fluctuations occurred in May 2022. -The distribution of SST was observed to be stable, ranging from 27.6 to 30.3°C. The highest SST occurred on 12 May 2022, reaching 30.3°C, while the lowest SST, of 27.6°C, occurred on 17 May 2022~~, which was 27.6°C~~. The average *in-situ* SST in May, on the 3rd trip, was 28.6°C and the *ex-situ* average was 29.6ºC.

Formatted: Justified

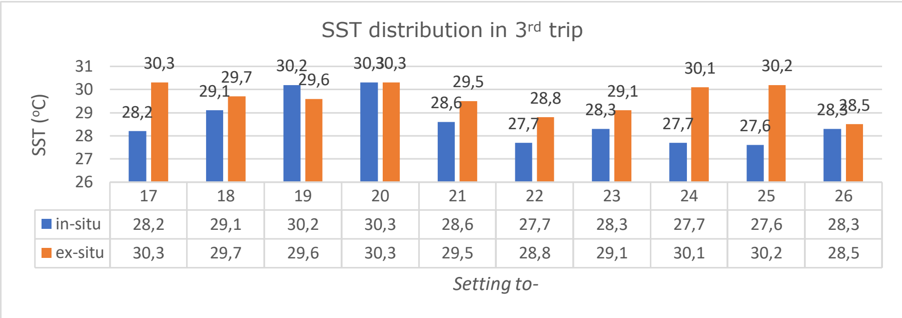


Figure 10. ~~Graph of~~ SST distribution in the 3rd trip.

In Figure 11, the comparison of SST with the highest catches number in May 2022, ~~shows that the highest of catch number~~ occurred at the setting 23, with a total of 5,045 kg,~~.~~ ~~This is also followed by~~at a high SST value ~~of reaching~~ 28.3°C. T~~While t~~he lowest catches number ~~at least~~ on the 3rd trip occurred at the 25th setting, with a total of 641 kg ~~with~~ and an SST reaching 27.6°C.

Based on the previous ~~explanation~~findings, it can be concluded that in May 2022 if the SST is high, the catches number is high ~~or capsized~~and if the SST is low, the catches number is low too.

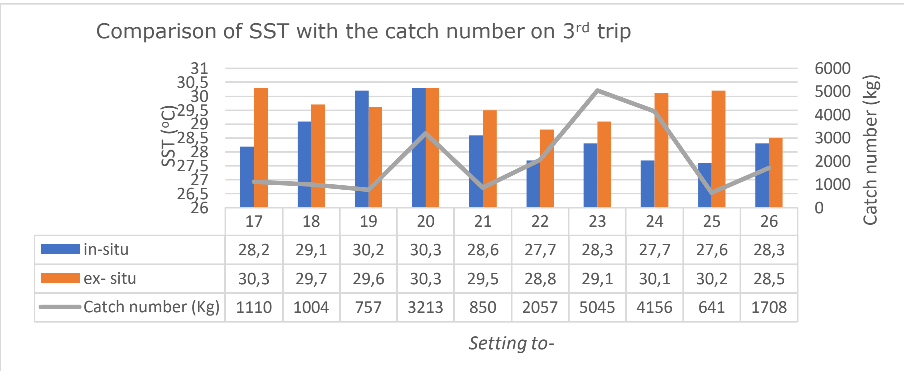


Figure 11. Comparison of SST with the catches number in May 2022 on the 3rd trip.

Formatted: Centered

Chlorophyll-a concentration. One of the waters fertility factors~~of the waters~~ is the availability of chlorophyll-a in the waters. According to Nufus et al (2017) the fertility level of ~~a~~ coastal waters can be assessed from the biological and chemical characteristics, especially from the availability of essential nutrients. Based on the ~~t~~Table ~~above~~5, the concentration of chlorophyll-a in Sadeng waters tends ~~not~~ to experience ~~a large change in value~~fluctuations.

Table 5

Concentration of chlorophyll-a in Sadeng waters in 2017 to 2021

Period (Month/year)	*chlorophyll-a (mg m^{-3})*				
	2017	*2018*	*2019*	*2020*	*2021*
April	0,38	0,33	0,58	0,28	0,39
May	0,40	0,73	0,76	0,34	0,41

~~Based on the table above, the concentration of chlorophyll-a in Sadeng waters tends not to experience a large change in value.~~ The highest value of chlorophyll-a, 0.76 mg m^{-3}, occurred in May 2019, ~~which reached 0.76 mg m^{3}~~ while the lowest value occurred ~~also~~ in April 2020, with a value of 0.28 mg m^{-3}~~mg m^{3}~~, as observed in Figure 12. The high and low values of chlorophyll-a ~~in these waters can be~~are influenced by the nutrients content in the waters, which is also closely related to the abundance of phytoplankton. If the nutrients in the waters are ~~high~~abundant, the chlorophyll-a value will also be high ~~and capsized~~. In addition, other factors that can affect the level of chlorophyll-a in ~~a~~ waters are the temperature and salinity.

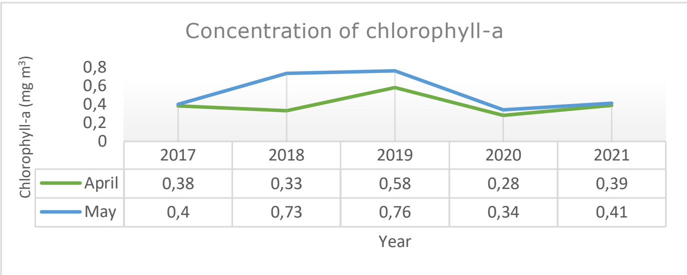


Figure 12. ~~Graph of chlorophyll~~Chlorophyll-a concentration in 2017 – 2021.

1. Concentration of chlorophyll-a in April 2022, on the 1st trip.

The distribution of chlorophyll-a concentration in April seemed to fluctuate. This can be seen from the 9 sampling points obtained from the NASA Ocean Color level 3, with a daily period ~~or~~, as it can be seen in Table 6~~the following table~~.

Table 6

The concentration of chlorophyll-a in Sadeng waters in April 2022 for the 1st trip

Date	*Position*		*Chlorophyll-a (mg m^{3})*	*Catch number (kg)*
	Latitude (S)	*Longitude (E)*		
01/04/2022	08°42'14''	110°31'22''	0,13	345
02/04/2022	08°46'05''	110°33'36''	0,15	1.013
03/04/2022	08°51'00''	110°35'12''	0,15	785
03/04/2022	08°49'07''	110°36'05''	0,12	2.010
04/04/2022	08°52'07''	110°36'10''	0,15	1.215
05/04/2022	08°41'47''	110°33'00''	0,14	1.080
06/04/2022	08°38'05''	110°51'51''	0,14	567
07/04/2022	08°47'00''	110°34'00''	0,15	2.050
08/04/2022	08°43'12''	110°33'26''	0,13	2.121
	Average		0,14	1.242

Formatted: Font: Italic

Formatted: Font: Italic

Commented [WU11]: According to the format requirements, the decimals separator is ".", not ",". Please make the necessary corrections in the whole manuscript.

Commented [WU12]: Carefully correct the concentration unit of measure, in the whole document: it is mg m^{-3} (negative exponent; mass per volume), including the tables and figures

Commented [WU13]: According to the format requirements, the decimals separator is ".", not ",". Please make the necessary corrections in the whole manuscript.

Based on table 6 above, at the ~~it can be seen that from~~ 9 sampling points ~~taken~~ observed during this trip, the highest increase in the value of chlorophyll-a occurred on ~~02, 03 and 07~~ April 2022 with a concentration value of 0.15 mg m^3. Meanwhile, the lowest chlorophyll-a value occurred on April 3rd~~,~~ 2022, with a chlorophyll-a concentration value of 0.12 mg m^3. The average concentration of chlorophyll-a ~~in~~ on the 1st of April trip was 0.14 mg m^3.

Commented [WU14]: Please use 1st of April etc

Commented [A15]: Make the necessary correction (negative exponent), in the whole document

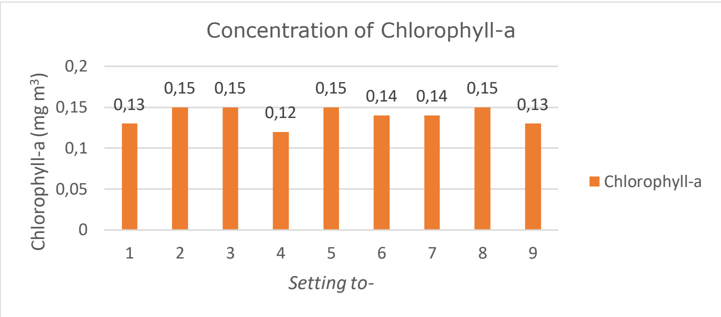


Figure 13. ~~Graph of chlorophyll~~Chlorophyll-a concentration in April 2022, on the 1st trip.

Commented [WU16]: Carefully correct the concentration unit of measure, in the whole document: it is mg m^{-3} (negative exponent; mass per volume), including the tables and figures

In Figure 14 the comparison of the value of chlorophyll-a and the catches number in April 2022 shows that the highest catches number occurred in the 8th setting, with a total of 2,050 kg~~. This was followed by a~~, at a high concentration of chlorophyll-a, ~~with a value~~ of 0.15 mg m^3. Meanwhile, the smallest catch number on the 1st trip occurred in the first setting, with the amount of 345 k,g where the chlorophyll-a concentration value reached 0.13 mg m^3. It can be concluded that in April 2022, if the concentration of chlorophyll-a is high then the catches number is high. Conversely, ~~or capsized~~ if the chlorophyll-a is low then the catches number is also low.

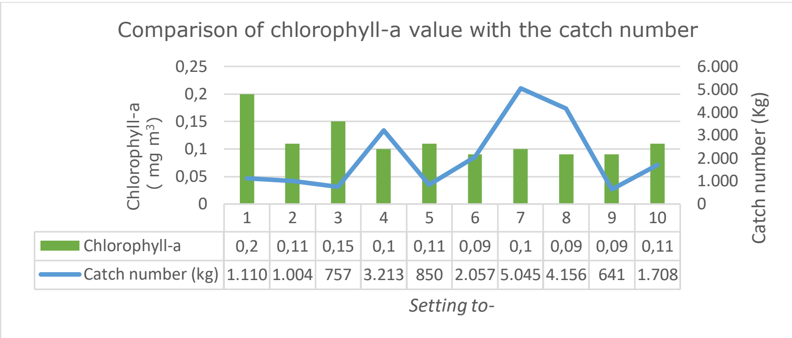


Figure 14. Comparison graph of chlorophyll-a value with the catches number on the 1st April 2022 trip.

Commented [WU17]: Carefully correct the concentration unit of measure, in the whole document: it is mg m^{-3} (negative exponent; mass per volume), including the tables and figures

1. Concentration of chlorophyll-a in Sadeng waters in April 2022 on the second trip.

In April 2022, we ~~took~~ considered 7 sampling points during the fishing operations; data were obtained from the NASA Ocean Color satellite (NASA 2007). The detailed chlorophyll-a concentration values can be seen in ~~the following t~~Table 7:

Table 7

The concentration of chlorophyll-a in Sadeng waters in April 2022, for the second trip

Date	Position		chlorophyll-a	Catches
	Latitude (S)	Longitude (T)	(mg m^3)	number (kg)

10/04/2022	08°36'38"	110°38'20"	0,11	1.070
11/04/2022	08°37'44"	110°29'54"	0,12	566
12/04/2022	08°35'20"	110°34'19"	0,11	2.053
13/04/2022	09°05'52"	110°09'27"	0,12	1.046
14/04/2022	08°32'25"	110°35'24"	0,10	781
15/04/2022	08°30'37"	110°38'14"	0,11	2.004
16/04/2022	08°30'25"	110°32'43"	0,09	953
	Average		0,10	1.210

Commented [WU18]: According to the format requirements, the decimals separator is ".", not ",". Please make the necessary corrections in the whole manuscript.

~~The following~~Figure 15 is a graph of the results of the 7 sampling points taken during the 2nd trip:

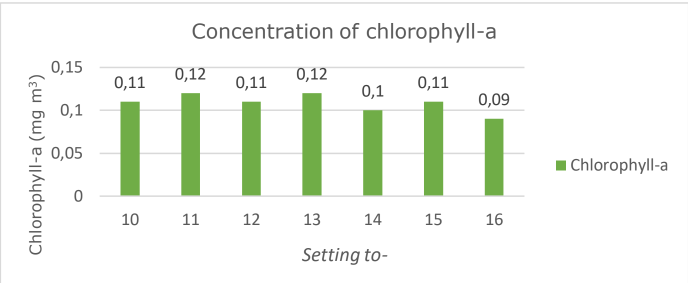


Figure 15. ~~Graph of~~ chlorophyll-a value in April 2022, on the 2nd trip.

Commented [WU19]: Correct the unit of measure for the concentration, in the figure, on the y-axis: mg m^{-3} (negative exponent; mass per volume)

Based on the data above, it can be seen that from 7 sampling points taken during this trip, the highest increase in the value of chlorophyll-a occurred on April 13th~~,~~ 2022, with a concentration value of 0.12 mg m^3. Meanwhile, the lowest chlorophyll-a value occurred on April 16~~,~~th 2022, with a chlorophyll-a concentration value of 0.09 mg m^3. The average concentration of chlorophyll-a in April, ~~of~~ at the 1st fishing operation trip, was of 0.10 mg m^3.

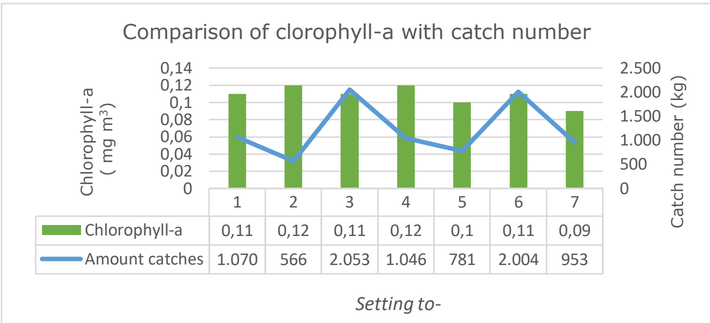


Figure 16. Comparison ~~graph~~ of the value of chlorophyll-a with the catches number, on the 2nd April 2022 trip.

Commented [WU20]: Correct the unit of measure for the concentration, in the figure, on the y-axis: mg m^{-3} (negative exponent; mass per volume)

In Figure 16 the comparison of the value of chlorophyll-a and the catch number in April 2022 shows that the highest ~~of~~ catch number occurred at the 15th setting, with a total of 2,004 kg~~. This is~~, inversely proportional to the ~~low value of~~ chlorophyll-a concentration ~~with a value (of~~ 0.11 mg m^3, the lowest value). ~~While the~~ The smallest catch on the 2nd fishing operation trip occurred at the 11th setting, with the amount of 566 kg, ~~where~~ when the value of chlorophyll-a concentration ~~got a~~was the highest ~~concentration value of~~ (0.12 mg m^3). From the ~~explanation~~ findings above, it can be concluded that in April the ~~value~~

Commented [WU21]: THE HIGHEST VALUE IS 2,053

~~of~~ catch quantities are ~~chlorophyll-a concentration is~~ inversely proportional to the values of chlorophyll-a concentrations~~catch number in April~~.

1. Concentration of chlorophyll-a in Sadeng waters in May 2022 on the third trip.

The concentration of chlorophyll-a in May 2022 was observed to be stable, ranging from 0.09 to 0.15 mg m^3. In May 2022, 10 sample points were taken using the satellite imagery obtained from NASA Ocean Color. T~~he following is t~~he concentration of chlorophyll-a in Sadeng waters in May 2022 is presented in Table 8.

Table 8

The concentration of chlorophyll-a in Sadeng waters in May 2020, for the 3rd trip

Date	*Position*		*Chlorophyll-a*	*Catch*
	Latitude (S)	*Longitude (T)*	*(mg m^3)*	*number (kg)*
09/05/2022	08°28'50''	110°08'51''	0,20	1.110
10/05/2022	08°44'19''	110°25'58''	0,11	1.004
11/05/2022	08°46'04''	110°54'56''	0,15	757
12/05/2022	09°09'10''	110°16'09''	0,10	3.213
13/05/2022	09°41'15''	109°59'03''	0,11	850
14/05/2022	09°27'33''	109°54'56''	0,09	2.057
15/05/2022	08°57'29''	110°06'22''	0,10	5.045
16/05/2022	08°46'14''	110°37'47''	0,09	4.156
17/05/2022	08°43'39''	110°46'36''	0,09	641
18/05/2022	08°33'23''	110°34'50''	0,11	1.708
	Average		0,11	2,054

~~And when a graph is created it will look like the image below~~The same data was synthesized in Figure 17:

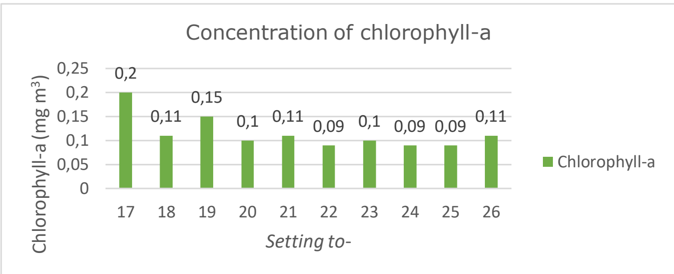
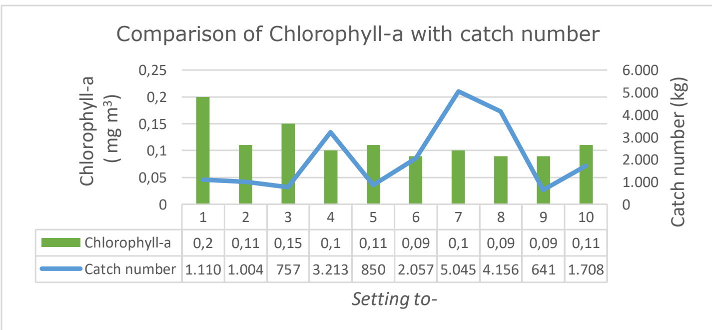


Figure 17. ~~Graph of chlorophyll~~Chlorophyll-a concentration in May 2022, on the third trip.

I~~f seen i~~n Table 8 and Figure 17, it can be observed~~is found~~ that the concentration of chlorophyll-a fluctuates in May. The highest chlorophyll-a value occurred on 11th of May 2022, of ~~which reached~~ 0.15 mg m^3~~.~~, while the lowest chlorophyll-a value occurred on 14th, 16th, and 17th of May 2022, of ~~which was~~ 0.09 mg m^3. The average concentration of chlorophyll-a in April 2022, on the fourth fishing operation trip, was 0.11 mg m^3.



Commented [WU22]: Correct the unit of measure for the concentration: mg m^{-3} (negative exponent; mass per volume)

Commented [WU23]: According to the format requirements, the decimals separator is ".", not ",". Please make the necessary corrections in the whole manuscript.

Commented [WU24]: Correct the unit of measure for the concentration, in the figure, on the y-axis: mg m^{-3} (negative exponent; mass per volume)

Figure 18. Comparison ~~graph~~ of chlorophyll-a concentration with the number of catches in May 2022.

In Figure 18 the comparison of the value of chlorophyll-a and the number of catches in May 2022 shows that the highest number of catches occurred at the setting 23, with a total of 5,045 kg~~. This is also followed~~, at ~~by~~ a high concentration of chlorophyll-a, with a value of 0.10 mg m^3. Meanwhile, the smallest catch number on the 1st fishing operation trip occurred at the 25th setting, with a total of 641 kg where the chlorophyll-a concentration value reached 0.09. Based on the previous ~~explanation~~findings, it can be concluded that in May, if the concentration of chlorophyll-a is high then the catch number is high or ~~capsized~~ conversely, if the chlorophyll-a is low then the catch number is also low.

SST data is obtained based on ~~SST~~ the analysis of MODIS images. The data is then verified ~~with~~ against the ~~results of the~~ measurements ~~of SST data~~. The verification results are shown in ~~the following~~ Table 9:

Table 9

Verification of in-situ SST data with satellite imagery

No. setting	*Data in-situ*	*Data ex-situ*	*Value of error (%)*
1	27,0	28,28	4,92
2	28,1	28,28	0,69
3	28,0	28,29	1,12
4	28,5	26,78	6,69
5	29,0	27,42	6,08
6	27,1	27,39	1,12
7	26,7	28,18	5,69
8	29,2	25,7	13,46
9	30,1	26,98	12,00
10	30,2	28,28	7,38
11	29,7	26,08	13,92
12	27,5	26,21	4,96
13	29,8	27,66	8,23
14	28,5	27,53	3,73
15	30,1	28,04	7,92
16	28,3	27,56	2,85
17	28,2	27,11	4,19
18	29,1	28,4	2,69
19	30,2	28,32	7,23
20	30,3	27,41	11,12
21	28,6	26,13	9,50
22	27,7	28,86	4,46
23	28,3	28,33	0,12
24	27,7	28,56	3,31
25	27,6	27,01	2,27
26	28,3	28,48	0,69
Mean relatives error	28,61	27,59	5,63

According to Fadika et al (2014), data verification is done by calculating the MRE. *Iin-situ* SST data verification ~~table with~~ against the Aqua MODIS satellite image data, at 26 sampling points, ~~above~~ shows that the average relative error value is 5.63%. This value is included in the correct category, where the resulting value is no more than 30%. Jaelani et al (2013) in their journal stated that ~~the~~ values with an average relative error of less

Commented [WU25]: Correct the unit of measure for the concentration, in the figure, on the y-axis: mg m^{-3} (negative exponent; mass per volume)

Commented [WU26]: According to the format requirements, the decimals separator is ".", not ",". Please make the necessary corrections in the whole manuscript.

than 30% in image data processing can be used for further analysis. Based on the previous statement, it can be concluded that the SST satellite image data can be further analyzed because it has ~~a truth value~~an accuracy of 91.89%. According to Simanjuntak et al (2012), among the factors that cause errors in the~~retrieval of~~ satellite image data~~, one of which~~ is a~~n~~ reading error ~~in reading~~ at the time of observation.

Analysis of the effect of SST and chlorophyll-a on the total catch.

1. Normality test.

The normality test is ~~one~~ part of the data analysis requirements~~ test~~. It is a~~or the~~ classical assumption test:~~t~~, ~~meaning that~~ before ~~we~~ performing a statistical analysis to test the hypothesis, ~~in this case, a~~ regression analysis ~~in this regression model~~ is used to determine whether the residual values ~~generated is~~are normally distributed or not. The residual is normally distributed if the significance is more than 0.05 (Gunawan 2020).

In ~~From~~ Table 10, the test results, obtained with the SPSS software, can be seen.~~,~~ ~~A~~The asymptotic normality obtained ~~results~~had the significance value (sig.)~~obtained. Sig~~ 0.200 (>~~-~~0.05), so~~ this~~ the residual values can be ~~said to be~~considered as normally distributed.

Table 10

Normality test

One-Sample Kolmogorov-Smirnov Test

		Unstandardized Residual
N		26
Normal Parameters[a,b]	Mean	.0000000
	Std. Deviation	1016.50300169
Most Extreme Differences	Absolute	.108
	Positive	.108
	Negative	-.071
Test Statistic		.108
Asymp. Sig. (2-fish)		.200[c,d]

a. Test distribution is Normal.
b. Calculated from data.
c. Lilliefors Significance Correction.
d. This is a lower bound of the true significance.

~~From the test results with SPSS software. Asymp results obtained. Sig 0.200 > 0.05, so this residual value can be said to be normally distributed.~~ The basis for decision making in the K - S Normality test is as follows:

- If the significance value (sig.) >0.05 then the data is normally distributed. On the contrary,
- If the significance value (sig.) <0.05, then the data is not normally distributed.

2. Linearity Test

In Table 11 of the SST - catches relationship's Deviation from Linearity, the significance value (sig.) obtained is 0.868, greater than 0.05. So it can be concluded that there is a significant linear relationship between the SST variable (X) and the number of catches (Y).

Table 11

Linearity test of the catch number with SST

ANOVA Table

			Sum of Squares	df	Mean Square	F	Sig.
Catches * SST	Between Groups	(Combined)	21329060,787	19	1122582,147	0,539	0,858
		Linearity	1812590,669	1	1812590,669	0,870	0,387

Commented [WU27]: Please present the statistics tables in the required format and clarify all the abbreviations and labels.

Commented [WU28]: ? correct the format

Commented [WU29]: ? correct the format

Commented [WU30]: Use the required format for thousands and for decimals, in the whole document

Commented [WU31]: According to the format requirements, the decimals separator is ".", not ",". Please make the necessary corrections in the whole manuscript.

		Sum of Squares	df	Mean Square	F	Sig.
	Deviation from Linearity	19516470,118	18	1084248,340	0,521	0,868
Within Groups		12497302,667	6	2082883,778		
Total		33826363,454	25			

~~From the output above, the Deviation from Linearity sig value is obtained. is 0.868 greater than 0.05. So it can be concluded that there is a significant linear relationship between the SST variable (X) and the number of catches (Y).~~ ~~From the above value~~In Table 12 of~~,~~ ~~the~~ Chlorophyll a - catches relationship's Deviation from Linearity, the significance value ~~-~~is 0.889, greater than 0.05. So it can be concluded that there is a significant linear relationship between the chlorophyll-a variable (X) and the catch number (Y).

Table 12

Linearity test of Total Catch with chlorophyll-a

Commented [WU32]: ? correct the format

ANOVA Table

			Sum of Squares	df	Mean Square	F	Sig.
Catches * Chlorophyll-a	Between Groups	(Combined)	10614882,479	7	1516411,783	1,176	0,364
		Linearity	7753006,461	1	7753006,461	6,012	0,025
		Deviation from Linearity	2861876,018	6	476979,336	0,370	0,889
	Within Groups		23211480,975	18	1289526,721		
	Total		33826363,454	25			

~~From the above value, the Deviation from Linearity sig value is 0.889, greater than 0.05. So it can be concluded that there is a significant linear relationship between the chlorophyll-a variable (X) and the catch number (Y).~~ The basis for decision making in the linearity test by comparing the significance value is as follows:

- If the value of Deviation from Linearity sig. > 0.05, then there is a significant linear relationship between the independent variable and the dependent variable.
- If the value of Deviation from linearity sig. < 0.05, then there is no significant linear relationship between the independent variable and the dependent variable.

3. Multicollinearity ~~Test~~test

The multicollinearity test was used to test whether the regression model found a correlation between the independent variables. If ~~there is or there is~~ a correlation exists, then there is a multicollinearity (multico) problem (Gunawan 2020). M~~How to find out whether there is m~~ulticollinearity is detected by examining~~looking at~~ the Variance Inflation Factor (VIF) value and tolerance, with reference to certain conditions: ~~-~~ i~~I~~f the VIF value is less than 10 and the tolerance is more than 0.1, it is ~~declared~~ considered that there is no multicollinearity (Gunawan 2020).

~~From~~In ~~the output results above~~Table 13, it is ~~kn~~shown that the value of the Collinearity Tolerance of the two variables is 0.90, more than 0.10, and the VIF statistic value of 1.11 is less than 10.

Tabel 13

Multicollinearity Test

Commented [WU33]: ? correct the format

Coefficients[a]

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.	Collinearity Statistics Tolerance	Collinearity Statistics VIF
1	(Constant)	2421,912	998,784		2,425	0,024		
	SST	1,219	2,630	0,089	0,464	0,647	0,900	1,111
	Chlorophyll-a	-117,383	50,033	-0,451	-2,346	0,028	0,900	1,111

~~From the output results above, it is known that the value of the Collinearity Tolerance of the two variables is 0.90 more than 0.10 and the VIF statistic value of 1.11 is less than 10.~~ So it can be concluded that the data above does not occur multicollinearity between independent variables. The basis for making decisions on the multicollinearity test with tolerance is as follows:

- If the tolerance value is greater than 0.10, it means that there is no multicollinearity in the regression model.
- If the tolerance value is less than 0.10, it means that there is multicollinearity in the regression model.

4. Heteroscedasticity Test

The heteroscedasticity test aims to test whether in the regression model there is an inequality of variance from one observation to another. A good regression model is one ~~that does not occur~~without heteroscedasticity~~,~~ or ~~in other words a good regression model is one that has~~with homoscedasticity (Gunawan 2020).

Based on ~~the output above~~Table 14, it ~~is known~~can be observed that the significance value (sig.) for the SST variable (X_1) is 0.811 ~~and~~ , while the significance value (sig.) for the chlorophyll-a variable (X_2) is 0.089.

Table 14

Heteroscedasticity Test Coefficients[a]

~~**Coefficients[a]**~~

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	2825,294	3687,361		0,766	0,452
	SST	-30,753	126,844	-0,048	-0,242	0,811
	Chlorophyll-a	-9494,419	5333,793	-0,354	-1,780	0,089

~~Based on the output above, it is known that the significance value (sig.) for the SST variable (X_1) is 0.811 and while the significance value (sig.) for the chlorophyll-a variable (X_2) is 0.089.~~ Because the significance value of the two variables above is greater than 0.05, according to the basis for decision making in the Glejser test, it can be concluded that there is no symptom of heteroscedasticity. The basis for decision making in the heteroscedasticity test, using the Glejser ~~test~~ conditions, is as follows:

- If the significance value (Sig.) is greater than 0.05, then the conclusion is that there is no heteroscedasticity symptom in the regression model.
- On the other hand, if the significance value (sig.) is less than 0.05, the conclusion is that heteroscedasticity is occurring.

5. Multiple linear regression

This analysis is used to measure the magnitude of the influence between the independent and dependent variables. There are several eligibility requirements that must be met when regression analysis is used, namely: the number of samples used must be the same, the number of independent variables is 1, the residual value must be normally distributed, there is a linear relationship, there are no symptoms of heteroscedasticity.

Based on Table 15, it is explained that the correlation coefficient (R) of 0.471 between the variables sea surface temperature and chlorophyll-a with the catch means that there is a very strong positive relationship between SST and chlorophyll-a with the fish catch.

Table 15.

Model summary

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
	.471[a]	0,221	0,154	1036,89027

a. Predictors: (Constant), Chlorophyll-a, SST

Formatted: Right

Formatted: Font: Not Italic

Commented [WU34]: ? correct the format

Formatted: Font: Not Italic

Formatted: Centered

~~Based on the table above, it is explained that the correlation (R) between the variable sea surface temperature and chlorophyll-a (X) with the catch (Y) of 0.471 means that there is a very strong positive relationship between SST and chlorophyll-a on the fish catch.~~ Meanwhile, the R square coefficient obtained is 0.221 or 22%, meaning that the independent variables (SST and chlorophyll-a) affect the Y variable (catch) by 22% while the rest of the catch is influenced by other variables.

Based on Table 16, it is observed that the coefficient test of the SST variable produces $t_{count} < t_{table}$ (0.598 < 2.069) and the significance value obtained is 0.556 (Sig > 0.05) so that SST only weakly affects the catch.

Table 16

t test

Coefficients[a]

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	2262,186	977,214		2,315	0,030
	SST	1,539	2,573	0,116	0,598	0,556
	Chlorophyll-a	-106,246	48,953	-0,421	-2,170	0,041

a. Dependent Variable: Cathes

~~Based on the table data above, it is known that the coefficient test of the SST variable produces $t_{count} < t_{table}$ (0.598 < 2.069) and the significance value obtained is 0.556 (Sig > 0.05) so that SST partially does not affect the catch.~~ Meanwhile, by testing the coefficient of chlorophyll-a variable, it was found that $t_{count} > t_{table}$ (2.170 > 2.069), with ~~and~~ a significance value of 0.041 (Sig < 0.05) so that it is known that ~~partially~~ chlorophyll-a has ~~an~~ a strong influence on the catch.

$$Y = 2262{,}186 + 1{,}539\ X_1 + -106{,}246\ X_2$$

The above equation describes the ~~level of manipulative data that appears when the~~ effect of changing the values of the independent variables ~~are manipulated. The manipulative level~~, in the regression algorithm ~~is.:~~ The interpretation is as follows:

a. Each change ~~of~~ by one unit in X_1 and X_2 ~~is~~ produces an increase of 2262.186 units.
b. Every ~~1 degree~~ change by 1 degree in SST (X_1) results in an increase of 1,539 in the catch (Y).
c. Each change of 1 mg m^{-3} in chlorophyll-a (X_2) ~~resulted~~ results in an increase of 106.246 in the catch (Y).

~~From~~In Table 17, ~~the table above, it is known~~can be observed that $F_{count} < F_{table}$ (3.271 < 3.40), ~~w~~While the significance value obtained is 0.056 (Sig > 0.05), so it can be concluded that there is an influence between the combined SST and chlorophyll-a variables ~~to~~on the ~~of~~ catch ~~number~~quantities.

Table 17

Significance test (f_{test})

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	7034292,282	2	3517146,141	3,271	.056[b]
	Residual	24728253,103	23	1075141,439		
	Total	31762545,385	25			

a. Dependent Variable: Catch number
b. Predictors: (Constant), Chlorophyll-a, SST

~~From the table above, it is known that $F_{count} < F_{table}$ (3.271 < 3.40). While the significance value obtained is 0.056 (Sig > 0.05) so it can be concluded that there is an influence between SST and chlorophyll-a variables to the of catch number.~~

Commented [WU35]: correct the format

Commented [WU36]: Correct the sign: it is either + or -. Explain how you decided

Commented [WU37]: What kind of change? Increase or decrease?

Commented [WU38]: What kind of change? Increase or decrease?

Commented [WU39]: Why is the coefficient negative?

Commented [WU40]: correct the format

Conclusions. The results of the significance test showed that ~~partially (X_1)~~ SST~~-~~ had a~~n~~ partial influence on the catch number, while chlorophyll-a~~ (X_2)~~ had a significant effect on the catch quantity~~number~~. ~~These results can be seen from the level of significance of each of them 0.556 > (0.05) and 0.041 > (0.05).~~ Meanwhile, if the test was carried out simultaneously, the results would obtaine~~d~~ a significance of 0.056, which means that the combined SST and chlorophyll-a ~~variables~~ have an influence on the catch ~~number~~quantities.

Conflict of interest. The authors declare no conflict of interest.

References

Commented [WU41]: citation for "Ghufron (…)" not found in the text; incorrect format for "Wijopriono (…)"

Abidin A. F., Amron, Marzuki M. I., 2020 Relationship between chlorophyll-a and sea surface temperarure to tuna catch in the Southern Water of Java. Science Research Journal 22(2):55-68.

Alfajri A., Mubarak M., Mulyadi A., 2017 [Spatial and Temporal analysis of sea surface temperature distribution in West Sumatra waters]. Indonesian Environmental Dynamics 4(1): 65-74. [In Indonesian].

Anggraeni R., Solichin A., Saputra S. W., 2015 [Several biological aspects of skipjack tuna (*Katsuwonus pelamis*) in relation to fisheries management in PPP Sadeng, Gunungkidul Regency, Yogyakarta]. Management of Aquatic Resources Journal (MAQUARES) 4(3):230-239. [In Indonesian].

Azizah A., Wibisana H., 2020 [Temporal analysis of sea surface temperature distribution from 2018 to 2020 with Terra Modis image data]. Marine Journal: Indonesian Journal of Marine Science and Technology 13(3):196–205. [In Indonesian].

Fadika U., Rifai A., Rochaddi B., 2014 [Seasonal wind direction and speed and its relation to the distribution of sea surface temperature in Southern Pangandaran, West Java]. Journal of Oceanography 3(3):429–437. [In Indonesian].

Ghufron M. Z., Triarso I., Kunarso K., 2019 [Analysis of the relationship of sea surface temperature and chlorophyll-a the Suomi NPP VIIRS satellite image against the catch of the seine purse in PPN Pengambengan, Bali]. Fisheries Science (IJFST) 14(2):128-135. [In Indonesian].

Gunawan C., 2020 [Proficient in Mastering SPSS Practical Guide to Processing Research Data (Deeppublish)]. PUBLISHER, ~~p.~~ 210 p.. [In Indonesian].

Hastuti, Wirasatriya A., Maslukah L., Subardjo P., Kunarso, 2021 [The Effect of chlorophyll-a factors and sea surface temperature on anchovy catches (*Stelesphorus* sp) in Jepara]. Indonesian Journal of Oceanography ~~0~~3(~~0~~2):1-9. [In Indonesian].

Hendiarti N., Ohde T., 2004 Investigation of different processes in Indonesian waters using SeaWiFS data. Deep Sea Research Part II Topical Studies in Oceanography 51(1-3):85-97.

Jaelani L. M., Matsushita B., Yang W., Fukushima T., 2013 Evaluation of four MERIS atmospheric correction algorithms in Lake Kasumigaura, Japan. International Journal of Remote Sensing 34(24):8967–8985.

Jayawiguna M. H., Triyono, Wibowo S., 2019 [Overview of the potential, development and challenges of utilizing marine and fishery resources at FMA-RI 573]. AMAFRAD Press p. 3-10. [In Indonesian].

Kusmana C., Hikmat A., 2015 The biodiversity of flora in Indonesia. Journal of Natural Resources and Environmental Management 5(2):187–198.

Ma A., Priatna A., Hidayat T., 2017 In the fisheries management area of the Republic of Indonesia 573 (WPPNRI 573) Indian Ocean distribution and potential resources of pelagic fish in fisheries management area of the Republic of Indonesia. PUBLISHER 23:47–56.

Nufus H., Karina S., Agustina S., 2017 [Analysis of chlorophyll-a distribution and water quality in the Krueng Raba Lhoknga River, Aceh Besar]. Scientific Journal of Marine and Fisheries Students Unsyiah 2(1):58–65. [In Indonesian].

Nugraha E., Gunawan R., Danapraja S., Yusrizal, Kusdinar A., Waluyo A. S., Hutajulu J., Prayitno H., Halim S., Sutisna D. H., 2020 The sea surface temperature effect on the

Formatted: Font: Italic

Formatted: Font: Italic

length and size of skipjack tuna (*Katsuwonus pelamis*) catches in the Banda Sea, Indonesia. AACL Bioflux 13(1):1-18.
Nikijuluw V., 2008 [The status of Indian Ocean tuna resources and its implications for Indonesia]. Journal of Indonesian Fisheries Policy 1(1):PAGE RANGE. [In Indonesian].
Nurman A., 2010 [Utilization of fashionable data to detect fishing areas on the East and West Coasts of North Sumatra]. Journal of Geography 2(2):17-30. [In Indonesian].
Sidik A., Agussalim A., Ridho M. R., 2015 [The accuracy of the value of chlorophyll-a concentration and sea surface temperature using remote sensing data in the waters of Anggantang Island, Sembilang National Park]. Maspari 7(2):25–32. [In Indonesian].
Simanjuntak B. L., Handoyo G., Sugianto D. N., 2012 [Analysis of bathymetry and tidal components for determination of additional depth of jetty ponds in Tanjung Gundul Bengkayang Waters – West Kalimantan]. Journal of Oceanography 1(1):1-8. [In Indonesian].
Sugiyono, 2019 [Quantitative research methods]. Alphabet., p. 464 p. [In Indonesian].
Wahyuningrum P. I., Nurani T. W., Rahmi T. A., 2012 [Multi purpose capture fishery business in Sadeng, Gunungkidul Regency, Special Region of Yogyakarta]. Maspari Journal 4(1):10-22. [in Indonesian].
Wijopriono., (2012). [The carrying capacity of tuna fisheries resources in the Indian Ocean in relation to fisheries industrialization]. Journal of Indonesian Fisheries Policy 4(2):101-108. [In Indonesian].
Yeka A., Monika D., Rahmani R. M., Sarianto D., Fitri Y., Nurlaela E., Kusmedy B., Nugraha E., Hutajulu J., 2022 The effect of chlorophyll-a on the catches of skipjack tuna (Katsuwonus pelamis) in Banda Sea, Maluku, Indonesia. AACL Bioflux 15(3):1226-1237.

Formatted: Font: Italic

Received: 06 December 2021. Accepted: 18 October 2022. Published online: 29 October 2022.
Authors:
Priyantini Dewi, Jakarta Technical University of Fisheries, Faculty of Fishing Technology, AUP Street Pasarminggu 12520, South Jakarta, Indonesia, e-mail: prizt.dewi@gmail.com
Sutarjo, Jakarta Technical University of Fisheries, Faculty of Fishing Technology, AUP Street Pasarminggu 12520, South Jakarta, Indonesia, e-mail: sutarjoz79@gmail.com
Maman Hermawan, Jakarta Technical University of Fisheries, Faculty of Fishing Technology, AUP Street Pasarminggu 12520, South Jakarta, Indonesia, e-mail: mhermawan60@gmail.com
Bongbongan Kusmedy, Jakarta Technical University of Fisheries, Faculty of Fishing Technology, AUP Street Pasarminggu 12520, South Jakarta, Indonesia, e-mail: bkhutapea@gmail.com
Yusrizal, Jakarta Technical University of Fisheries, Faculty of Fishing Technology, AUP Street Pasarminggu 12520, South Jakarta, Indonesia, e-mail: buyung_trc@yahoo.co.id
Mira Maulita, Jakarta Technical University of Fisheries, Faculty of Aquatic Resources Management, AUP Street Pasarminggu 12520, South Jakarta, Indonesia, e-mail: maulita.stp@gmail.com
Eli Nurlaela, Jakarta Technical University of Fisheries, Faculty of Fishing Technology, AUP Street Pasarminggu 12520, South Jakarta, Indonesia, e-mail: elimumtaza@gmail.com
Sopiyan Danapraja, Jakarta Technical University of Fisheries, Faculty of Fisheries Extension, AUP Street Pasarminggu 12520, South Jakarta, Indonesia, e-mail: sopiyanraja@gmail.com
Erick Nugraha, Jakarta Technical University of Fisheries, Faculty of Fishing Technology, AUP Street Pasarminggu 12520, South Jakarta, Indonesia, e-mail: nugraha_eriq1@yahoo.co.id

How to cite this article:
Dewi P., Sutarjo, Hermawan M., Kusmedy B., Yusrizal, Maulita M., Nurlaela E., Danapraja S., Nugraha E., 2022 Study of Sea Surface Temperature and Chlorophyll-a to the Number of Fish Caught in the Waters of Sadeng, Yogyakarta, Indonesia. AACL Bioflux

← Kembali | Arsipkan | Pindahkan | Hapus | Spam | •••

erick nugraha <nugraha_eriq1@yahoo.co.id>
Kepada: Eni Kovacs

Rab, 4 Jan jam 09.09

Dear Dr. Eni

Happy New Year 2023.

I send you edited journal. thank you

› Tampilkan pesan asli

Nugraha_S... .docx
1.3MB

Study of sea surface temperature and chlorophyll-a influence on the quantity ~~number~~ of fish caught in the waters of Sadeng, Yogyakarta, Indonesia

[1]Priyantini Dewi, [2]Sutarjo, [1]Maman Hermawan, [1]Yusrizal, [3]Mira Maulita, [1]Bongbongan Kusmedy, [1]Eli Nurlaela, [4]Sopiyan Danapraja, [1]Erick Nugraha

[1] Faculty of Fishing Technology, Jakarta Technical University of Fisheries, South Jakarta, Indonesia; [2] Fleet Monitoring and Operation, Directorate General of Marine and Fisheries Resources Surveillance, Jakarta, Indonesia; [3] Faculty of Aquatic Resources Management, Jakarta Technical University of Fisheries, South Jakarta, Indonesia; [4] Faculty of Fisheries Extension, Jakarta Technical University of Fisheries, South Jakarta, Indonesia; Corresponding author: E. Nugraha, nugraha_eriq1@yahoo.co.id

Abstract. Oceanographic factors can be an indicator in determining the potential of fishing areas. The sampling technique of Sea Surface Temperature (SST) and chlorophyll-a data in this study was carried out directly (in-situ) and using satellite image data that can be downloaded from NASA Ocean Color to obtain SST and chlorophyll-a data. The purpose of this study was to analyze the effect of SST and chlorophyll-a on the quantity of purse seine catches, based on multiple correlation tests and multiple linear regression analysis. Species of fish caught during the study included: yellowfin tuna *(Thunnus albacares)*, skipjack tuna *(Katsuwonus pelamis)*, dolphin fish *(Coryphaena hippurus)*, starry triggerfish *(Abalistes stellaris)*, rainbow runner *(Elagatis bipinnulata)*, scad mackerel *(Decapterus russelli)* and squid *(Loligo)*. The SST was measured in-situ. In the waters of Sadeng, Yogyakarta, the SST is relatively homogeneous, ranging from 27° to 30.3°C. Data verification is carried out *ex-situ*, with the aim of testing the level of accuracy. Satellite image data was processed for as many as 26 sampling points. The relative error was of 5.63%. Correlation test results between SST variables, chlorophyll-a and catches in the waters of Sadeng, Yogyakarta were performed for the period April to May 2022. The analysis of the effect of SST and chlorophyll-a showed that SST had a weak effect, while chlorophyll-a had a significant effect on the catches), as indicated by their level of significance of 0.556 (>0.05) and 0.041 (<0.05), respectively. Meanwhile, if the test was carried out on the combination of SST and chlorophyll-a, the result would have a significance of 0.056, which means that the SST and chlorophyll-a variables together strongly influence the catch.

Key Words: Geographic Information System (GIS), satellite imagery, oceanography, MODIS.

Introduction. Sadeng waters which are included in FMA 573 have the potential as habitat for economically important fish such as skipjack tuna *(Katsuwonus pelamis)*, bigeye tuna *(Thunnus obesus)*, yellowfin tuna *(Thunnus albacares)*, mackerel tuna *(Euthynnus affinis)*, mackerel scad *(Decapterus russelli)* and sardin *(Sardinella lemuru)* (Nikijuluw 2008; Wijopriono 2012; Wahyuningrum et al 2012; Jayawiguna et al 2019). Skipjack tuna *(Katsuwonus pelamis)* is the second largest commodity in the area (Anggraeni et al 2015; Ma'mun et al 2017). Its geographical condition favors Indonesia's biodiversity (Kusmana & Hikmat 2015). Hendiarti et al 2004 explained that Sea Surface Temperature (SST) can affect the metabolism and reproduction of organisms in the sea. The distribution of SST is very important to know because it can provide information about the front, upwelling, currents, weather/climate and fishing ground (Abidin et al 2020). Sidik et al (2015) and Azizah et al (2020) explained that the influence of SST on the growth of phytoplankton will indirectly affect the concentration of chlorophyll-a in waters. According to Alfajri et al (2017), the Aqua satellitecreated by NASA functions as an observation satellite in the marine field. The Aqua-Modis satellite can measure various types of water parameters, one of which is SST in the waters. Oceanographic factors that are often associated with catches are SST and chlorophyll-a (Hastuti et al 2021).

Commented [WU1]: In the whole manuscript (title, text, tables and figures), replace "number" by "quantity", when it is about catches, because a mass is expressed, in kg, which is a quantity, not a number. Also, please use the correct unit of measure and format for the concentration (mg m^{-3}), everywhere in the manuscript.

Commented [AV2R1]: Corrected. Thank you

Commented [WU3]: Full denomination when first mentioned.

Commented [AV4R3]: Corrected thank you

Formatted: Font: Italic

Based on the discussion above and given the lack of research on SST and chlorophyll-a influence on the catch number in Sadeng waters, we researched if there is a relationship between these variables. The results of this study are expected to help fishermen to determine fishing areas, based on oceanographic parameters.

Material and Method

Description of the study sites. The research was conducted from ~~18~~ March 18 to ~~30~~ May 30 2022, by participating in activities of fishing by purse seine operating in the Indian Ocean. The research locations are as shown in Figure 1 below:

Figure 1. Map of fishing ground.

Method of collecting data. Data collection is done by collecting primary data and secondary data. Primary data concerned the fishing area position, the *in-situ* SST measured directly and the number of catches calculated for each trip. The secondary data were chlorophyll-a and SST images obtained by level 3 Aqua MODIS satellite imagery. Materials and tools used include: purse seine, GPS, compass, digital thermometer, software (.Excel, Seadas 7.5.3, Arcmap 10.8, SPSS), Camera, Chlorophyll-a Image, SST Image.

Data processing method. In processing MODIS data, SeaDas software is used. The results obtained are Aqua MODIS images at level 3, which produce SST values in degrees Celsius (°C) and chlorophyll-a (mg m^{-3}). Due to the relatively wider area, the projection system used is the GCS *(Geographic Coordinate System)* with the WGS84 datum. The processing of chlorophyll-a and SST values contained in the Aqua MODIS image map was carried out using the SeaDAS software. Data were filtered with Microsoft Excel, and a map of the distribution of chlorophyll-a and SST was made, using the IDW (Inverse Distance Weighted) analysis & the contouring menu, by interpolation, a simple deterministic method based on the surrounding points (Nurman 2010).

Data analysis method. The method used to observe the data used associative research methods with a quantitative approach to observe certain populations or samples (Sugiyono 2010). Analysis of the effect of SST and chlorophyll-a on the catch was tested by several methods including a verification test of satellite imagery data (*ex-situ*) and direct measuring (*in-situ*) data, a classical assumption test, and multiple linear regression analysis.

Results and Discussion

Catch production.

1. Catches number on the 1st trip.

Commented [WU5]: ?

Commented [AV6R5]: Nan data = type of numeric data

Formatted: Font: Italic

Formatted: Font: Italic

Commented [A7]: Carefully correct the concentration unit of measure, in the whole document: it is mg m^{-3} (negative exponent; mass per volume), including the tables and figures

Commented [AV8R7]: Corrected thank you

The 1st trip was held on 1 to 8 April 2022 by setting 9 times the gear, with the overall catch consisting of *T. albacares* (2,552 kg), *K. pelamis* (3,023 kg), *D. russelli* (2,837 kg), *C. hippurus* (105 kg), *E. affinis* (337 kg) and *A. stellaris* (2,332 kg), with a total of 11,186 kg. The catches were dominated by *K. pelamis*.

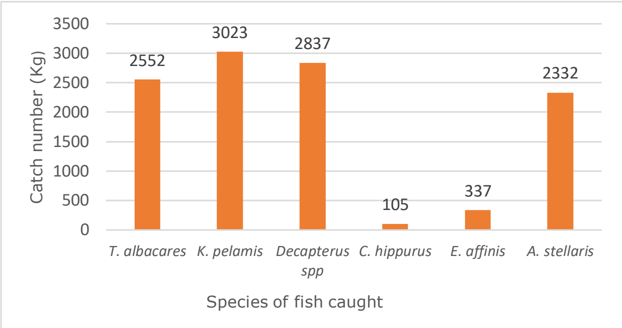
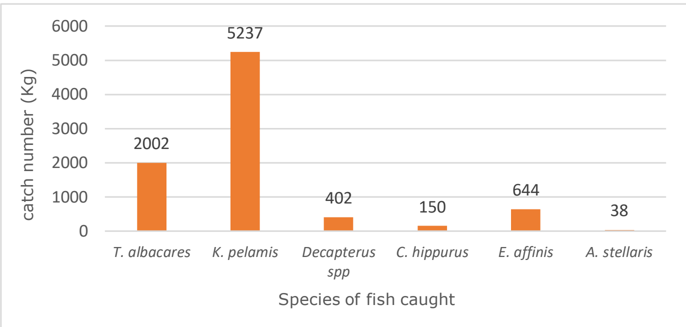


Figure 2. The number of catches on the 1st trip.

2. The number of catches of the 2nd trip.
The 2nd trip was held on 10 to 16 April 2022 with 7 days of fishing operations or 7 settings. The catches of the 2nd trip consisted of *T. albacares* (2,002 kg), *K. pelamis* (5,237 kg), *D. russelli* (402 kg), *C. hippurus* (150 kg), *E. affinis* (644 kg), *A. stellaris* (38 kg), with a total of 8,473 kg. The catches on the 2nd trip were dominated by *T. albacares, K. pelamis,* and *D. russelli.*



Gambar 3. The number of catches on the 2nd trip.

3. The number of catches of the 3rd trip.
The 3rd trip was held on 09 to 18 May 2022 with 10 days of catching and 10 settings. The catches on this trip were dominated by *K. pelamis*. The composition of the catch was: *T. albacares* (3,503 kg), *K. pelamis* (10,378 kg), *D. russelli* (5,866 kg), *C. hippurus* (143 kg), *Loligo* (497 kg), *E. bipinnulata* (154 kg), with a total of 20,541 kg.

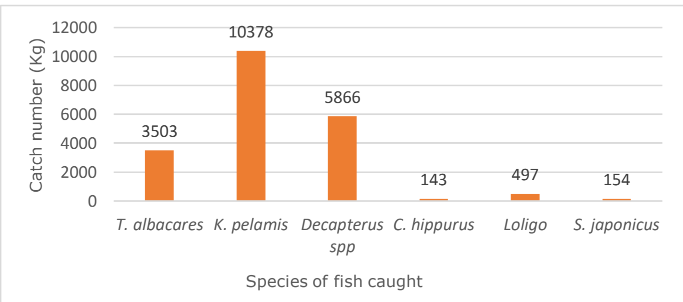


Figure 4. The catch of the 3rd trip.

Catch composition. In 3 trips with 26 catches, the catch was 40,200 kg. *K. pelamis* dominated with as much as 18,638 kg and an average of 716 kg per setting, the 2nd highest catch was *D. russelli* with as much as 9,105 kg and an average of 350 kg per setting, and the 3rd was *T. albacares* with as much as 8,057 kg and an average per setting of 309 kg. Meanwhile, the lowest catches were *C. hippurus* with 398 kg and *E. bipinnulata* with 154 kg and an average of 15.3 kg and 5.9 kg, respectively, for each setting. Table 1 shows the composition of the catching trips:

Table 1

Fish composition and catch number

Species	*Catch number (Kg)*			Total	*Average*	*Percentage (%)*
	Trip 1	*Trip 2*	*Trip 3*			
T. albacares	2,552	2,002	3,503	8,057	309	20
K. pelamis	3,023	5,237	10,378	18,638	716	46.3
D. russelli	2,837	402	5,866	9,105	350	22.6
C. hippurus	105	150	143	398	15.30	1
A. stellaris	2,332	38	0	2,370	91.15	5.9
E. affinis	337	644	0	981	37.73	2.5
E. bipinnulata	0	0	154	154	5.92	0.4
Loligo	0	0	497	497	19.11	1.3

The diagram in Figure 6 synthesizes this information: :

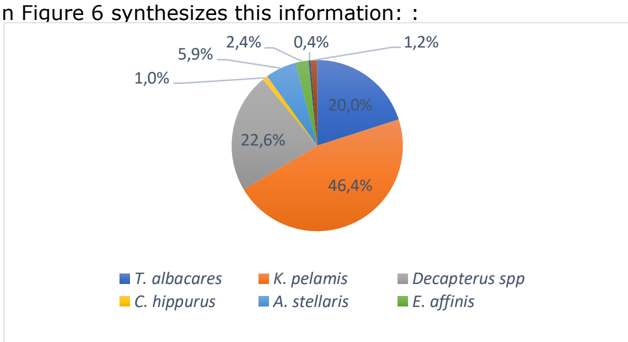


Figure 6. The composition of the caught fish species.

Distribution of Sea Surface Temperature (SST).

1. Distribution of SST in April 2022 for the 1st trip.

The distribution of SST was observed to be stable, this can be seen from the 9 sampling points that were obtained during the 1st trip in April. Table 2shows *in-situ* and *ex-situ* SST distribution values measured from 01 to 08 April 2022:

Table 2

The distribution of SST in Sadeng waters in April 2022, on the 1st trip

Date	*Position*		*SST (°C)*	
	Latitude (S)	*Longitude (T)*	*In-situ*	*ex-situ*

Commented [WU9]: According to the format requirements, the decimals separator is ".", not ",". Please make the necessary corrections in the whole manuscript.

Commented [AV10R9]: Corrected. Thank you

Formatted: Font: Italic

Formatted: Font: Italic

01/04/2022	08°42'14''	110°31'22''	27.0	31.7
02/04/2022	08°46'05''	110°33'36''	28.1	31.3
03/04/2022	08°51'00''	110°35'12''	28.0	31.3
03/04/2022	08°49'07''	110°36'05''	28.5	31.4
04/04/2022	08°52'07''	110°36'10''	29.0	31.5
05/04/2022	08°41'47''	110°33'00''	27.1	31.5
06/04/2022	08°38'05''	110°51'51''	26.7	31.2
07/04/2022	08°47'00''	110°34'00''	29.2	31.1
08/04/2022	08°43'12''	110°33'26''	30.1	31.7
	Average		28.1	31.4

Zulkhasyni (2015) stated that in general high SST occurs in the west season to the transition season, where the west season starts in September and ends in February, every year. The *K. pelamis* was caught at a temperature range of 29° to 30°C from November to March (Nugraha et al 2020). According to Yeka et al (2022), the potential area for catching *K. pelamis* has a close relationship with the environmental parameters, especially the chlorophyll-a, whose optimum ranges from 0.12 to 0.22 mg m^{-3}. SST *in-situ* of Sadeng waters in April 2022 ranged from 26.7° to 30.1°C. The highest SST occurred in April 8 2022, reaching 30.1°C, while the lowest temperature occurred on April 6, 2022, reaching 26.7°C. The average *in-situ* SST in April 2022 on the first trip was 28.1°C and the average *ex-situ* temperature was 31.4°C, as illustrated in Figure 6..

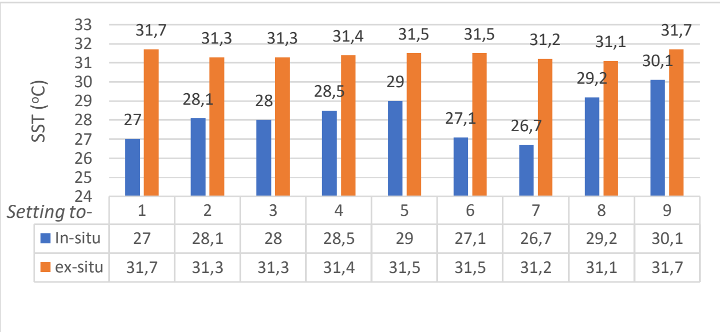


Figure 6. SST distribution in the 1st trip.

The highest number of catches occurred at the setting 9, with a total of 2,121 kg, at a high SST, reaching 30.1°C, while the least catch occurred at the setting 1, with a total catch of 345 kg, at a lower SST, of 27°C. This shows that in April 2022 if the SST value is high, the number of catches will be high and vice versa if the SST is low, the number of catches will also be low. The comparison of SST with the number of catches in April 2022 can be seen in Figure 7 below:

Commented [WU11]: According to the format requirements, the decimals separator is ".", not ",". Please make the necessary corrections in the whole manuscript.

Formatted: Font: Italic

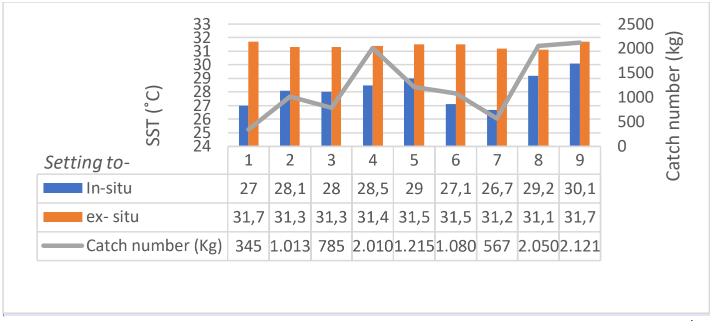


Figure 7. Comparison of SST with catch number in April 2022 on the 1st trip.

2. Distribution of the SST in April 2022 for the 2nd trip.
This month, the SST data collection method was carried out in-situ and *ex-situ* at 7 points of the fishing ground, as observed in Table 3.

Table 3

The distribution of SST in Sadeng waters in April 2022 on the 2nd trip

Date	*Position*		*SST (°C)*	
	Latitude (S)	*Longitude (E)*	*in-situ*	*ex-situ*
10/04/2022	08°36'38"	110°38'20''	30,.2	31,.7
11/04/2022	08°37'44"	110°29'54''	29,.7	29,.9
12/04/2022	08°35'20''	110°34'19''	27,.5	30,.1
13/04/2022	09°05'52"	110°09'27''	29,.8	30,.1
14/04/2022	08°32'25''	110°35'24''	28,.5	30,.1
15/04/2022	08°30'37''	110°38'14''	30,.1	30,.3
16/04/2022	08°30'25''	110°32'43''	28,.3	29,.4
	Average		29,.1	30,.2

Based on the data above, it can be seen that for all 7 sampling points, the SST distribution in April 2022 looks stable, ranging from 27.5 to 30.2°C. The highest temperature increase occurred on 10th of April 2022, reaching 30.2°C, while the lowest temperature occurred on April 12th of 2022, with a temperature reaching 27.5°C. The *in-situ* average in April 2022, on the 2nd trip, was 29.1°C and the *ex-situ* average was 30.2°C.

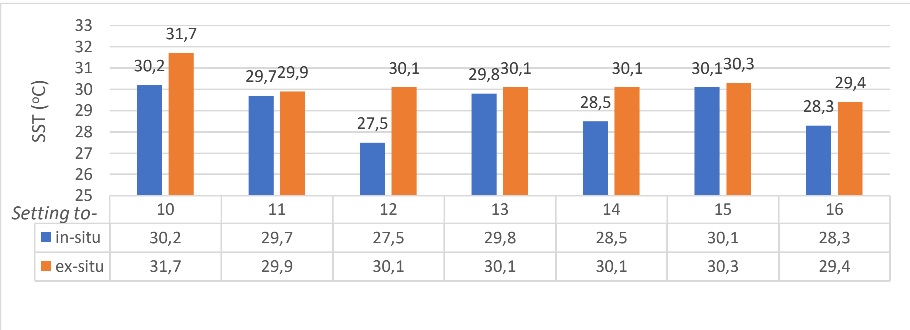


Figure 8. SST distribution on the 2nd trip.

Commented [WU12]: Setting to - ????

Formatted: Font: Italic

Commented [WU13]: According to the format requirements, the decimals separator is ".", not ",". Please make the necessary corrections in the whole manuscript.

Commented [AV14R13]: Corrected thank you

In Figure 9, the comparison of the SST value with the catch in April 2022 shows that the highest of catch number occurred in the 12th setting, with as much as 2,053 kg, at an SST value reaching 27.5°C. Meanwhile, the smallest number of catches occurred in the 11th setting, with as much as 566 kg and an SST reaching 29.7°C. This shows that in April 2022, if the SST is high then the catch decreases and conversely, if the SST is low then the catch number is high, inversely proportional to the 1st trip.

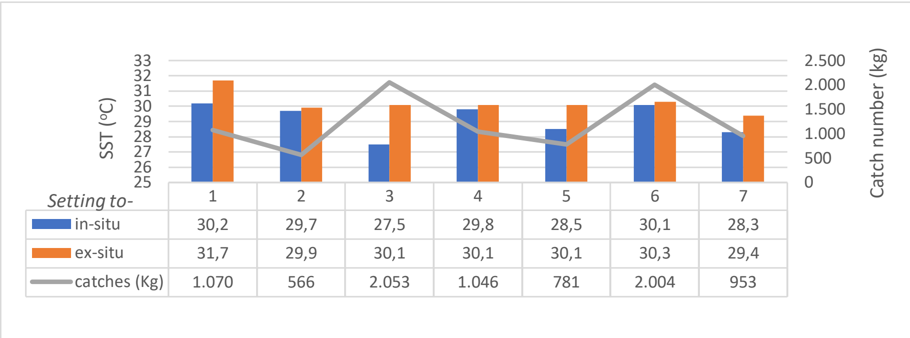


Figure 9. Comparison of the SST Value and the catch quantity in April 2022, on the 2nd trip.

Commented [WU15]: Correct the figure by replacing catch number by catch quantity

Commented [AV16R15]: Corrected thank you

3. Distribution of the SST in May 2022, for the 3rd trip.
In May 2022 the sampling point method was carried out directly on the satellite imagery, 10 times, as shown in Table 4:

Table 4

The distribution of SST in Sadeng waters in May 2022, on the 3rd trip

Date	*Position*		*SST (°C)*	
	Latitude (S)	*Longitude (E)*	*in-situ*	*ex-situ*
09/05/2022	08°28'50''	110°08'51''	28.2	30.3
10/05/2022	08°44'19''	110°25'58''	29.1	29.7
11/05/2022	08°46'04''	110°54'56''	30.2	29.6
12/05/2022	09°09'10''	110°16'09''	30.3	30.3
13/05/2022	09°41'15''	109°59'03''	28.6	29.5
14/05/2022	09°27'33''	109°54'56''	27.7	28.8
15/05/2022	08°57'29''	110°06'22''	28.3	29.1
16/05/2022	08°46'14''	110°37'47''	27.7	30.1
17/05/2022	08°43'39''	110°46'36''	27.6	30.2
18/05/2022	08°33'23''	110°34'50''	28.3	28.5
	Average		28.6	29.6

Commented [WU17]: According to the format requirements, the decimals separator is ".", not ",". Please make the necessary corrections in the whole manuscript.

Commented [AV18R17]: Corrected. Thank you

Based on Table 4 and Figure 10, SST fluctuations occurred in May 2022. The distribution of SST was observed to be stable, ranging from 27.6 to 30.3°C. The highest SST occurred on 12 May 2022, reaching 30.3°C, while the lowest SST, of 27.6°C, occurred on 17 May 2022. The average SST *in-situ* in May, on the 3rd trip, was 28.6°C and the *ex-situ* average was 29.6ºC.

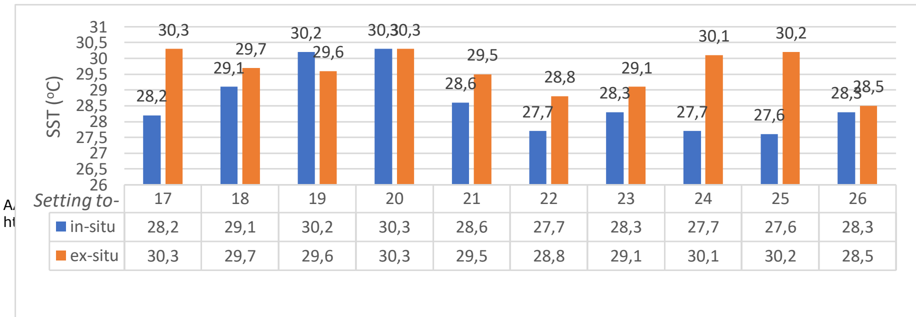


Figure 10. SST distribution in the 3rd trip.

In Figure 11, the comparison of SST with the highest catches number in May 2022, occurred at the setting 23, with a total of 5,045 kg, at a high SST value of 28.3°C. The lowest catches number on the 3rd trip occurred at the 25th setting, with a total of 641 kg and an SST reaching 27.6°C.

Based on the previous findings, it can be concluded that in May 2022 if the SST is high, the catches number is high and if the SST is low, the catches number is low too.

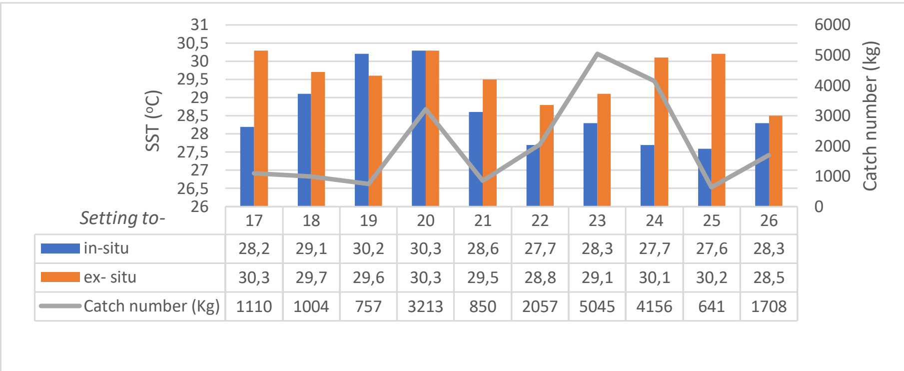


Figure 11. Comparison of SST with the catches number in May 2022 on the 3rd trip.

Chlorophyll-a concentration. One of the waters fertility factors is the availability of chlorophyll-a in the waters. According to Nufus et al (2017) the fertility level of coastal waters can be assessed from the biological and chemical characteristics, especially from the availability of essential nutrients. Based on the Table 5, the concentration of chlorophyll-a in Sadeng waters tends to experience fluctuations.

Table 5

Concentration of chlorophyll-a in Sadeng waters in 2017 to 2021

Period (Month/year)	*chlorophyll-a (mg m^{-3})*				
	2017	*2018*	*2019*	*2020*	*2021*
April	0.38	0.33	0.58	0.28	0.39
May	0.40	0.73	0.76	0.34	0.41

Commented [WU19]: According to the format requirements, the decimals separator is ".", not ",". Please make the necessary corrections in the whole manuscript.

The highest value of chlorophyll-a, 0.76 mg m^{-3}, occurred in May 2019, while the lowest value occurred in April 2020, with a value of 0.28 mg m^{-3}, as observed in Figure 12. The high and low values of chlorophyll-a are influenced by the nutrients content in the waters, which is also closely related to the abundance of phytoplankton. If the nutrients in the waters are abundant, the chlorophyll-a value will also be high. In addition, other factors that can affect the level of chlorophyll-a in waters are the temperature and salinity.

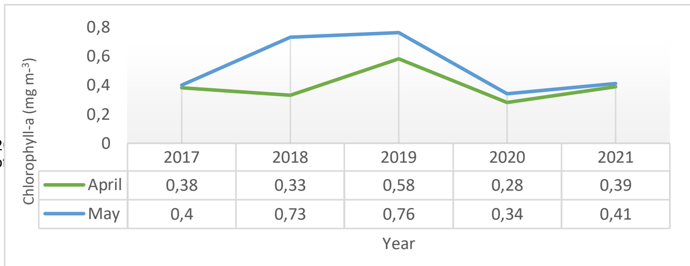


Figure 12. Chlorophyll-a concentration in 2017 – 2021.

1. Concentration of chlorophyll-a in April 2022, on the 1st trip.

The distribution of chlorophyll-a concentration in April seemed to fluctuate. This can be seen from the 9 sampling points obtained from the NASA Ocean Color level 3, with a daily period, as it can be seen in Table 6.

Table 6

The concentration of chlorophyll-a in Sadeng waters in April 2022 for the 1st trip

Date	*Position*		*Chlorophyll-a (mg m-3)*	*Catch number (kg)*
	Latitude (S)	*Longitude (E)*		
01/04/2022	08°42'14''	110°31'22''	0.13	345
02/04/2022	08°46'05''	110°33'36''	0.15	1,013
03/04/2022	08°51'00''	110°35'12''	0.15	785
03/04/2022	08°49'07''	110°36'05''	0.12	2,010
04/04/2022	08°52'07''	110°36'10''	0.15	1,215
05/04/2022	08°41'47''	110°33'00''	0.14	1,080
06/04/2022	08°38'05''	110°51'51''	0.14	567
07/04/2022	08°47'00''	110°34'00''	0.15	2,050
08/04/2022	08°43'12''	110°33'26''	0.13	2,121
	Average		0.14	1,242

Based on table 6 above, at the 9 sampling points observed during this trip, the highest increase in the value of chlorophyll-a occurred on 1st April 2022 with a concentration value of 0.15 mg m^{-3}. Meanwhile, the lowest chlorophyll-a value occurred on April 3rd 2022, with a chlorophyll-a concentration value of 0.12 mg m^{-3}. The average concentration of chlorophyll-a on the 1st of April trip was 0.14 mg m^{-3}.

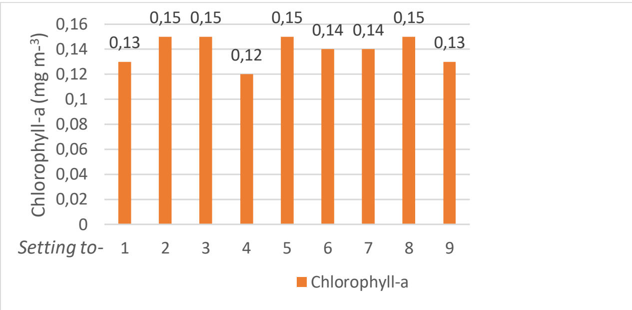


Figure 13. Chlorophyll-a concentration in April 2022, on the 1st trip.

In Figure 14 the comparison of the value of chlorophyll-a and the catches number in April 2022 shows that the highest catches number occurred in the 8th setting, with a total of 2,050 kg, at a high concentration of chlorophyll-a, of 0.15 mg m^{-3}. Meanwhile, the smallest catch number on the 1st trip occurred in the first setting, with the amount of 345 kg where the chlorophyll-a concentration value reached 0.13 mg m^{-3}. It can be concluded that in

Commented [WU20]: Carefully correct the concentration unit of measure, in the whole document: it is mg m^{-3} (negative exponent; mass per volume), including the tables and figures

Commented [WU21]: According to the format requirements, the decimals separator is ".", not ",". Please make the necessary corrections in the whole manuscript.

Commented [WU22]: Please use 1st of April etc

Commented [AV23R22]: Corrected. Thank you

Formatted: Superscript

Commented [A24]: Make the necessary correction (negative exponent), in the whole document

Commented [AV25R24]: Corrected. Thank you

Commented [WU26]: Carefully correct the concentration unit of measure, in the whole document: it is mg m^{-3} (negative exponent; mass per volume), including the tables and figures

Formatted: Justified

April 2022, if the concentration of chlorophyll-a is high then the catches number is high. Conversely, if the chlorophyll-a is low then the catches number is also low.

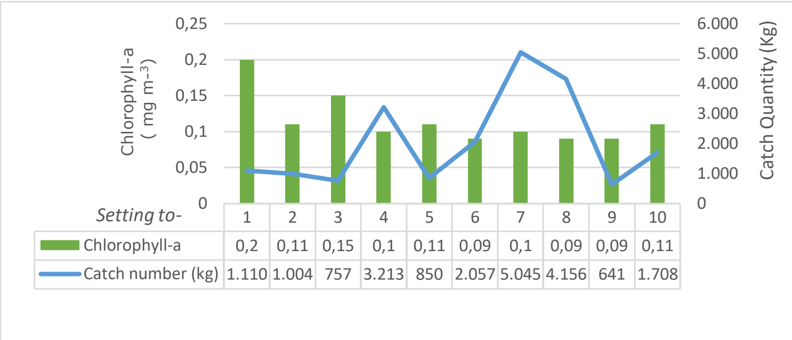


Figure 14. Comparison graph of chlorophyll-a value with the catches ~~number~~ quantity on the 1st April 2022 trip.

1. Concentration of chlorophyll-a in Sadeng waters in April 2022 on the second trip.

In April 2022, we considered 7 sampling points during the fishing operations; data were obtained from the NASA Ocean Color satellite (NASA 2007). The detailed chlorophyll-a concentration values can be seen in Table 7:

Table 7

The concentration of chlorophyll-a in Sadeng waters in April 2022, for the second trip

Date	Position		chlorophyll-a (mg m-3)	Catches number (kg)
	Latitude (S)	Longitude (T)		
10/04/2022	08°36'38"	110°38'20"	0,.11	1,.070
11/04/2022	08°37'44"	110°29'54"	0,.12	566
12/04/2022	08°35'20"	110°34'19"	0,.11	2,.053
13/04/2022	09°05'52"	110°09'27"	0,.12	1,.046
14/04/2022	08°32'25"	110°35'24"	0,.10	781
15/04/2022	08°30'37"	110°38'14"	0,.11	2,.004
16/04/2022	08°30'25"	110°32'43"	0,.09	953
Average			0,.10	1,.210

Figure 15 is a graph of the results of the 7 sampling points taken during the 2nd trip:

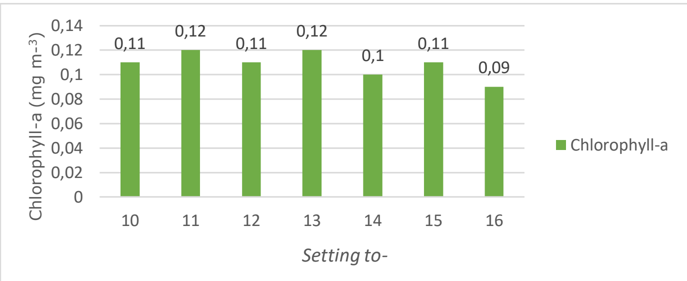


Figure 15. chlorophyll-a value in April 2022, on the 2nd trip.

Commented [WU27]: Carefully correct the concentration unit of measure, in the whole document: it is mg m-3 (negative exponent; mass per volume), including the tables and figures

Commented [WU28]: According to the format requirements, the decimals separator is ".", not ",". Please make the necessary corrections in the whole manuscript.

Commented [WU29]: Correct the unit of measure for the concentration, in the figure, on the y-axis: mg m-3 (negative exponent; mass per volume)

Commented [AV30R29]: Corrected. Thank you

Based on the data above, it can be seen that from 7 sampling points taken during this trip, the highest increase in the value of chlorophyll-a occurred on April 13th 2022, with a concentration value of 0.12 mg m^{-3}. Meanwhile, the lowest chlorophyll-a value occurred on April 16th 2022, with a chlorophyll-a concentration value of 0.09 mg m^{-3}. The average concentration of chlorophyll-a in April, at the 1st fishing operation trip, was of 0.10 mg m^{-3}.

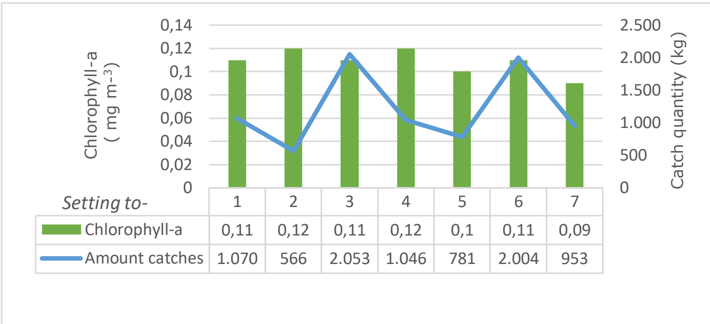


Figure 16. Comparison of the value of chlorophyll-a with the catches ~~number~~quantity, on the 2nd April 2022 trip.

In Figure 16 the comparison of the value of chlorophyll-a and the catch number in April 2022 shows that the highest catch number occurred at the 15th setting, with a total of 2,004 kg, inversely proportional to the chlorophyll-a concentration (0.11 mg m^{-3}, the lowest value). The smallest catch on the 2nd fishing operation trip occurred at the 11th setting, with the amount of 566 kg, when the value of chlorophyll-a concentration was the highest (0.12 mg m^{-3}). From the findings above, it can be concluded that in April the catch quantities are inversely proportional to the values of chlorophyll-a concentrations.

1. Concentration of chlorophyll-a in Sadeng waters in May 2022 on the third trip.

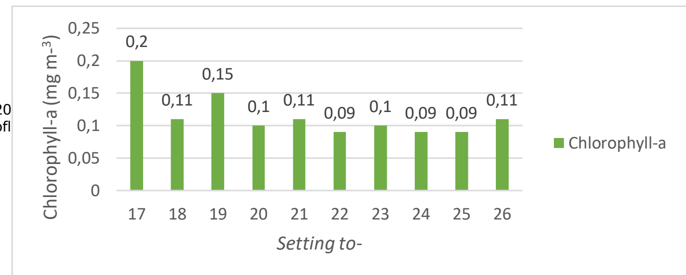
The concentration of chlorophyll-a in May 2022 was observed to be stable, ranging from 0.09 to 0.15 mg m^{-3}. In May 2022, 10 sample points were taken using the satellite imagery obtained from NASA Ocean Color. The concentration of chlorophyll-a in Sadeng waters in May 2022 is presented in Table 8.

Table 8

The concentration of chlorophyll-a in Sadeng waters in May 2020, for the 3rd trip

Date	*Position*		*Chlorophyll-a*	*Catch*
	Latitude (S)	*Longitude (T)*	*(mg m^{-3})*	*number (kg)*
09/05/2022	08°28'50''	110°08'51''	0.20	1.110
10/05/2022	08°44'19''	110°25'58''	0.11	1.004
11/05/2022	08°46'04''	110°54'56''	0.15	757
12/05/2022	09°09'10''	110°16'09''	0.10	3.213
13/05/2022	09°41'15''	109°59'03''	0.11	850
14/05/2022	09°27'33''	109°54'56''	0.09	2.057
15/05/2022	08°57'29''	110°06'22''	0.10	5.045
16/05/2022	08°46'14''	110°37'47''	0.09	4.156
17/05/2022	08°43'39''	110°46'36''	0.09	641
18/05/2022	08°33'23''	110°34'50''	0.11	1.708
	Average		0.11	2,054

The same data was synthesized in Figure 17:



Commented [WU31]: Correct the unit of measure for the concentration, in the figure, on the y-axis: mg m^{-3} (negative exponent; mass per volume)

Commented [WU32]: THE HIGHEST VALUE IS 2,053

Commented [WU33]: Correct the unit of measure for the concentration: mg m^{-3} (negative exponent; mass per volume)

Commented [AV34R33]: Corrected. Thank you

Commented [WU35]: According to the format requirements, the decimals separator is ".", not ",". Please make the necessary corrections in the whole manuscript.

Figure 17. Chlorophyll-a concentration in May 2022, on the third trip.

In Table 8 and Figure 17, it can be observed that the concentration of chlorophyll-a fluctuates in May. The highest chlorophyll-a value occurred on 11th of May 2022, of 0.15 mg m-3, while the lowest chlorophyll-a value occurred on 14th, 16th, and 17th of May 2022, of 0.09 mg m-3. The average concentration of chlorophyll-a in April 2022, on the fourth fishing operation trip, was 0.11 mg m-3.

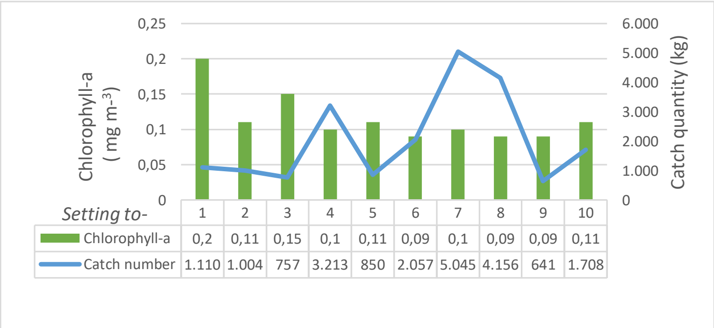


Figure 18. Comparison of chlorophyll-a concentration with the ~~number of catches~~ catching quantity in May 2022.

In Figure 18 the comparison of the value of chlorophyll-a and the ~~number of catches~~catching quantity in May 2022 shows that the highest ~~number~~ quantity of catches occurred at the setting 23, with a total of 5,045 kg, at a high concentration of chlorophyll-a, with a value of 0.10 mg m-3. Meanwhile, the smallest catch number on the 1st fishing operation trip occurred at the 25th setting, with a total of 641 kg where the chlorophyll-a concentration value reached 0.09. Based on the previous findings, it can be concluded that in May, if the concentration of chlorophyll-a is high then the catch number is high or conversely, if the chlorophyll-a is low then the catch number is also low.

SST data is obtained based on the analysis of MODIS images. The data is then verified against the measurements. The verification results are shown in Table 9:

Table 9

Verification of in-situ SST data with satellite imagery

No. setting	*Data in-situ*	*Data ex-situ*	*Value of error (%)*
1	27~~,~~.0	28~~,~~.28	4~~,~~.92
2	28~~,~~.1	28~~,~~.28	0~~,~~.69
3	28~~,~~.0	28~~,~~.29	1~~,~~.12
4	28~~,~~.5	26~~,~~.78	6~~,~~.69
5	29~~,~~.0	27~~,~~.42	6~~,~~.08
6	27~~,~~.1	27~~,~~.39	1~~,~~.12
7	26~~,~~.7	28~~,~~.18	5~~,~~.69

Commented [WU36]: Correct the unit of measure for the concentration, in the figure, on the y-axis: mg m-3 (negative exponent; mass per volume)

Commented [AV37R36]: Corrected. Thank you

Commented [WU38]: Correct the unit of measure for the concentration, in the figure, on the y-axis: mg m-3 (negative exponent; mass per volume)

Commented [WU39]: According to the format requirements, the decimals separator is ".", not ",". Please make the necessary corrections in the whole manuscript.

8	29.2	25.7	13.46
9	30.1	26.98	12.00
10	30.2	28.28	7.38
11	29.7	26.08	13.92
12	27.5	26.21	4.96
13	29.8	27.66	8.23
14	28.5	27.53	3.73
15	30.1	28.04	7.92
16	28.3	27.56	2.85
17	28.2	27.11	4.19
18	29.1	28.4	2.69
19	30.2	28.32	7.23
20	30.3	27.41	11.12
21	28.6	26.13	9.50
22	27.7	28.86	4.46
23	28.3	28.33	0.12
24	27.7	28.56	3.31
25	27.6	27.01	2.27
26	28.3	28.48	0.69
Mean relatives error	28.61	27.59	5.63

According to Fadika et al (2014), data verification is done by calculating the MRE. *In-situ* SST data verification against the Aqua MODIS satellite image data, at 26 sampling points, shows that the average relative error value is 5.63%. This value is included in the correct category, where the resulting value is no more than 30%. Jaelani et al (2013) in their journal stated that values with an average relative error of less than 30% in image data processing can be used for further analysis. Based on the previous statement, it can be concluded that the SST satellite image data can be further analyzed because it has an accuracy of 91.89%. According to Simanjuntak et al (2012), among the factors that cause errors in the satellite image datais a reading error at the time of observation.

Analysis of the effect of SST and chlorophyll-a on the total catch.

Commented [WU40]: Please present the statistics tables in the required format and clarify all the abbreviations and labels.

1. Normality test.

The normality test is part of the data analysis requirements. It is a classical assumption test: before performing a statistical analysis to test the hypothesis, a regression analysis is used to determine whether the residual values are normally distributed or not. The residual is normally distributed if the significance is more than 0.05 (Gunawan 2020).

In Table 10, the test results, obtained with the SPSS software, can be seen. The asymptotic normality obtained had the significance value (sig.)0.200 (>0.05), so the residual values can be considered as normally distributed.

Table 10

Normality test

Commented [WU41]: ? correct the format

One-Sample Kolmogorov-Smirnov Test

		Unstandardized Residual
N		26
Normal Parameters[a,b]	Mean	.0000000
	Std. Deviation	1016.50300169
Most Extreme Differences	Absolute	.108
	Positive	.108
	Negative	-.071
Test Statistic		.108
Asymp. Sig. (2-fish)		.200[c,d]

a. Test distribution is Normal.

b. Calculated from data.

c. Lilliefors Significance Correction.

d. This is a lower bound of the true significance.

The basis for decision making in the K - S Normality test is as follows:

- If the significance value (sig.) >0.05 then the data is normally distributed. On the contrary,
- If the significance value (sig.) <0.05, then the data is not normally distributed.

2. Linearity Test

In Table 11 of the SST - catches relationship's Deviation from Linearity, the significance value (sig.) obtained is 0.868, greater than 0.05. So it can be concluded that there is a significant linear relationship between the SST variable (X) and the number of catches (Y).

Table 11

Linearity test of the catch number with SST

ANOVA Table

			Sum of Squares	df	Mean Square	F	Sig.
Catches * SST	Between Groups	(Combined)	21329060.787	19	1122582.147	0.539	0.858
		Linearity	1812590.669	1	1812590.669	0.870	0.387
		Deviation from Linearity	19516470.118	18	1084248.340	0.521	0.868
	Within Groups		12497302.667	6	2082883.778		
	Total		33826363.454	25			

In Table 12 of the Chlorophyll-a catches relationship's Deviation from Linearity, the significance value is 0.889, greater than 0.05. So it can be concluded that there is a significant linear relationship between the chlorophyll-a variable (X) and the catch number (Y).

Table 12

Linearity test of Total Catch with chlorophyll-a

ANOVA Table

			Sum of Squares	df	Mean Square	F	Sig.
Catches * Chlorophyll-a	Between Groups	(Combined)	10614882.479	7	1516411.783	1.176	0.364
		Linearity	7753006.461	1	7753006.461	6.012	0.025
		Deviation from Linearity	2861876.018	6	476979.336	0.370	0.889
	Within Groups		23211480.975	18	1289526.721		
	Total		33826363.454	25			

The basis for decision making in the linearity test by comparing the significance value is as follows:

- If the value of Deviation from Linearity sig.>0.05, then there is a significant linear relationship between the independent variable and the dependent variable.
- If the value of Deviation from linearity sig.<0.05, then there is no significant linear relationship between the independent variable and the dependent variable.

3. Multicollinearity test

The multicollinearity test was used to test whether the regression model found a correlation between the independent variables. If a correlation exists, then there is a multicollinearity (multico) problem (Gunawan 2020). Multicollinearity is detected by

Commented [WU42]: ? correct the format

Commented [WU43]: Use the required format for thousands and for decimals, in the whole document

Commented [WU44]: According to the format requirements, the decimals separator is ".", not ",". Please make the necessary corrections in the whole manuscript.

Commented [WU45]: ? correct the format examining the Variance Inflation Factor (VIF) value and tolerance, with reference to certain conditions: if the VIF value is less than 10 and the tolerance is more than 0.1, it is considered that there is no multicollinearity (Gunawan 2020).

In Table 13, it is shown that the value of the Collinearity Tolerance of the two variables is 0.90, more than 0.10, and the VIF statistic value of 1.11 is less than 10.

Tabel 13

Multicollinearity Test

Commented [WU46]: ? correct the format

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	2421.912	998.784		2.425	0.024		
	SST	1.219	2.630	0.089	0.464	0.647	0.900	1.111
	Chlorophyll-a	-117.383	50.033	-0.451	-2.346	0.028	0.900	1.111

So it can be concluded that the data above does not occur multicollinearity between independent variables. The basis for making decisions on the multicollinearity test with tolerance is as follows:

- If the tolerance value is greater than 0.10, it means that there is no multicollinearity in the regression model.
- If the tolerance value is less than 0.10, it means that there is multicollinearity in the regression model.

4. Heteroscedasticity Test

The heteroscedasticity test aims to test whether in the regression model there is an inequality of variance from one observation to another. A good regression model is one without heteroscedasticity or with homoscedasticity (Gunawan 2020).

Based on Table 14, it can be observed that the significance value (sig.) for the SST variable (X_1) is 0.811, while the significance value (sig.) for the chlorophyll-a variable (X_2) is 0.089.

Table 14

Heteroscedasticity Test Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	2825.294	3687.361		0.766	0.452
	SST	-30.753	126.844	-0.048	-0.242	0.811
	Chlorophyll-a	-9494.419	5333.793	-0.354	-1.780	0.089

Because the significance value of the two variables above is greater than 0.05, according to the basis for decision making in the Glejser test, it can be concluded that there is no symptom of heteroscedasticity. The basis for decision making in the heteroscedasticity test, using the Glejser conditions, is as follows:

- If the significance value (Sig.) is greater than 0.05, then the conclusion is that there is no heteroscedasticity symptom in the regression model.
- On the other hand, if the significance value (sig.) is less than 0.05, the conclusion is that heteroscedasticity is occurring.

5. Multiple linear regression

This analysis is used to measure the magnitude of the influence between the independent and dependent variables. There are several eligibility requirements that must be met when regression analysis is used, namely: the number of samples used must be the same, the number of independent variables is 1, the residual value must be normally distributed, there is a linear relationship, there are no symptoms of heteroscedasticity.

Based on Table 15, it is explained that the correlation coefficient (R) of 0.471 between the variables sea surface temperature and chlorophyll-a with the catch means that there is a very strong positive relationship between SST and chlorophyll-a with the fish catch.

Table 15

Model summary

Commented [WU47]: ? correct the format

Model Summary				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
	.471[a]	0.221	0.154	1036.89027
a. Predictors: (Constant), Chlorophyll-a, SST				

Meanwhile, the R square coefficient obtained is 0.221 or 22%, meaning that the independent variables (SST and chlorophyll-a) affect the Y variable (catch) by 22% while the rest of the catch is influenced by other variables.

Based on Table 16, it is observed that the coefficient test of the SST variable produces $t_{count} < t_{table}$ (0.598 < 2.069) and the significance value obtained is 0.556 (Sig > 0.05) so that SST only weakly affects the catch.

Table 16

t test

Commented [WU48]: correct the format

Coefficients[a]

Formatted: Centered

Formatted: Centered

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	2262.186	977.214		2.315	0.030
	SST	1.539	2.573	0.116	0.598	0.556
	Chlorophyll-a	-106.246	48,953	-0.421	-2.170	0.041

a. Dependent Variable: Cathes

Meanwhile, by testing the coefficient of chlorophyll-a variable, it was found that $t_{count} > t_{table}$ (2.170>2.069), with a significance value of 0.041 (Sig<0.05) so that it is known thatchlorophyll-a has a strong influence on the catch.

$$Y = 2262{,}186 + 1{,}539\ X_1 + -106{,}246\ X_2$$

Commented [WU49]: Correct the sign: it is either + or -. Explain how you decided

The above equation describes the effect of changing the values of the independent variables, in the regression algorithm. The interpretation is as follows:

a. Each change by one unit in X_1 and X_2 produces an increase of 2262.186 units.
b. Every change by 1 degree in SST (X_1) results in an increase of 1,539 in the catch (Y).
c. Each change of 1 mg m^{-3} in chlorophyll-a (X_2) results in an increase of 106.246 in the catch (Y).

Commented [WU50]: What kind of change? Increase or decrease?

Commented [WU51]: What kind of change? Increase or decrease?

Commented [WU52]: Why is the coefficient negative?

In Table 17, able it can be observed that $F_{count} < F_{table}$ (3.271<3.40), while the significance value obtained is 0.056 (Sig>0.05), so it can be concluded that there is an influence between the combined SST and chlorophyll-a variables on the catch quantities.

Table 17

Significance test (f_{test})

Commented [WU53]: correct the format

ANOVA[a]

Formatted: Centered

Formatted: Centered

Formatted: Centered

Formatted: Centered

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	7034292.282	2	3517146.141	3.271	.056[b]
	Residual	24728253.103	23	1075141.439		
	Total	31762545.385	25			

a. Dependent Variable: Catch number

b. Predictors: (Constant), Chlorophyll-a, SST

Conclusions. The results of the significance test showed that SST had a partial influence on the catch number, while chlorophyll-a had a significant effect on the catch quantity. Meanwhile, if the test was carried out simultaneously, the results would obtaine a significance of 0.056, which means that the combined SST and chlorophyll-a have an influence on the catch quantities.

Conflict of interest. The authors declare no conflict of interest.

References

Commented [WU54]: citation for "Ghufron (...)" not found in the text; incorrect format for "Wijopriono (...)"

Abidin A. F., Amron, Marzuki M. I., 2020 Relationship between chlorophyll-a and sea surface temperarure to tuna catch in the Southern Water of Java. Science Research Journal 22(2):55-68.

Alfajri A., Mubarak M., Mulyadi A., 2017 [Spatial and Temporal analysis of sea surface temperature distribution in West Sumatra waters]. Indonesian Environmental Dynamics 4(1): 65-74. [In Indonesian].

Anggraeni R., Solichin A., Saputra S. W., 2015 [Several biological aspects of skipjack tuna (*Katsuwonus pelamis*) in relation to fisheries management in PPP Sadeng, Gunungkidul Regency, Yogyakarta]. Management of Aquatic Resources Journal (MAQUARES) 4(3):230-239. [In Indonesian].

Azizah A., Wibisana H., 2020 [Temporal analysis of sea surface temperature distribution from 2018 to 2020 with Terra Modis image data]. Marine Journal: Indonesian Journal of Marine Science and Technology 13(3):196–205. [In Indonesian].

Fadika U., Rifai A., Rochaddi B., 2014 [Seasonal wind direction and speed and its relation to the distribution of sea surface temperature in Southern Pangandaran, West Java]. Journal of Oceanography 3(3):429–437. [In Indonesian].

~~Ghufron M. Z., Triarso I., Kunarso K., 2019 [Analysis of the relationship of sea surface temperature and chlorophyll-a the Suomi NPP VIIRS satellite image against the catch of the seine purse in PPN Pengambengan, Bali]. Fisheries Science (IJFST) 14(2):128-135. [In Indonesian].~~

Gunawan C., 2020 [Proficient in Mastering SPSS Practical Guide to Processing Research Data (Deeppublish)]. Deepublish, Yogyakarta~~PUBLISHER,~~ 210 p.~~.~~ [In Indonesian].

Hastuti, Wirasatriya A., Maslukah L., Subardjo P., Kunarso, 2021 [The Effect of chlorophyll-a factors and sea surface temperature on anchovy catches (*Stelesphorus* sp) in Jepara]. Indonesian Journal of Oceanography 3(2):1-9. [In Indonesian].

Hendiarti N., Ohde T., 2004 Investigation of different processes in Indonesian waters using SeaWiFS data. Deep Sea Research Part II Topical Studies in Oceanography 51(1-3):85-97.

Jaelani L. M., Matsushita B., Yang W., Fukushima T., 2013 Evaluation of four MERIS atmospheric correction algorithms in Lake Kasumigaura, Japan. International Journal of Remote Sensing 34(24):8967–8985.

Jayawiguna M. H., Triyono, Wibowo S., 2019 [Overview of the potential, development and challenges of utilizing marine and fishery resources at FMA-RI 573]. AMAFRAD Press p. 3-10. [In Indonesian].

Kusmana C., Hikmat A., 2015 The biodiversity of flora in Indonesia. Journal of Natural Resources and Environmental Management 5(2):187–198.

Ma'mun A., Priatna A., Hidayat T., Nurulludin. 2017 ~~In the fisheries management area of the Republic of Indonesia 573 (WPPNRI 573) Indian Ocean distribution~~ Distribution and potential resources of pelagic fish in Fisheries Management Area of the Republic of Indonesia (FMA-RI 573) Indian Ocean. Indonesian Fisheries Research Journal (JPPI)~~PUBLISHER~~ 23:47–56.

Nufus H., Karina S., Agustina S., 2017 [Analysis of chlorophyll-a distribution and water quality in the Krueng Raba Lhoknga River, Aceh Besar]. Scientific Journal of Marine and Fisheries Students Unsyiah 2(1):58–65. [In Indonesian].

Nugraha E., Gunawan R., Danapraja S., Yusrizal, Kusdinar A., Waluyo A. S., Hutajulu J., Prayitno H., Halim S., Sutisna D. H., 2020 The sea surface temperature effect on the length and size of skipjack tuna (*Katsuwonus pelamis*) catches in the Banda Sea, Indonesia. AACL Bioflux 13(1):1-18.

Nikijuluw V., 2008 [The status of Indian Ocean tuna resources and its implications for Indonesia]. Journal of Indonesian Fisheries Policy 1(1):31-44PAGE RANGE. [In Indonesian].
Nurman A., 2010 [Utilization of fashionable data to detect fishing areas on the East and West Coasts of North Sumatra]. Journal of Geography 2(2):17-30. [In Indonesian].
Sidik A., Agussalim A., Ridho M. R., 2015 [The accuracy of the value of chlorophyll-a concentration and sea surface temperature using remote sensing data in the waters of Anggantang Island, Sembilang National Park]. Maspari 7(2):25–32. [In Indonesian].
Simanjuntak B. L., Handoyo G., Sugianto D. N., 2012 [Analysis of bathymetry and tidal components for determination of additional depth of jetty ponds in Tanjung Gundul Bengkayang Waters – West Kalimantan]. Journal of Oceanography 1(1):1-8. [In Indonesian].
Sugiyono, 2019 [Quantitative research methods]. Alphabet, 464 p. [In Indonesian].
Wahyuningrum P. I., Nurani T. W., Rahmi T. A., 2012 [Multi purpose capture fishery business in Sadeng, Gunungkidul Regency, Special Region of Yogyakarta]. Maspari Journal 4(1):10-22. [in Indonesian].
Wijopriono., 2012 [The carrying capacity of tuna fisheries resources in the Indian Ocean in relation to fisheries industrialization]. Journal of Indonesian Fisheries Policy 4(2):101-108. [In Indonesian].
Yeka A., Monika D., Rahmani R. M., Sarianto D., Fitri Y., Nurlaela E., Kusmedy B., Nugraha E., Hutajulu J., 2022 The effect of chlorophyll-a on the catches of skipjack tuna (Katsuwonus pelamis) in Banda Sea, Maluku, Indonesia. AACL Bioflux 15(3):1226-1237.

Received: 06 December 2021. Accepted: 18 October 2022. Published online: 29 October 2022.
Authors:
Priyantini Dewi, Jakarta Technical University of Fisheries, Faculty of Fishing Technology, AUP Street Pasarminggu 12520, South Jakarta, Indonesia, e-mail: prizt.dewi@gmail.com
Sutarjo, Jakarta Technical University of Fisheries, Faculty of Fishing Technology, AUP Street Pasarminggu 12520, South Jakarta, Indonesia, e-mail: sutarjoz79@gmail.com
Maman Hermawan, Jakarta Technical University of Fisheries, Faculty of Fishing Technology, AUP Street Pasarminggu 12520, South Jakarta, Indonesia, e-mail: mhermawan60@gmail.com
Bongbongan Kusmedy, Jakarta Technical University of Fisheries, Faculty of Fishing Technology, AUP Street Pasarminggu 12520, South Jakarta, Indonesia, e-mail: bkhutapea@gmail.com
Yusrizal, Jakarta Technical University of Fisheries, Faculty of Fishing Technology, AUP Street Pasarminggu 12520, South Jakarta, Indonesia, e-mail: buyung_trc@yahoo.co.id
Mira Maulita, Jakarta Technical University of Fisheries, Faculty of Aquatic Resources Management, AUP Street Pasarminggu 12520, South Jakarta, Indonesia, e-mail: maulita.stp@gmail.com
Eli Nurlaela, Jakarta Technical University of Fisheries, Faculty of Fishing Technology, AUP Street Pasarminggu 12520, South Jakarta, Indonesia, e-mail: elimumtaza@gmail.com
Sopiyan Danapraja, Jakarta Technical University of Fisheries, Faculty of Fisheries Extension, AUP Street Pasarminggu 12520, South Jakarta, Indonesia, e-mail: sopiyanraja@gmail.com
Erick Nugraha, Jakarta Technical University of Fisheries, Faculty of Fishing Technology, AUP Street Pasarminggu 12520, South Jakarta, Indonesia, e-mail: nugraha_eriq1@yahoo.co.id

How to cite this article:
Dewi P., Sutarjo, Hermawan M., Kusmedy B., Yusrizal, Maulita M., Nurlaela E., Danapraja S., Nugraha E., 2022 Study of Sea Surface Temperature and Chlorophyll-a to the Number of Fish Caught in the Waters of Sadeng, Yogyakarta, Indonesia. AACL Bioflux

← Kembali Arsipkan Pindahkan Hapus Spam •••

Eni Kovacs <ek.bioflux@gmail.com> Rab, 4 Jan jam 16.23
Kepada: erick nugraha

Dear Dr. Nugraha,

Please find the manuscript attached and make all the requested changes, as some of the comments were not addressed by the authors.

Thank you for your cooperation!

› Tampilkan pesan asli

--
Kind regards,
Editor AACL Bioflux
Eniko Kovacs

Nugraha_S....docx
1.3MB

Study of sea surface temperature and chlorophyll-a influence on the quantity of fish caught in the waters of Sadeng, Yogyakarta, Indonesia

[1]Priyantini Dewi, [2]Sutarjo, [1]Maman Hermawan, [1]Yusrizal, [3]Mira Maulita, [1]Bongbongan Kusmedy, [1]Eli Nurlaela, [4]Sopiyan Danapraja, [1]Erick Nugraha

[1] Faculty of Fishing Technology, Jakarta Technical University of Fisheries, South Jakarta, Indonesia; [2] Fleet Monitoring and Operation, Directorate General of Marine and Fisheries Resources Surveillance, Jakarta, Indonesia; [3] Faculty of Aquatic Resources Management, Jakarta Technical University of Fisheries, South Jakarta, Indonesia; [4] Faculty of Fisheries Extension, Jakarta Technical University of Fisheries, South Jakarta, Indonesia; Corresponding author: E. Nugraha, nugraha_eriq1@yahoo.co.id

Abstract. Oceanographic factors can be an indicator in determining the potential of fishing areas. The sampling technique of Sea Surface Temperature (SST) and chlorophyll-a data in this study was carried out directly (in-situ) and using satellite image data that can be downloaded from NASA Ocean Color to obtain SST and chlorophyll-a data. The purpose of this study was to analyze the effect of SST and chlorophyll-a on the quantity of purse seine catches, based on multiple correlation tests and multiple linear regression analysis. Species of fish caught during the study included: yellowfin tuna *(Thunnus albacares),* skipjack tuna *(Katsuwonus pelamis),* dolphin fish *(Coryphaena hippurus),* starry triggerfish *(Abalistes stellaris)*, rainbow runner *(Elagatis bipinnulata),* scad mackerel *(Decapterus russelli)* and squid *(Loligo).* The SST was measured in-situ. In the waters of Sadeng, Yogyakarta, the SST is relatively homogeneous, ranging from 27° to 30.3°C. Data verification is carried out *ex-situ*, with the aim of testing the level of accuracy. Satellite image data was processed for as many as 26 sampling points. The relative error was of 5.63%. Correlation test results between SST variables, chlorophyll-a and catches in the waters of Sadeng, Yogyakarta were performed for the period April to May 2022. The analysis of the effect of SST and chlorophyll-a showed that SST had a weak effect, while chlorophyll-a had a significant effect on the catches), as indicated by their level of significance of 0.556 (>0.05) and 0.041 (<0.05), respectively. Meanwhile, if the test was carried out on the combination of SST and chlorophyll-a, the result would have a significance of 0.056, which means that the SST and chlorophyll-a variables together strongly influence the catch.
Key Words: Geographic Information System (GIS), satellite imagery, oceanography, MODIS.

Introduction. Sadeng waters which are included in FMA 573 have the potential as habitat for economically important fish such as skipjack tuna *(Katsuwonus pelamis)*, bigeye tuna *(Thunnus obesus),* yellowfin tuna *(Thunnus albacares),* mackerel tuna *(Euthynnus affinis),* mackerel scad *(Decapterus russelli)* and sardin *(Sardinella lemuru)* (Nikijuluw 2008; Wijopriono 2012; Wahyuningrum et al 2012; Jayawiguna et al 2019). Skipjack tuna *(Katsuwonus pelamis)* is the second largest commodity in the area (Anggraeni et al 2015; Ma'mun et al 2017). Its geographical condition favors Indonesia's biodiversity (Kusmana & Hikmat 2015). Hendiarti et al 2004 explained that Sea Surface Temperature (SST) can affect the metabolism and reproduction of organisms in the sea. The distribution of SST is very important to know because it can provide information about the front, upwelling, currents, weather/climate and fishing ground (Abidin et al 2020). Sidik et al (2015) and Azizah et al (2020) explained that the influence of SST on the growth of phytoplankton will indirectly affect the concentration of chlorophyll-a in waters. According to Alfajri et al (2017), the Aqua satellite created by NASA functions as an observation satellite in the marine field. The Aqua-Modis satellite can measure various types of water parameters, one of which is SST in the waters. Oceanographic factors that are often associated with catches are SST and chlorophyll-a (Hastuti et al 2021).

Based on the discussion above and given the lack of research on SST and chlorophyll-a influence on the catch number in Sadeng waters, we researched if there is a relationship between these variables. The results of this study are expected to help fishermen to determine fishing areas, based on oceanographic parameters.

Material and Method

Description of the study sites. The research was conducted from March 18 to May 30 2022, by participating in activities of fishing by purse seine operating in the Indian Ocean. The research locations are as shown in Figure 1 below:

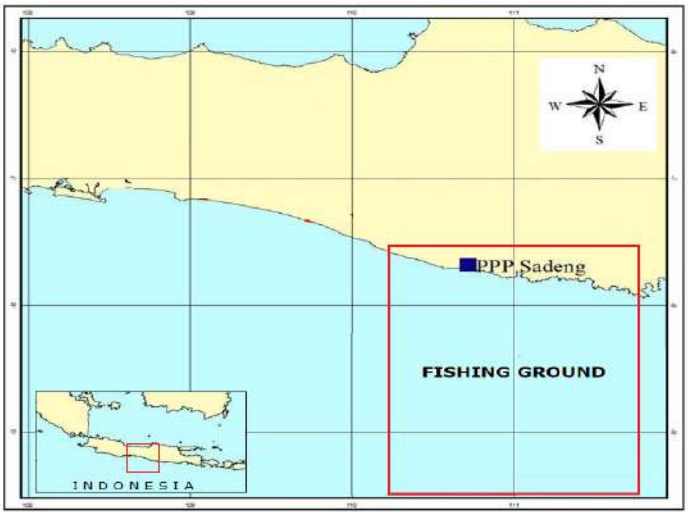


Figure 1. Map of fishing ground.

Method of collecting data. Data collection is done by collecting primary data and secondary data. Primary data concerned the fishing area position, the *in-situ* SST measured directly and the number of catches calculated for each trip. The secondary data were chlorophyll-a and SST images obtained by level 3 Aqua MODIS satellite imagery. Materials and tools used include: purse seine, GPS, compass, digital thermometer, software (.Excel, Seadas 7.5.3, Arcmap 10.8, SPSS), Camera, Chlorophyll-a Image, SST Image.

Data processing method. In processing MODIS data, SeaDas software is used. The results obtained are Aqua MODIS images at level 3, which produce SST values in degrees Celsius (°C) and chlorophyll-a (mg m^{-3}). Due to the relatively wider area, the projection system used is the Geographic Coordinate System (GCS) with the WGS84 datum. The processing of chlorophyll-a and SST values contained in the Aqua MODIS image map was carried out using the SeaDAS software. Data were filtered with Microsoft Excel, and a map of the distribution of chlorophyll-a and SST was made, using the IDW (Inverse Distance Weighted) analysis & the contouring menu, by interpolation, a simple deterministic method based on the surrounding points (Nurman 2010).

Data analysis method. Associative research methods were used with a quantitative approach to observe certain populations or samples (Sugiyono 2010). Analysis of the effect of SST and chlorophyll-a on the catch was tested by several methods including a verification test of satellite imagery data (ex-situ) and direct measuring (in-situ) data, a classical assumption test, and multiple linear regression analysis.

Results and Discussion

Catch production.
1. Catches number on the 1^{st} trip: The 1^{st} trip was held on 1 to 8 April 2022 by setting 9 times the gear, with the overall catch consisting of *T. albacares* (2,552 kg), *K. pelamis*

(3,023 kg), *D. russelli* (2,837 kg), *C. hippurus* (105 kg), *E. affinis* (337 kg) and *A. stellaris* (2,332 kg), with a total of 11,186 kg. The catches were dominated by *K. pelamis*.

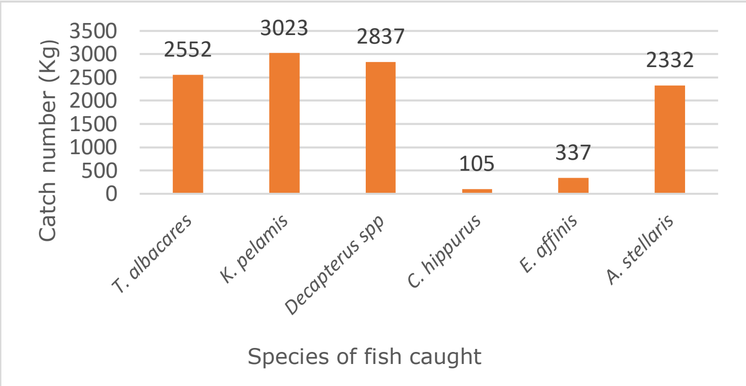


Figure 2. The number of catches on the 1st trip.

2. The number of catches of the 2nd trip: The 2nd trip was held on 10 to 16 April 2022 with 7 days of fishing operations or 7 settings. The catches of the 2nd trip consisted of *T. albacares* (2,002 kg), *K. pelamis* (5,237 kg), *D. russelli* (402 kg), *C. hippurus* (150 kg), *E. affinis* (644 kg), *A. stellaris* (38 kg), with a total of 8,473 kg. The catches on the 2nd trip were dominated by *T. albacares, K. pelamis,* and *D. russelli.*

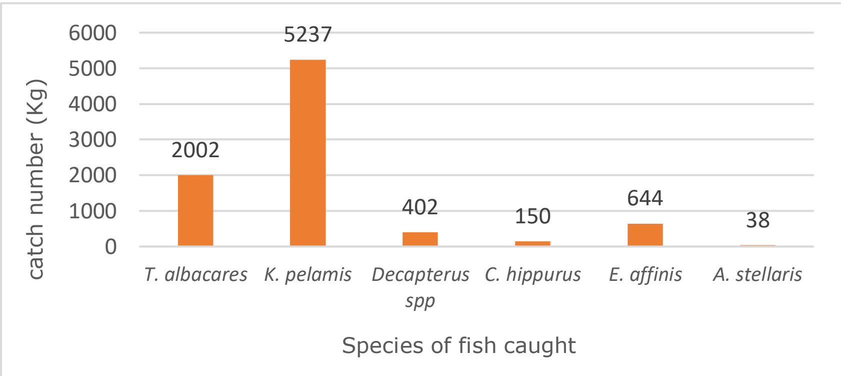


Figure 3. The number of catches on the 2nd trip.

3. The number of catches of the 3rd trip: The 3rd trip was held on 09 to 18 May 2022 with 10 days of catching and 10 settings. The catches on this trip were dominated by *K. pelamis*. The composition of the catch was: *T. albacares* (3,503 kg), *K. pelamis* (10,378 kg), *D. russelli* (5,866 kg), *C. hippurus* (143 kg), *Loligo* (497 kg), *E. bipinnulata* (154 kg), with a total of 20,541 kg.

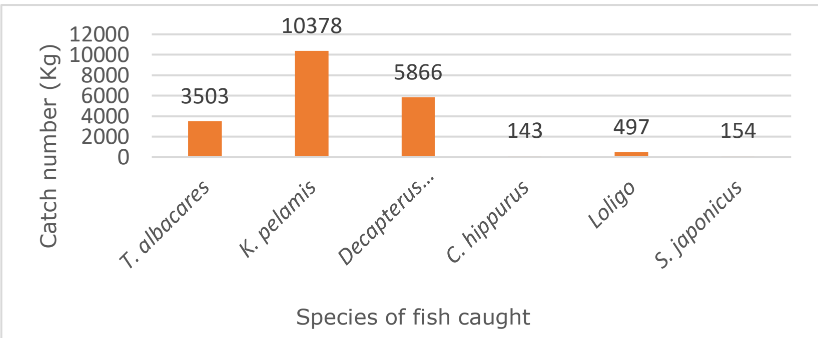


Figure 4. The catch of the 3rd trip.

Catch composition. In 3 trips with 26 catches, the catch was 40,200 kg. *K. pelamis* dominated with as much as 18,638 kg and an average of 716 kg per setting, the 2nd highest

catch was *D. russelli* with as much as 9,105 kg and an average of 350 kg per setting, and the 3rd was *T. albacares* with as much as 8,057 kg and an average per setting of 309 kg. Meanwhile, the lowest catches were *C. hippurus* with 398 kg and *E. bipinnulata* with 154 kg and an average of 15.3 kg and 5.9 kg, respectively, for each setting. Table 1 shows the composition of the catching trips:

Table 1

Fish composition and catch number

Species	*Catch number (Kg)*			Total	*Average*	*Percentage (%)*
	Trip 1	*Trip 2*	*Trip 3*			
T. albacares	2,552	2,002	3,503	8,057	309	20
K. pelamis	3,023	5,237	10,378	18,638	716	46.3
D. russelli	2,837	402	5,866	9,105	350	22.6
C. hippurus	105	150	143	398	15.30	1
A. stellaris	2,332	38	0	2,370	91.15	5.9
E. affinis	337	644	0	981	37.73	2.5
E. bipinnulata	0	0	154	154	5.92	0.4
Loligo	0	0	497	497	19.11	1.3

The diagram in Figure 6 synthesizes the composition if the fish species caught.

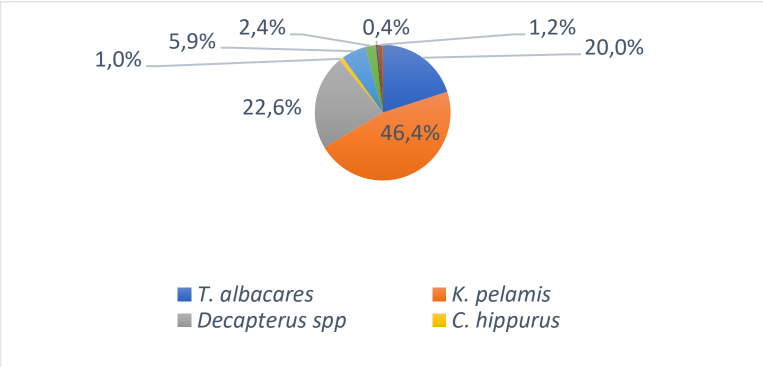


Figure 6. The composition of the caught fish species.

Distribution of Sea Surface Temperature (SST).

1. Distribution of SST in April 2022 for the 1st trip: The distribution of SST was observed to be stable, this can be seen from the 9 sampling points that were obtained during the 1st trip in April. Table 2 shows in-situ and ex-situ SST distribution values measured from 01 to 08 April 2022:

Table 2

The distribution of SST in Sadeng waters in April 2022, on the 1st trip

Date	*Position*		*SST (°C)*	
	Latitude (S)	*Longitude (T)*	*In-situ*	*ex-situ*
01/04/2022	08°42'14''	110°31'22''	27.0	31.7
02/04/2022	08°46'05''	110°33'36''	28.1	31.3
03/04/2022	08°51'00''	110°35'12''	28.0	31.3
03/04/2022	08°49'07''	110°36'05''	28.5	31.4
04/04/2022	08°52'07''	110°36'10''	29.0	31.5
05/04/2022	08°41'47''	110°33'00''	27.1	31.5
06/04/2022	08°38'05''	110°51'51''	26.7	31.2
07/04/2022	08°47'00''	110°34'00''	29.2	31.1
08/04/2022	08°43'12''	110°33'26''	30.1	31.7
	Average		28.1	31.4

Zulkhasyni (2015) stated that in general high SST occurs in the west season to the transition season, where the west season starts in September and ends in February, every year. The *K. pelamis* was caught at a temperature range of 29° to 30°C from November to March (Nugraha et al 2020). According to Yeka et al (2022), the potential area for catching *K. pelamis* has a close relationship with the environmental parameters, especially the chlorophyll-a, whose optimum ranges from 0.12 to 0.22 mg m^{-3}. SST in-situ of Sadeng waters in April 2022 ranged from 26.7° to 30.1°C. The highest SST occurred in April 8 2022, reaching 30.1°C, while the lowest temperature occurred on April 6, 2022, reaching 26.7°C. The average *in-situ* SST in April 2022 on the first trip was 28.1°C and the average *ex-situ* temperature was 31.4ºC, as illustrated in Figure 6..

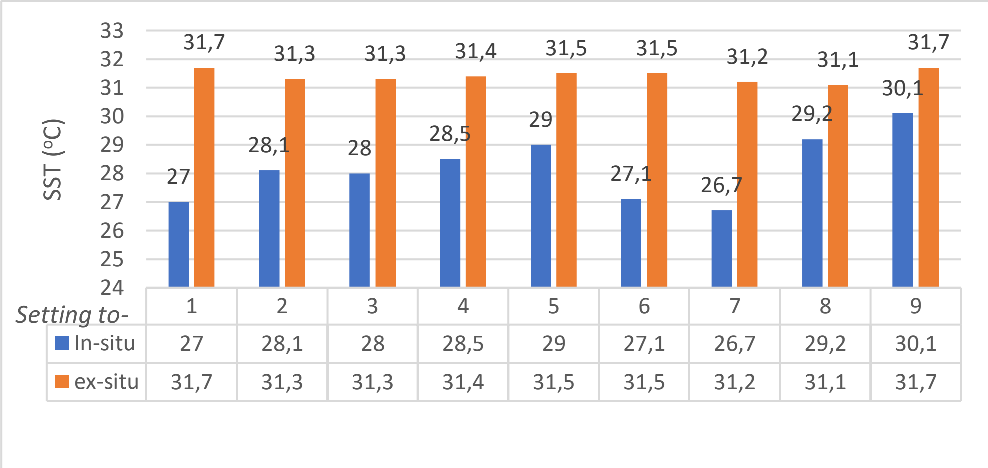


Figure 6. SST distribution in the 1st trip.

The highest number of catches occurred at the setting 9, with a total of 2,121 kg, at a high SST, reaching 30.1°C, while the least catch occurred at the setting 1, with a total catch of 345 kg, at a lower SST, of 27°C. This shows that in April 2022 if the SST value is high, the number of catches will be high and vice versa if the SST is low, the number of catches will also be low. The comparison of SST with the number of catches in April 2022 can be seen in Figure 7 below:

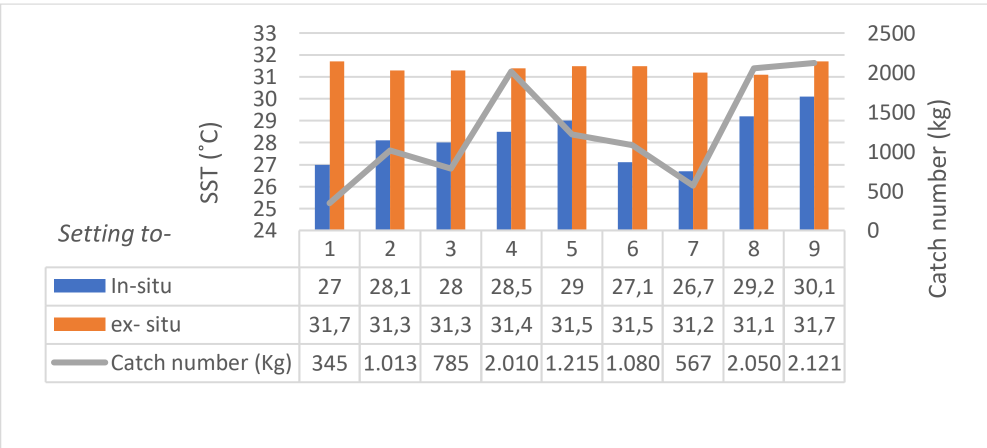


Figure 7. Comparison of SST with catch number in April 2022 on the 1st trip.

2. Distribution of the SST in April 2022 for the 2nd trip: This month, the SST data collection method was carried out in-situ and ex-situ at 7 points of the fishing ground, as observed in Table 3.

Table 3

The distribution of SST in Sadeng waters in April 2022 on the 2nd trip

Date	Position		SST (°C)	
	Latitude (S)	*Longitude (E)*	*in-situ*	*ex-situ*
10/04/2022	08°36'38"	110°38'20"	30.2	31.7
11/04/2022	08°37'44"	110°29'54"	29.7	29.9
12/04/2022	08°35'20"	110°34'19"	27.5	30.1
13/04/2022	09°05'52"	110°09'27"	29.8	30.1
14/04/2022	08°32'25"	110°35'24"	28.5	30.1
15/04/2022	08°30'37"	110°38'14"	30.1	30.3
16/04/2022	08°30'25"	110°32'43"	28.3	29.4
Average			29.1	30.2

Based on the data above, it can be seen that for all 7 sampling points, the SST distribution in April 2022 looks stable, ranging from 27.5 to 30.2°C. The highest temperature increase occurred on 10th of April 2022, reaching 30.2°C, while the lowest temperature occurred on April 12th of 2022, with a temperature reaching 27.5°C. The in-situ average in April 2022, on the 2nd trip, was 29.1°C and the ex-situ average was 30.2°C.

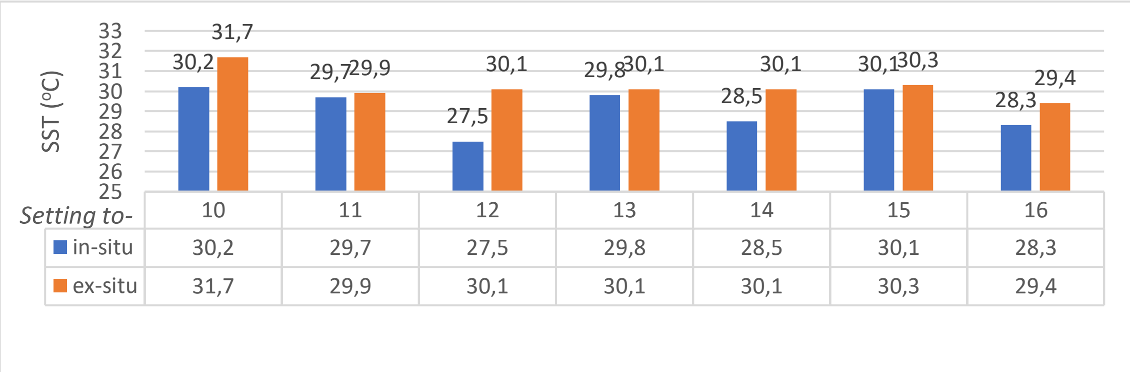


Figure 8. SST distribution on the 2nd trip.

In Figure 9, the comparison of the SST value with the catch in April 2022 shows that the highest of catch number occurred in the 12th setting, with as much as 2,053 kg, at an SST value reaching 27.5°C. Meanwhile, the smallest number of catches occurred in the 11th setting, with as much as 566 kg and an SST reaching 29.7°C. This shows that in April 2022, if the SST is high then the catch decreases and conversely, if the SST is low then the catch number is high, inversely proportional to the 1st trip.

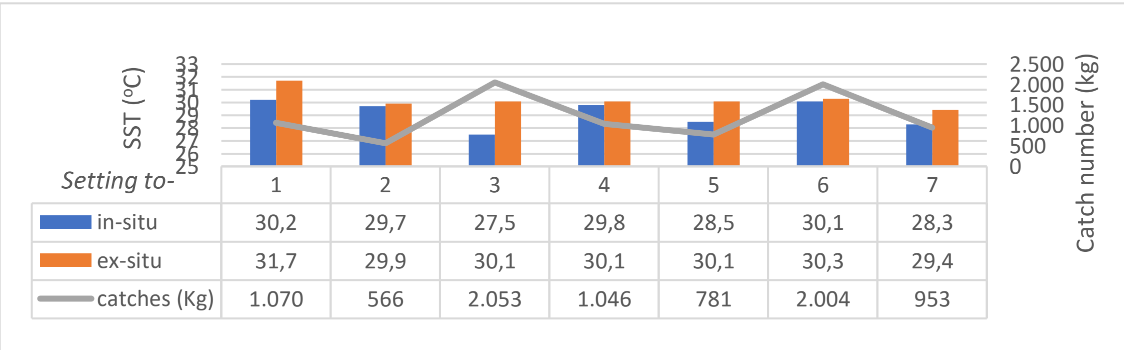


Figure 9. Comparison of the SST value and the catch quantity in April 2022, on the 2nd trip.

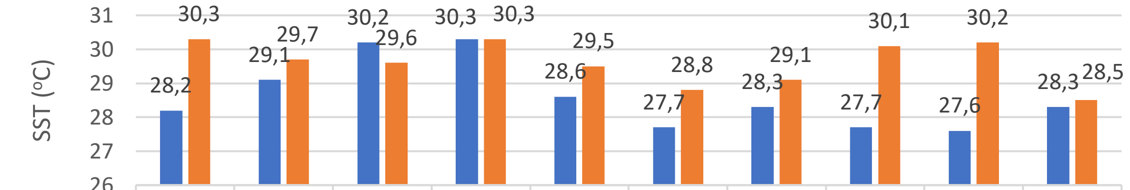
3. Distribution of the SST in May 2022, for the 3rd trip: In May 2022 the sampling point method was carried out directly on the satellite imagery, 10 times, as shown in Table 4:

Table 4

The distribution of SST in Sadeng waters in May 2022, on the 3rd trip

Date	Position		SST (°C)	
	Latitude (S)	Longitude (E)	in-situ	ex-situ
09/05/2022	08°28'50''	110°08'51''	28.2	30.3
10/05/2022	08°44'19''	110°25'58''	29.1	29.7
11/05/2022	08°46'04''	110°54'56''	30.2	29.6
12/05/2022	09°09'10''	110°16'09''	30.3	30.3
13/05/2022	09°41'15''	109°59'03''	28.6	29.5
14/05/2022	09°27'33''	109°54'56''	27.7	28.8
15/05/2022	08°57'29''	110°06'22''	28.3	29.1
16/05/2022	08°46'14''	110°37'47''	27.7	30.1
17/05/2022	08°43'39''	110°46'36''	27.6	30.2
18/05/2022	08°33'23''	110°34'50''	28.3	28.5
	Average		28.6	29.6

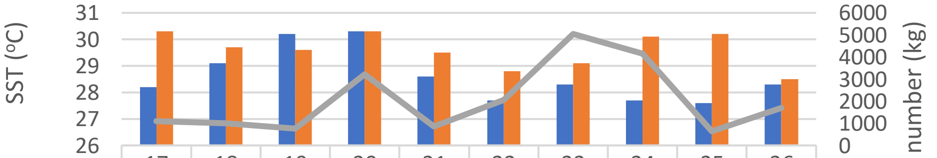
Based on Table 4 and Figure 10, SST fluctuations occurred in May 2022. The SST distribution was stable, ranging from 27.6 to 30.3°C. The highest SST occurred on 12 May 2022, reaching 30.3°C, while the lowest SST, of 27.6°C, occurred on 17 May 2022. The average SST in-situ in May, on the 3rd trip, was 28.6°C and the ex-situ average was 29.6°C.



Setting to-	17	18	19	20	21	22	23	24	25	26
in-situ	28,2	29,1	30,2	30,3	28,6	27,7	28,3	27,7	27,6	28,3
ex-situ	30,3	29,7	29,6	30,3	29,5	28,8	29,1	30,1	30,2	28,5

Figure 10. SST distribution in the 3rd trip.

In Figure 11, the comparison of SST with the highest catches number in May 2022, occurred at the setting 23, with a total of 5,045 kg, at a high SST value of 28.3°C. The lowest catches number on the 3rd trip occurred at the 25th setting, with a total of 641 kg and a SST reaching 27.6°C. Based on the previous findings, it can be concluded that in May 2022 if the SST is high, the catches number is high and if the SST is low, the catches number is low too.



Setting to-	17	18	19	20	21	22	23	24	25	26
in-situ	28,2	29,1	30,2	30,3	28,6	27,7	28,3	27,7	27,6	28,3
ex- situ	30,3	29,7	29,6	30,3	29,5	28,8	29,1	30,1	30,2	28,5
Catch number (Kg)	1110	1004	757	3213	850	2057	5045	4156	641	1708

Figure 11. Comparison of SST with the catches number in May 2022 on the 3rd trip.

Chlorophyll-a concentration. One of the waters fertility factors is the availability of chlorophyll-a in the waters. According to Nufus et al (2017) the fertility level of coastal waters can be assessed from the biological and chemical characteristics, especially from the availability of essential nutrients. Based on the Table 5, the concentration of chlorophyll-a in Sadeng waters tends to experience fluctuations.

Table 5

Concentration of chlorophyll-a in Sadeng waters in 2017 to 2021

Period (Month/year)	*chlorophyll-a (mg m^{-3})*				
	2017	*2018*	*2019*	*2020*	*2021*
April	0.38	0.33	0.58	0.28	0.39
May	0.40	0.73	0.76	0.34	0.41

The highest value of chlorophyll-a, 0.76 mg m^{-3}, occurred in May 2019, while the lowest value occurred in April 2020, with a value of 0.28 mg m^{-3}, as observed in Figure 12. The high and low values of chlorophyll-a are influenced by the nutrients content in the waters, which is also closely related to the abundance of phytoplankton. If the nutrients in the waters are abundant, the chlorophyll-a value will also be high. In addition, other factors that can affect the level of chlorophyll-a in waters are the temperature and salinity.

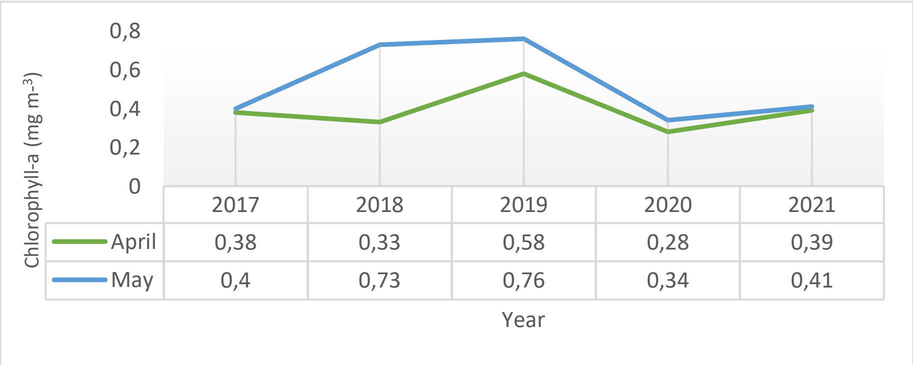


Figure 12. Chlorophyll-a concentration in 2017–2021.

1. Concentration of chlorophyll-a in April 2022, on the 1st trip: The distribution of chlorophyll-a concentration in April seemed to fluctuate. This can be seen from the 9 sampling points obtained from the NASA Ocean Color level 3, with a daily period, as it can be seen in Table 6.

Table 6

The concentration of chlorophyll-a in Sadeng waters in April 2022 for the 1st trip

Date	*Position*		*Chlorophyll-a (mg m^{-3})*	*Catch number (kg)*
	Latitude (S)	*Longitude (E)*		
01/04/2022	08°42'14''	110°31'22''	0.13	345
02/04/2022	08°46'05''	110°33'36''	0.15	1,013
03/04/2022	08°51'00''	110°35'12''	0.15	785
03/04/2022	08°49'07''	110°36'05''	0.12	2,010
04/04/2022	08°52'07''	110°36'10''	0.15	1,215
05/04/2022	08°41'47''	110°33'00''	0.14	1,080
06/04/2022	08°38'05''	110°51'51''	0.14	567
07/04/2022	08°47'00''	110°34'00''	0.15	2,050
08/04/2022	08°43'12''	110°33'26''	0.13	2,121
	Average		0.14	1,242

Based on Table 6 above, at the 9 sampling points observed during this trip, the highest increase in the value of chlorophyll-a occurred on 1st April 2022 with a concentration value of 0.15 mg m^{-3}. Meanwhile, the lowest chlorophyll-a value occurred on April 3rd 2022, with a chlorophyll-a concentration value of 0.12 mg m^{-3}. The average concentration of chlorophyll-a on the 1st of April trip was 0.14 mg m^{-3}.

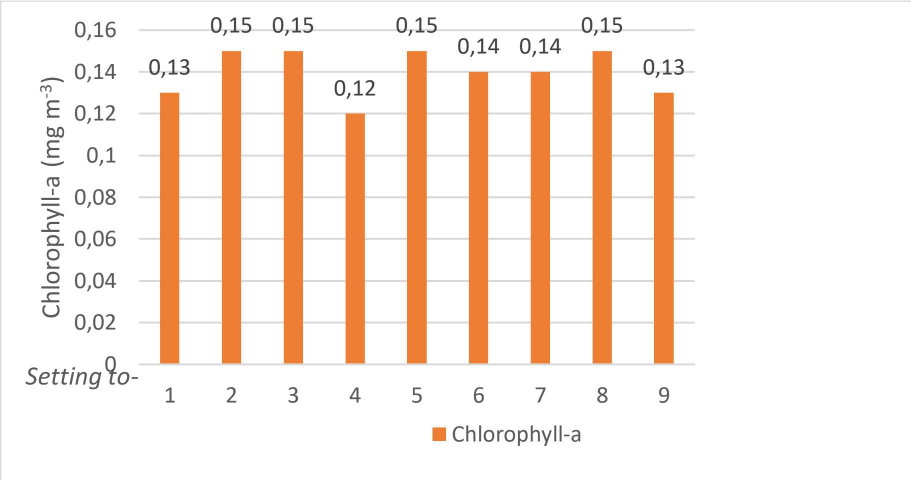


Figure 13. Chlorophyll-a concentration in April 2022, on the 1st trip.

In Figure 14 the comparison of the value of chlorophyll-a and the catches number in April 2022 shows that the highest catches number occurred in the 8th setting, with a total of 2,050 kg, at a high concentration of chlorophyll-a, of 0.15 mg m^{-3}. Meanwhile, the smallest catch number on the 1st trip occurred in the first setting, with the amount of 345 kg where the chlorophyll-a concentration value reached 0.13 mg m^{-3}. It can be concluded that in April 2022, if the concentration of chlorophyll-a is high then the catches number is high. Conversely, if the chlorophyll-a is low then the catches number is also low.

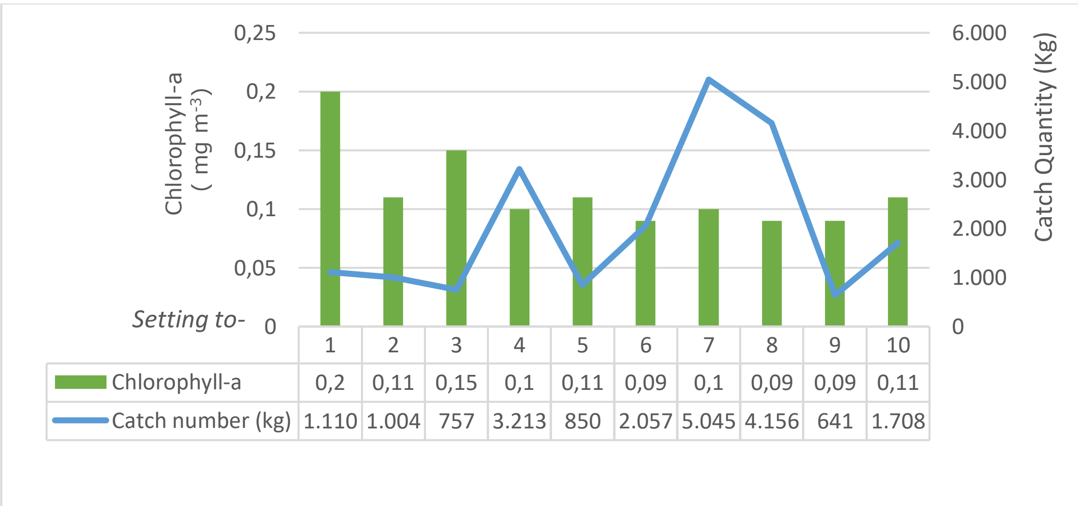


Figure 14. Comparison graph of chlorophyll-a value with the catches quantity on the 1st April 2022 trip.

1. Concentration of chlorophyll-a in Sadeng waters in April 2022 on the second trip: In April 2022, we considered 7 sampling points during the fishing operations; data were obtained from the NASA Ocean Color satellite (NASA 2007). The detailed chlorophyll-a concentration values can be seen in Table 7:

Table 7

The concentration of chlorophyll-a in Sadeng waters in April 2022, for the second trip

Date	*Position*		*chlorophyll-a*	*Catches*
	Latitude (S)	Longitude (T)	*(mg m-^{3})*	*number (kg)*
10/04/2022	08°36'38"	110°38'20"	0.11	1,070
11/04/2022	08°37'44"	110°29'54"	0.12	566
12/04/2022	08°35'20"	110°34'19"	0.11	2,053
13/04/2022	09°05'52"	110°09'27"	0.12	1,046
14/04/2022	08°32'25"	110°35'24"	0.10	781
15/04/2022	08°30'37"	110°38'14"	0.11	2,004
16/04/2022	08°30'25"	110°32'43"	0.09	953
	Average		0.10	1,210

Figure 15 is a graph of the results of the 7 sampling points taken during the 2nd trip:

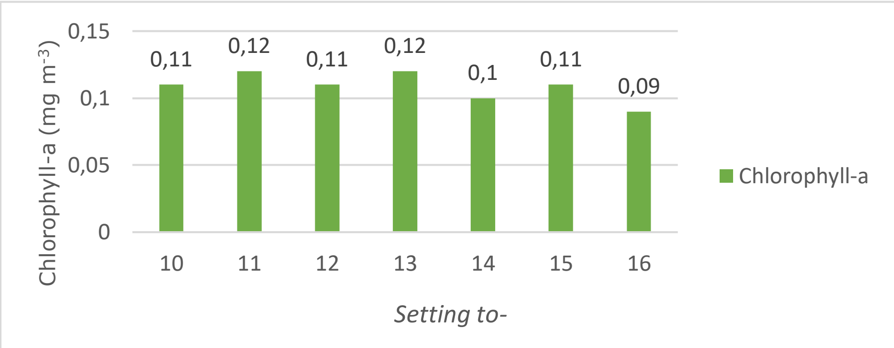


Figure 15. chlorophyll-a value in April 2022, on the 2nd trip.

Based on the data above, it can be seen that from 7 sampling points taken during this trip, the highest increase in the value of chlorophyll-a occurred on April 13th 2022, with a concentration value of 0.12 mg m^{-3}. Meanwhile, the lowest chlorophyll-a value occurred on April 16th 2022, with a chlorophyll-a concentration value of 0.09 mg m^{-3}. The average concentration of chlorophyll-a in April, at the 1st fishing operation trip, was of 0.10 mg m^{-3}.

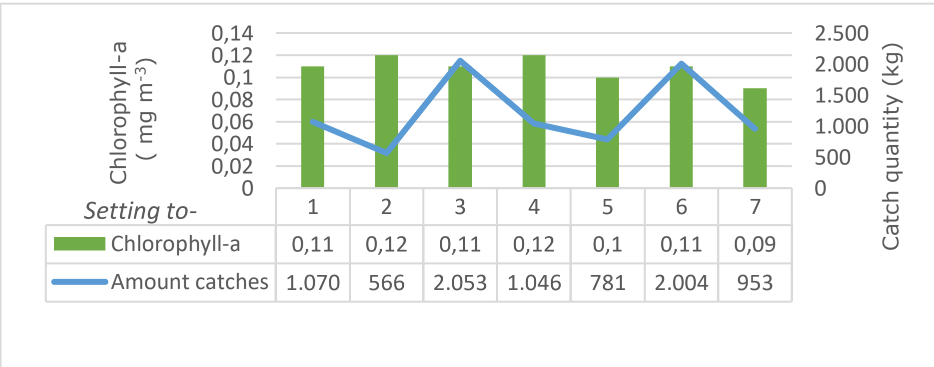


Figure 16. Comparison of the value of chlorophyll-a with the catches quantity, on the 2nd April 2022 trip.

In Figure 16 the comparison of the value of chlorophyll-a and the catch number in April 2022 shows that the highest catch number occurred at the 15th setting, with a total of 2,004 kg, inversely proportional to the chlorophyll-a concentration (0.11 mg m^{-3}, the lowest value). The smallest catch on the 2nd fishing operation trip occurred at the 11th setting, with the amount of 566 kg, when the value of chlorophyll-a concentration was the highest (0.12 mg m-^{3}). From the findings above, it can be concluded that in April the catch quantities are inversely proportional to the values of chlorophyll-a concentrations.

1. Concentration of chlorophyll-a in Sadeng waters in May 2022 on the third trip: The concentration of chlorophyll-a in May 2022 was observed to be stable, ranging from 0.09 to 0.15 mg m^{-3}. In May 2022, 10 sample points were taken using the satellite imagery obtained from NASA Ocean Color. The concentration of chlorophyll-a in Sadeng waters in May 2022 is presented in Table 8.

Table 8

The concentration of chlorophyll-a in Sadeng waters in May 2020, for the 3rd trip

Date	*Position*		*Chlorophyll-a (mg m^{-3})*	*Catch number (kg)*
	Latitude (S)	*Longitude (T)*		
09/05/2022	08°28'50''	110°08'51''	0.20	1,110
10/05/2022	08°44'19''	110°25'58''	0.11	1,004
11/05/2022	08°46'04''	110°54'56''	0.15	757
12/05/2022	09°09'10''	110°16'09''	0.10	3,213
13/05/2022	09°41'15''	109°59'03''	0.11	850
14/05/2022	09°27'33''	109°54'56''	0.09	2,057
15/05/2022	08°57'29''	110°06'22''	0.10	5,045
16/05/2022	08°46'14''	110°37'47''	0.09	4,156
17/05/2022	08°43'39''	110°46'36''	0.09	641
18/05/2022	08°33'23''	110°34'50''	0.11	1,708
	Average		0.11	2,054

The data was synthesized in Figure 17:

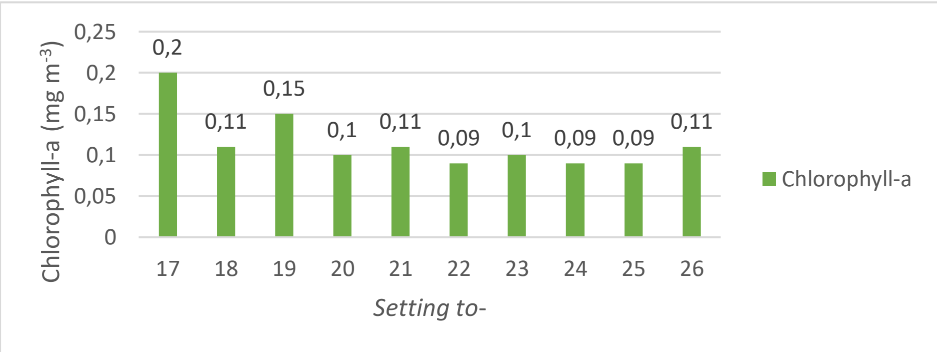


Figure 17. Chlorophyll-a concentration in May 2022, on the 3rd trip.

In Table 8 and Figure 17, it can be observed that the concentration of chlorophyll-a fluctuates in May. The highest chlorophyll-a value occurred on 11th of May 2022, of 0.15 mg m^{-3}, while the lowest chlorophyll-a value occurred on 14th, 16th, and 17th of May 2022, of 0.09 mg m^{-3}. The average concentration of chlorophyll-a in April 2022, on the fourth fishing operation trip, was 0.11 mg m^{-3}.

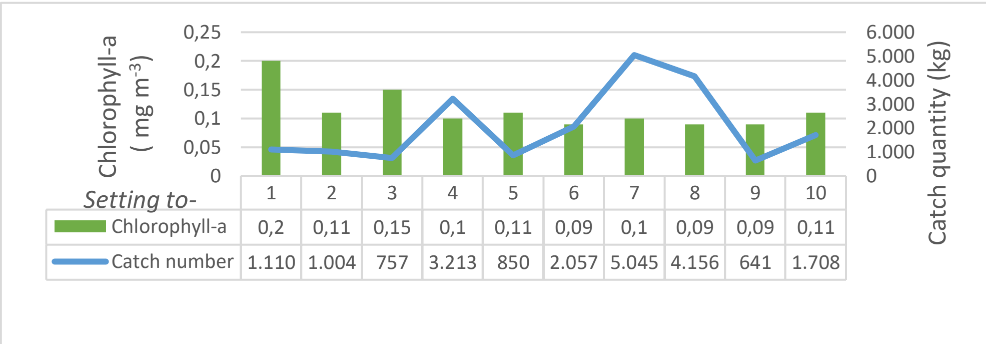


Figure 18. Comparison of chlorophyll-a concentration with the catching quantity in May 2022.

In Figure 18 the comparison of the value of chlorophyll-a and the catching quantity in May 2022 shows that the highest quantity of catches occurred at the setting 23, with a total of 5,045 kg, at a high concentration of chlorophyll-a, with a value of 0.10 mg m^{-3}. Meanwhile, the smallest catch number on the 1^{st} fishing operation trip occurred at the 25^{th} setting, with a total of 641 kg where the chlorophyll-a concentration value reached 0.09. Based on the previous findings, it can be concluded that in May, if the concentration of chlorophyll-a is high then the catch number is high or conversely, if the chlorophyll-a is low then the catch number is also low.

SST data is obtained based on the analysis of MODIS images. The data is then verified against the measurements. The verification results are shown in Table 9:

Table 9

Verification of in-situ SST data with satellite imagery

No. setting	*Data in-situ*	*Data ex-situ*	*Value of error (%)*
1	27.0	28.28	4.92
2	28.1	28.28	0.69
3	28.0	28.29	1.12
4	28.5	26.78	6.69
5	29.0	27.42	6.08
6	27.1	27.39	1.12
7	26.7	28.18	5.69
8	29.2	25.7	13.46
9	30.1	26.98	12.00
10	30.2	28.28	7.38
11	29.7	26.08	13.92
12	27.5	26.21	4.96
13	29.8	27.66	8.23
14	28.5	27.53	3.73
15	30.1	28.04	7.92
16	28.3	27.56	2.85
17	28.2	27.11	4.19
18	29.1	28.4	2.69
19	30.2	28.32	7.23
20	30.3	27.41	11.12
21	28.6	26.13	9.50
22	27.7	28.86	4.46
23	28.3	28.33	0.12
24	27.7	28.56	3.31
25	27.6	27.01	2.27
26	28.3	28.48	0.69
Mean relatives error	28.61	27.59	5.63

According to Fadika et al (2014), data verification is done by calculating the MRE. In-situ SST data verification against the Aqua MODIS satellite image data, at 26 sampling points, shows that the average relative error value is 5.63%. This value is included in the correct category, where the resulting value is no more than 30%. Jaelani et al (2013) in their journal stated that values with an average relative error of less than 30% in image data processing can be used for further analysis. Based on the previous statement, it can be concluded that the SST satellite image data can be further analyzed because it has an accuracy of 91.89%. According to Simanjuntak et al (2012), among the factors that cause errors in the satellite image datais a reading error at the time of observation.

Analysis of the effect of SST and chlorophyll-a on the total catch.

1. Normality test.

The normality test is part of the data analysis requirements. It is a classical assumption test: before performing a statistical analysis to test the hypothesis, a

regression analysis is used to determine whether the residual values are normally distributed or not. The residual is normally distributed if the significance is more than 0.05 (Gunawan 2020).

In Table 10, the test results, obtained with the SPSS software, can be seen. The asymptotic normality obtained had the significance value (sig.)0.200 (>0.05), so the residual values can be considered as normally distributed.

Table 10

Normality test

One-Sample Kolmogorov-Smirnov Test		
		Unstandardized residual
N		26
Normal Parameters[a,b]	Mean	.0000000
	Std. deviation	1016.50300169
Most extreme differences	Absolute	.108
	Positive	.108
	Negative	-.071
Test statistic		.108
Asymp. Sig. (2-fish)		.200[c,d]

[a] Test distribution is Normal; [b] Calculated from data; [c] Lilliefors Significance Correction; [d] This is a lower bound of the true significance.

The basis for decision making in the K - S Normality test is as follows:
- If the significance value (sig.) >0.05 then the data is normally distributed. On the contrary,
- If the significance value (sig.) <0.05, then the data is not normally distributed.

2. Linearity Test

In Table 11 of the SST - catches relationship's Deviation from Linearity, the significance value (sig.) obtained is 0.868, greater than 0.05. So it can be concluded that there is a significant linear relationship between the SST variable (X) and the number of catches (Y).

Table 11

Linearity test of the catch number with SST

ANOVA Table							
			Sum of squares	df	Mean square	F	Sig.
Catches * SST	Between groups	(Combined)	21329060.787	19	1122582.147	0.539	0.858
		Linearity	1812590.669	1	1812590.669	0.870	0.387
		Deviation from linearity	19516470.118	18	1084248.340	0.521	0.868
	Within groups		12497302.667	6	2082883.778		
	Total		33826363.454	25			

In Table 12 of the Chlorophyll-a catches relationship's Deviation from Linearity, the significance value is 0.889, greater than 0.05. So it can be concluded that there is a significant linear relationship between the chlorophyll-a variable (X) and the catch number (Y).

Table 12

Linearity test of total catch with chlorophyll-a

ANOVA table							
			Sum of squares	*df*	*Mean square*	*F*	*Sig.*
Catches * Chlorophyll-a	Between groups	(Combined)	10614882.479	7	1516411.783	1.176	0.364
		Linearity	7753006.461	1	7753006.461	6.012	0.025
		Deviation from linearity	2861876.018	6	476979.336	0.370	0.889
	Within groups		23211480.975	18	1289526.721		
	Total		33826363.454	25			

The basis for decision making in the linearity test by comparing the significance value is as follows:

- If the value of Deviation from Linearity sig.>0.05, then there is a significant linear relationship between the independent variable and the dependent variable.
- If the value of Deviation from linearity sig.<0.05, then there is no significant linear relationship between the independent variable and the dependent variable.

3. Multicollinearity test

The multicollinearity test was used to test whether the regression model found a correlation between the independent variables. If a correlation exists, then there is a multicollinearity (multico) problem (Gunawan 2020). Multicollinearity is detected by examining the Variance Inflation Factor (VIF) value and tolerance, with reference to certain conditions: if the VIF value is less than 10 and the tolerance is more than 0.1, it is considered that there is no multicollinearity (Gunawan 2020).

In Table 13, it is shown that the value of the collinearity tolerance of the two variables is 0.90, more than 0.10, and the VIF statistic value of 1.11 is less than 10.

Table 13

Multicollinearity Test

Coefficients[a]								
Model		*Unstandardized coefficients*		*Standardized coefficients*	*t*	*Sig.*	*Collinearity statistics*	
		B	*Std. Err.*	*Beta*			*Tolerance*	*VIF*
1	(Constant)	2421.912	998.784		2.425	0.024		
	SST	1.219	2.630	0.089	0.464	0.647	0.900	1.111
	Chlorophyll-a	-117.383	50.033	-0.451	-2.346	0.028	0.900	1.111

a

So it can be concluded that the data above does not occur multicollinearity between independent variables. The basis for making decisions on the multicollinearity test with tolerance is as follows:

- If the tolerance value is greater than 0.10, it means that there is no multicollinearity in the regression model.
- If the tolerance value is less than 0.10, it means that there is multicollinearity in the regression model.

4. Heteroscedasticity Test

The heteroscedasticity test aims to test whether in the regression model there is an inequality of variance from one observation to another. A good regression model is one without heteroscedasticity or with homoscedasticity (Gunawan 2020).

Based on Table 14, it can be observed that the significance value (sig.) for the SST variable (X_1) is 0.811, while the significance value (sig.) for the chlorophyll-a variable (X_2) is 0.089.

Table 14

Heteroscedasticity test

Coefficients[a]						
Model		Unstandardized coefficients		Standardized coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	2825.294	3687.361		0.766	0.452
	SST	-30.753	126.844	-0.048	-0.242	0.811
	Chlorophyll-a	-9494.419	5333.793	-0.354	-1.780	0.089

a

Because the significance value of the two variables above is greater than 0.05, according to the basis for decision making in the Glejser test, it can be concluded that there is no symptom of heteroscedasticity. The basis for decision making in the heteroscedasticity test, using the Glejser conditions, is as follows:

- If the significance value (Sig.) is greater than 0.05, then the conclusion is that there is no heteroscedasticity symptom in the regression model.
- On the other hand, if the significance value (sig.) is less than 0.05, the conclusion is that heteroscedasticity is occurring.

5. Multiple linear regression

This analysis is used to measure the magnitude of the influence between the independent and dependent variables. There are several eligibility requirements that must be met when regression analysis is used, namely: the number of samples used must be the same, the number of independent variables is 1, the residual value must be normally distributed, there is a linear relationship, there are no symptoms of heteroscedasticity.

Based on Table 15, it is explained that the correlation coefficient (R) of 0.471 between the variables sea surface temperature and chlorophyll-a with the catch means that there is a very strong positive relationship between SST and chlorophyll-a with the fish catch.

Table 15

Model summary

Model summary				
Model	R	R Square	Adjusted R square	Std. Error of the estimate
	.471[a]	0.221	0.154	1036.89027

[a] Predictors: (Constant), Chlorophyll-a, SST.

Meanwhile, the R square coefficient obtained is 0.221 or 22%, meaning that the independent variables (SST and chlorophyll-a) affect the Y variable (catch) by 22% while the rest of the catch is influenced by other variables.

Based on Table 16, it is observed that the coefficient test of the SST variable produces $t_{count} < t_{table}$ (0.598 < 2.069) and the significance value obtained is 0.556 (Sig > 0.05) so that SST only weakly affects the catch.

Table 16

t_{test}

Coefficients[a]						
Model		Unstandardized coefficients		Standardized coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	2262.186	977.214		2.315	0.030
	SST	1.539	2.573	0.116	0.598	0.556
	Chlorophyll-a	-106.246	48,953	-0.421	-2.170	0.041

[a] Dependent variable: Cathes.

Meanwhile, by testing the coefficient of chlorophyll-a variable, it was found that $t_{count} > t_{table}$ (2.170>2.069), with a significance value of 0.041 (Sig<0.05) so that it is known thatchlorophyll-a has a strong influence on the catch.

$$Y = 2262{,}186 + 1{,}539\ X_1 + -106{,}246\ X_2$$

The above equation describes the effect of changing the values of the independent variables, in the regression algorithm. The interpretation is as follows:

a. Each change by one unit in X_1 and X_2 produces an increase of 2262.186 units.
b. Every change by 1 degree in SST (X_1) results in an increase of 1,539 in the catch (Y).
c. Each change of 1 mg m^{-3} in chlorophyll-a (X_2) results in an increase of 106.246 in the catch (Y).

In Table 17, able it can be observed that $F_{count} < F_{table}$ (3.271<3.40), while the significance value obtained is 0.056 (Sig>0.05), so it can be concluded that there is an influence between the combined SST and chlorophyll-a variables on the catch quantities.

Table 17

Significance test (f_{test})

	ANOVA[a]					
	Model	*Sum of squares*	*df*	*Mean square*	*F*	*Sig.*
1	Regression	7034292.282	2	3517146.141	3.271	.056[b]
	Residual	24728253.103	23	1075141.439		
	Total	31762545.385	25			

[a] Dependent variable: Catch number; [b] Predictors: (Constant), Chlorophyll-a, SST.

Conclusions. The results of the significance test showed that SST had a partial influence on the catch number, while chlorophyll-a had a significant effect on the catch quantity. Meanwhile, if the test was carried out simultaneously, the results would obtaine a significance of 0.056, which means that the combined SST and chlorophyll-a have an influence on the catch quantities.

Conflict of interest. The authors declare no conflict of interest.

References

Abidin A. F., Amron, Marzuki M. I., 2020 Relationship between chlorophyll-a and sea surface temperarure to tuna catch in the Southern Water of Java. Science Research Journal 22(2):55-68.

Alfajri A., Mubarak M., Mulyadi A., 2017 [Spatial and Temporal analysis of sea surface temperature distribution in West Sumatra waters]. Indonesian Environmental Dynamics 4(1): 65-74. [In Indonesian].

Anggraeni R., Solichin A., Saputra S. W., 2015 [Several biological aspects of skipjack tuna (*Katsuwonus pelamis*) in relation to fisheries management in PPP Sadeng, Gunungkidul Regency, Yogyakarta]. Management of Aquatic Resources Journal (MAQUARES) 4(3):230-239. [In Indonesian].

Azizah A., Wibisana H., 2020 [Temporal analysis of sea surface temperature distribution from 2018 to 2020 with Terra Modis image data]. Marine Journal: Indonesian Journal of Marine Science and Technology 13(3):196–205. [In Indonesian].

Fadika U., Rifai A., Rochaddi B., 2014 [Seasonal wind direction and speed and its relation to the distribution of sea surface temperature in Southern Pangandaran, West Java]. Journal of Oceanography 3(3):429–437. [In Indonesian].

Gunawan C., 2020 [Proficient in Mastering SPSS Practical Guide to Processing Research Data (Deeppublish)]. Deepublish, Yogyakarta 210 p. [In Indonesian].

Hastuti, Wirasatriya A., Maslukah L., Subardjo P., Kunarso, 2021 [The Effect of chlorophyll-a factors and sea surface temperature on anchovy catches (*Stelesphorus* sp) in Jepara]. Indonesian Journal of Oceanography 3(2):1-9. [In Indonesian].
Hendiarti N., Ohde T., 2004 Investigation of different processes in Indonesian waters using SeaWiFS data. Deep Sea Research Part II Topical Studies in Oceanography 51(1-3):85-97.
Jaelani L. M., Matsushita B., Yang W., Fukushima T., 2013 Evaluation of four MERIS atmospheric correction algorithms in Lake Kasumigaura, Japan. International Journal of Remote Sensing 34(24):8967–8985.
Jayawiguna M. H., Triyono, Wibowo S., 2019 [Overview of the potential, development and challenges of utilizing marine and fishery resources at FMA-RI 573]. AMAFRAD Press p. 3-10. [In Indonesian].
Kusmana C., Hikmat A., 2015 The biodiversity of flora in Indonesia. Journal of Natural Resources and Environmental Management 5(2):187–198.
Ma'mun A., Priatna A., Hidayat T., Nurulludin. 2017 Distribution and potential resources of pelagic fish in Fisheries Management Area of the Republic of Indonesia (FMA-RI 573) Indian Ocean. Indonesian Fisheries Research Journal (JPPI) 23:47–56.
Nufus H., Karina S., Agustina S., 2017 [Analysis of chlorophyll-a distribution and water quality in the Krueng Raba Lhoknga River, Aceh Besar]. Scientific Journal of Marine and Fisheries Students Unsyiah 2(1):58–65. [In Indonesian].
Nugraha E., Gunawan R., Danapraja S., Yusrizal, Kusdinar A., Waluyo A. S., Hutajulu J., Prayitno H., Halim S., Sutisna D. H., 2020 The sea surface temperature effect on the length and size of skipjack tuna (*Katsuwonus pelamis*) catches in the Banda Sea, Indonesia. AACL Bioflux 13(1):1-18.
Nikijuluw V., 2008 [The status of Indian Ocean tuna resources and its implications for Indonesia]. Journal of Indonesian Fisheries Policy 1(1):31-44. [In Indonesian].
Nurman A., 2010 [Utilization of fashionable data to detect fishing areas on the East and West Coasts of North Sumatra]. Journal of Geography 2(2):17-30. [In Indonesian].
Sidik A., Agussalim A., Ridho M. R., 2015 [The accuracy of the value of chlorophyll-a concentration and sea surface temperature using remote sensing data in the waters of Anggantang Island, Sembilang National Park]. Maspari 7(2):25–32. [In Indonesian].
Simanjuntak B. L., Handoyo G., Sugianto D. N., 2012 [Analysis of bathymetry and tidal components for determination of additional depth of jetty ponds in Tanjung Gundul Bengkayang Waters – West Kalimantan]. Journal of Oceanography 1(1):1-8. [In Indonesian].
Sugiyono, 2019 [Quantitative research methods]. Alphabet, 464 p. [In Indonesian].
Wahyuningrum P. I., Nurani T. W., Rahmi T. A., 2012 [Multi purpose capture fishery business in Sadeng, Gunungkidul Regency, Special Region of Yogyakarta]. Maspari Journal 4(1):10-22. [in Indonesian].
Wijopriono. 2012 [The carrying capacity of tuna fisheries resources in the Indian Ocean in relation to fisheries industrialization]. Journal of Indonesian Fisheries Policy 4(2):101-108. [In Indonesian].
Yeka A., Monika D., Rahmani R. M., Sarianto D., Fitri Y., Nurlaela E., Kusmedy B., Nugraha E., Hutajulu J., 2022 The effect of chlorophyll-a on the catches of skipjack tuna (Katsuwonus pelamis) in Banda Sea, Maluku, Indonesia. AACL Bioflux 15(3):1226-1237.

Received: 23 August 2021. Accepted:. Published online:.
Authors:
Priyantini Dewi, Jakarta Technical University of Fisheries, Faculty of Fishing Technology, AUP Street Pasarminggu 12520, South Jakarta, Indonesia, e-mail: prizt.dewi@gmail.com
Sutarjo, Jakarta Technical University of Fisheries, Faculty of Fishing Technology, AUP Street Pasarminggu 12520, South Jakarta, Indonesia, e-mail: sutarjoz79@gmail.com
Maman Hermawan, Jakarta Technical University of Fisheries, Faculty of Fishing Technology, AUP Street Pasarminggu 12520, South Jakarta, Indonesia, e-mail: mhermawan60@gmail.com
Bongbongan Kusmedy, Jakarta Technical University of Fisheries, Faculty of Fishing Technology, AUP Street Pasarminggu 12520, South Jakarta, Indonesia, e-mail: bkhutapea@gmail.com
Yusrizal, Jakarta Technical University of Fisheries, Faculty of Fishing Technology, AUP Street Pasarminggu 12520, South Jakarta, Indonesia, e-mail: buyung_trc@yahoo.co.id
Mira Maulita, Jakarta Technical University of Fisheries, Faculty of Aquatic Resources Management, AUP Street Pasarminggu 12520, South Jakarta, Indonesia, e-mail: maulita.stp@gmail.com
Eli Nurlaela, Jakarta Technical University of Fisheries, Faculty of Fishing Technology, AUP Street Pasarminggu 12520, South Jakarta, Indonesia, e-mail: elimumtaza@gmail.com
Sopiyan Danapraja, Jakarta Technical University of Fisheries, Faculty of Fisheries Extension, AUP Street Pasarminggu 12520, South Jakarta, Indonesia, e-mail: sopiyanraja@gmail.com
Erick Nugraha, Jakarta Technical University of Fisheries, Faculty of Fishing Technology, AUP Street Pasarminggu 12520, South Jakarta, Indonesia, e-mail: nugraha_eriq1@yahoo.co.id

How to cite this article:
Dewi P., Sutarjo, Hermawan M., Kusmedy B., Yusrizal, Maulita M., Nurlaela E., Danapraja S., Nugraha E., 2023 Study of sea surface temperature and chlorophyll-a to the number of fish caught in the waters of Sadeng, Yogyakarta, Indonesia. AACL Bioflux

← Kembali Arsipkan Pindahkan Hapus Spam •••

erick nugraha <nugraha_eriq1@yahoo.co.id> Kam, 5 Jan jam 07.41
Kepada: Eni Kovacs

Dear Dr. Eni
I send you Edited Manuscript.

Thank You

Erick Nugraha
JTUF, Indonesia

> Tampilkan pesan asli

Nugraha_S... .docx
1.3MB

Study of sea surface temperature and chlorophyll-a influence on the quantity of fish caught in the waters of Sadeng, Yogyakarta, Indonesia

[1]Priyantini Dewi, [2]Sutarjo, [1]Maman Hermawan, [1]Yusrizal, [3]Mira Maulita, [1]Bongbongan Kusmedy, [1]Eli Nurlaela, [4]Sopiyan Danapraja, [1]Erick Nugraha

[1] Faculty of Fishing Technology, Jakarta Technical University of Fisheries, South Jakarta, Indonesia; [2] Fleet Monitoring and Operation, Directorate General of Marine and Fisheries Resources Surveillance, Jakarta, Indonesia; [3] Faculty of Aquatic Resources Management, Jakarta Technical University of Fisheries, South Jakarta, Indonesia; [4] Faculty of Fisheries Extension, Jakarta Technical University of Fisheries, South Jakarta, Indonesia; Corresponding author: E. Nugraha, nugraha_eriq1@yahoo.co.id

Abstract. Oceanographic factors can be an indicator in determining the potential of fishing areas. The sampling technique of Sea Surface Temperature (SST) and chlorophyll-a data in this study was carried out directly (in-situ) and using satellite image data that can be downloaded from NASA Ocean Color to obtain SST and chlorophyll-a data. The purpose of this study was to analyze the effect of SST and chlorophyll-a on the quantity of purse seine catches, based on multiple correlation tests and multiple linear regression analysis. Species of fish caught during the study included: yellowfin tuna *(Thunnus albacares),* skipjack tuna *(Katsuwonus pelamis),* dolphin fish *(Coryphaena hippurus),* starry triggerfish *(Abalistes stellaris)*, rainbow runner *(Elagatis bipinnulata),* scad mackerel *(Decapterus russelli)* and squid *(Loligo).* The SST was measured in-situ. In the waters of Sadeng, Yogyakarta, the SST is relatively homogeneous, ranging from 27° to 30.3°C. Data verification is carried out *ex-situ*, with the aim of testing the level of accuracy. Satellite image data was processed for as many as 26 sampling points. The relative error was of 5.63%. Correlation test results between SST variables, chlorophyll-a and catches in the waters of Sadeng, Yogyakarta were performed for the period April to May 2022. The analysis of the effect of SST and chlorophyll-a showed that SST had a weak effect, while chlorophyll-a had a significant effect on the catches), as indicated by their level of significance of 0.556 (>0.05) and 0.041 (<0.05), respectively. Meanwhile, if the test was carried out on the combination of SST and chlorophyll-a, the result would have a significance of 0.056, which means that the SST and chlorophyll-a variables together strongly influence the catch.
Key Words: Geographic Information System (GIS), satellite imagery, oceanography, MODIS.

Introduction. Sadeng waters which are included in FMA 573 have the potential as habitat for economically important fish such as skipjack tuna *(Katsuwonus pelamis)*, bigeye tuna *(Thunnus obesus),* yellowfin tuna *(Thunnus albacares),* mackerel tuna *(Euthynnus affinis),* mackerel scad *(Decapterus russelli)* and sardin *(Sardinella lemuru)* (Nikijuluw 2008; Wijopriono 2012; Wahyuningrum et al 2012; Jayawiguna et al 2019). Skipjack tuna *(Katsuwonus pelamis)* is the second largest commodity in the area (Anggraeni et al 2015; Ma'mun et al 2017). Its geographical condition favors Indonesia's biodiversity (Kusmana & Hikmat 2015). Hendiarti et al 2004 explained that Sea Surface Temperature (SST) can affect the metabolism and reproduction of organisms in the sea. The distribution of SST is very important to know because it can provide information about the front, upwelling, currents, weather/climate and fishing ground (Abidin et al 2020). Sidik et al (2015) and Azizah et al (2020) explained that the influence of SST on the growth of phytoplankton will indirectly affect the concentration of chlorophyll-a in waters. According to Alfajri et al (2017), the Aqua satellite created by NASA functions as an observation satellite in the marine field. The Aqua-Modis satellite can measure various types of water parameters, one of which is SST in the waters. Oceanographic factors that are often associated with catches are SST and chlorophyll-a (Hastuti et al 2021).

Based on the discussion above and given the lack of research on SST and chlorophyll-a influence on the catch number in Sadeng waters, we researched if there is a relationship between these variables. The results of this study are expected to help fishermen to determine fishing areas, based on oceanographic parameters.

Material and Method

Description of the study sites. The research was conducted from March 18 to May 30 2022, by participating in activities of fishing by purse seine operating in the Indian Ocean. The research locations are as shown in Figure 1 below:

Figure 1. Map of fishing ground.

Method of collecting data. Data collection is done by collecting primary data and secondary data. Primary data concerned the fishing area position, the *in-situ* SST measured directly and the number of catches calculated for each trip. The secondary data were chlorophyll-a and SST images obtained by level 3 Aqua MODIS satellite imagery. Materials and tools used include: purse seine, GPS, compass, digital thermometer, software (.Excel, Seadas 7.5.3, Arcmap 10.8, SPSS), Camera, Chlorophyll-a Image, SST Image.

Data processing method. In processing MODIS data, SeaDas software is used. The results obtained are Aqua MODIS images at level 3, which produce SST values in degrees Celsius (°C) and chlorophyll-a (mg m^{-3}). Due to the relatively wider area, the projection system used is the Geographic Coordinate System (GCS) with the WGS84 datum. The processing of chlorophyll-a and SST values contained in the Aqua MODIS image map was carried out using the SeaDAS software. Data were filtered with Microsoft Excel, and a map of the distribution of chlorophyll-a and SST was made, using the IDW (Inverse Distance Weighted) analysis & the contouring menu, by interpolation, a simple deterministic method based on the surrounding points (Nurman 2010).

Data analysis method. Associative research methods were used with a quantitative approach to observe certain populations or samples (Sugiyono 2010). Analysis of the effect of SST and chlorophyll-a on the catch was tested by several methods including a verification test of satellite imagery data (ex-situ) and direct measuring (in-situ) data, a classical assumption test, and multiple linear regression analysis.

Results and Discussion

Catch production.
1. Catches number on the 1^{st} trip: The 1^{st} trip was held on 1 to 8 April 2022 by setting 9 times the gear, with the overall catch consisting of *T. albacares* (2,552 kg), *K. pelamis*

(3,023 kg), *D. russelli* (2,837 kg), *C. hippurus* (105 kg), *E. affinis* (337 kg) and *A. stellaris* (2,332 kg), with a total of 11,186 kg. The catches were dominated by *K. pelamis*.

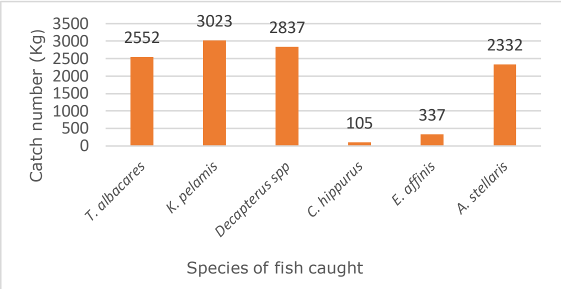


Figure 2. The number of catches on the 1st trip.

2. The number of catches of the 2nd trip: The 2nd trip was held on 10 to 16 April 2022 with 7 days of fishing operations or 7 settings. The catches of the 2nd trip consisted of *T. albacares* (2,002 kg), *K. pelamis* (5,237 kg), *D. russelli* (402 kg), *C. hippurus* (150 kg), *E. affinis* (644 kg), *A. stellaris* (38 kg), with a total of 8,473 kg. The catches on the 2nd trip were dominated by *T. albacares, K. pelamis,* and *D. russelli.*

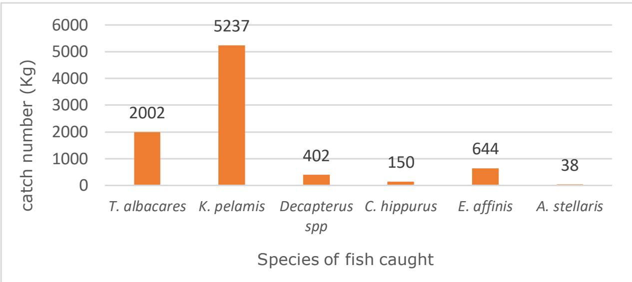


Figure 3. The number of catches on the 2nd trip.

3. The number of catches of the 3rd trip: The 3rd trip was held on 09 to 18 May 2022 with 10 days of catching and 10 settings. The catches on this trip were dominated by *K. pelamis*. The composition of the catch was: *T. albacares* (3,503 kg), *K. pelamis* (10,378 kg), *D. russelli* (5,866 kg), *C. hippurus* (143 kg), *Loligo* (497 kg), *E. bipinnulata* (154 kg), with a total of 20,541 kg.

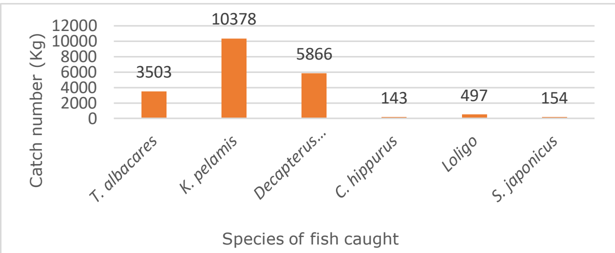


Figure 4. The catch of the 3rd trip.

Catch composition. In 3 trips with 26 catches, the catch was 40,200 kg. *K. pelamis* dominated with as much as 18,638 kg and an average of 716 kg per setting, the 2nd highest

catch was *D. russelli* with as much as 9,105 kg and an average of 350 kg per setting, and the 3rd was *T. albacares* with as much as 8,057 kg and an average per setting of 309 kg. Meanwhile, the lowest catches were *C. hippurus* with 398 kg and *E. bipinnulata* with 154 kg and an average of 15.3 kg and 5.9 kg, respectively, for each setting. Table 1 shows the composition of the catching trips:

Table 1

Fish composition and catch number

Species	*Catch number (Kg)*			Total	*Average*	*Percentage (%)*
	Trip 1	*Trip 2*	*Trip 3*			
T. albacares	2,552	2,002	3,503	8,057	309	20
K. pelamis	3,023	5,237	10,378	18,638	716	46.3
D. russelli	2,837	402	5,866	9,105	350	22.6
C. hippurus	105	150	143	398	15.30	1
A. stellaris	2,332	38	0	2,370	91.15	5.9
E. affinis	337	644	0	981	37.73	2.5
E. bipinnulata	0	0	154	154	5.92	0.4
Loligo	0	0	497	497	19.11	1.3

The diagram in Figure 6 synthesizes the composition if the fish species caught.

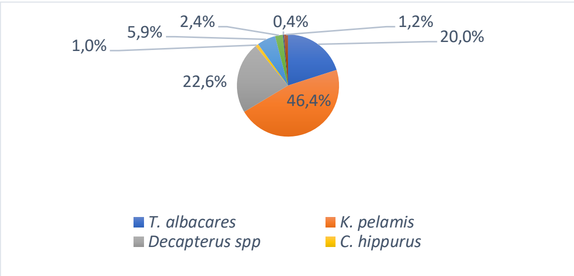


Figure 6. The composition of the caught fish species.

Distribution of Sea Surface Temperature (SST).

1. Distribution of SST in April 2022 for the 1st trip: The distribution of SST was observed to be stable, this can be seen from the 9 sampling points that were obtained during the 1st trip in April. Table 2 shows in-situ and ex-situ SST distribution values measured from 01 to 08 April 2022:

Table 2

The distribution of SST in Sadeng waters in April 2022, on the 1st trip

Date	*Position*		*SST (°C)*	
	Latitude (S)	*Longitude (T)*	*In-situ*	*ex-situ*
01/04/2022	08°42'14''	110°31'22''	27.0	31.7
02/04/2022	08°46'05''	110°33'36''	28.1	31.3
03/04/2022	08°51'00''	110°35'12''	28.0	31.3
03/04/2022	08°49'07''	110°36'05''	28.5	31.4
04/04/2022	08°52'07''	110°36'10''	29.0	31.5
05/04/2022	08°41'47''	110°33'00''	27.1	31.5
06/04/2022	08°38'05''	110°51'51''	26.7	31.2
07/04/2022	08°47'00''	110°34'00''	29.2	31.1
08/04/2022	08°43'12''	110°33'26''	30.1	31.7
	Average		28.1	31.4

Zulkhasyni (2015) stated that in general high SST occurs in the west season to the transition season, where the west season starts in September and ends in February, every year. The *K. pelamis* was caught at a temperature range of 29° to 30°C from November to March (Nugraha et al 2020). According to Yeka et al (2022), the potential area for catching *K. pelamis* has a close relationship with the environmental parameters, especially the chlorophyll-a, whose optimum ranges from 0.12 to 0.22 mg m^{-3}. SST in-situ of Sadeng waters in April 2022 ranged from 26.7° to 30.1°C. The highest SST occurred in April 8 2022, reaching 30.1°C, while the lowest temperature occurred on April 6, 2022, reaching 26.7°C. The average *in-situ* SST in April 2022 on the first trip was 28.1°C and the average *ex-situ* temperature was 31.4°C, as illustrated in Figure 6..

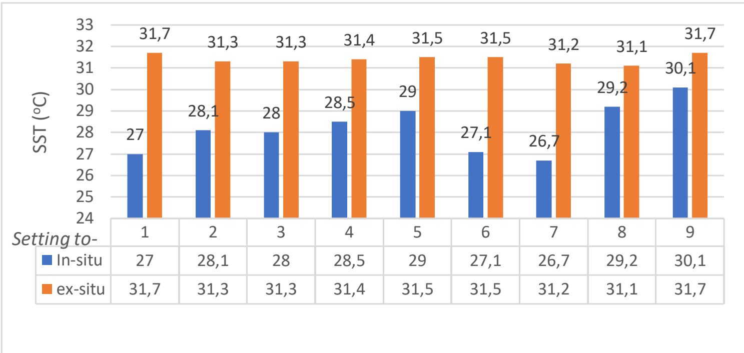


Figure 6. SST distribution in the 1st trip.

The highest number of catches occurred at the setting 9, with a total of 2,121 kg, at a high SST, reaching 30.1°C, while the least catch occurred at the setting 1, with a total catch of 345 kg, at a lower SST, of 27°C. This shows that in April 2022 if the SST value is high, the number of catches will be high and vice versa if the SST is low, the number of catches will also be low. The comparison of SST with the number of catches in April 2022 can be seen in Figure 7 below:

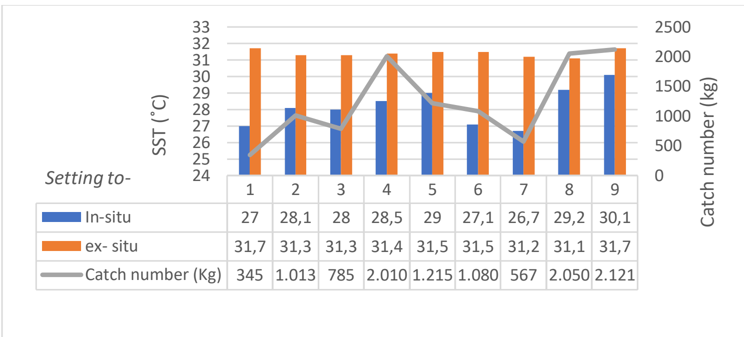


Figure 7. Comparison of SST with catch number in April 2022 on the 1st trip.

2. Distribution of the SST in April 2022 for the 2nd trip: This month, the SST data collection method was carried out in-situ and ex-situ at 7 points of the fishing ground, as observed in Table 3.

Table 3

The distribution of SST in Sadeng waters in April 2022 on the 2nd trip

Date	*Position*		*SST (°C)*	
	Latitude (S)	*Longitude (E)*	*in-situ*	*ex-situ*
10/04/2022	08°36'38"	110°38'20"	30.2	31.7
11/04/2022	08°37'44"	110°29'54"	29.7	29.9
12/04/2022	08°35'20"	110°34'19"	27.5	30.1
13/04/2022	09°05'52"	110°09'27"	29.8	30.1
14/04/2022	08°32'25"	110°35'24"	28.5	30.1
15/04/2022	08°30'37"	110°38'14"	30.1	30.3
16/04/2022	08°30'25"	110°32'43"	28.3	29.4
Average			29.1	30.2

Based on the data above, it can be seen that for all 7 sampling points, the SST distribution in April 2022 looks stable, ranging from 27.5 to 30.2°C. The highest temperature increase occurred on 10th of April 2022, reaching 30.2°C, while the lowest temperature occurred on April 12th of 2022, with a temperature reaching 27.5°C. The in-situ average in April 2022, on the 2nd trip, was 29.1°C and the ex-situ average was 30.2°C.

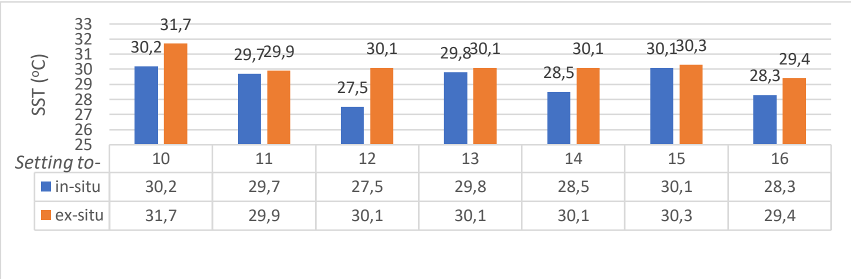


Figure 8. SST distribution on the 2nd trip.

In Figure 9, the comparison of the SST value with the catch in April 2022 shows that the highest of catch number occurred in the 12th setting, with as much as 2,053 kg, at an SST value reaching 27.5°C. Meanwhile, the smallest number of catches occurred in the 11th setting, with as much as 566 kg and an SST reaching 29.7°C. This shows that in April 2022, if the SST is high then the catch decreases and conversely, if the SST is low then the catch number is high, inversely proportional to the 1st trip.

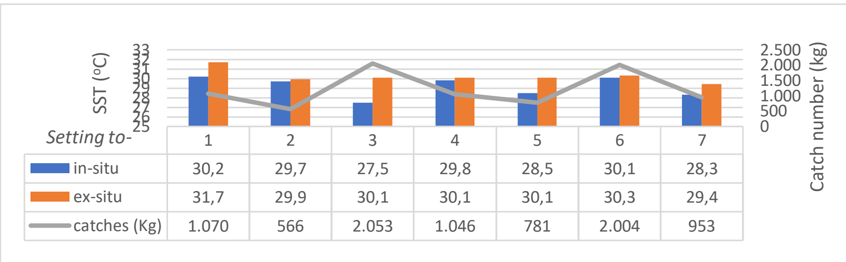


Figure 9. Comparison of the SST value and the catch quantity in April 2022, on the 2nd trip.

3. Distribution of the SST in May 2022, for the 3rd trip: In May 2022 the sampling point method was carried out directly on the satellite imagery, 10 times, as shown in Table 4:

Table 4

The distribution of SST in Sadeng waters in May 2022, on the 3rd trip

Date	*Position*		*SST (°C)*	
	Latitude (S)	*Longitude (E)*	*in-situ*	*ex-situ*
09/05/2022	08°28'50''	110°08'51''	28.2	30.3
10/05/2022	08°44'19''	110°25'58''	29.1	29.7
11/05/2022	08°46'04''	110°54'56''	30.2	29.6
12/05/2022	09°09'10''	110°16'09''	30.3	30.3
13/05/2022	09°41'15''	109°59'03''	28.6	29.5
14/05/2022	09°27'33''	109°54'56''	27.7	28.8
15/05/2022	08°57'29''	110°06'22''	28.3	29.1
16/05/2022	08°46'14''	110°37'47''	27.7	30.1
17/05/2022	08°43'39''	110°46'36''	27.6	30.2
18/05/2022	08°33'23''	110°34'50''	28.3	28.5
	Average		28.6	29.6

Based on Table 4 and Figure 10, SST fluctuations occurred in May 2022. The SST distribution was stable, ranging from 27.6 to 30.3°C. The highest SST occurred on 12 May 2022, reaching 30.3°C, while the lowest SST, of 27.6°C, occurred on 17 May 2022. The average SST in-situ in May, on the 3rd trip, was 28.6°C and the ex-situ average was 29.6ºC.

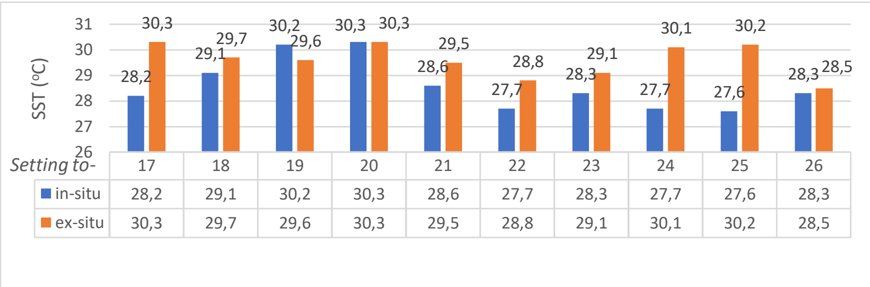


Figure 10. SST distribution in the 3rd trip.

In Figure 11, the comparison of SST with the highest catches number in May 2022, occurred at the setting 23, with a total of 5,045 kg, at a high SST value of 28.3°C. The lowest catches number on the 3rd trip occurred at the 25th setting, with a total of 641 kg and a SST reaching 27.6°C. Based on the previous findings, it can be concluded that in May 2022 if the SST is high, the catches number is high and if the SST is low, the catches number is low too.

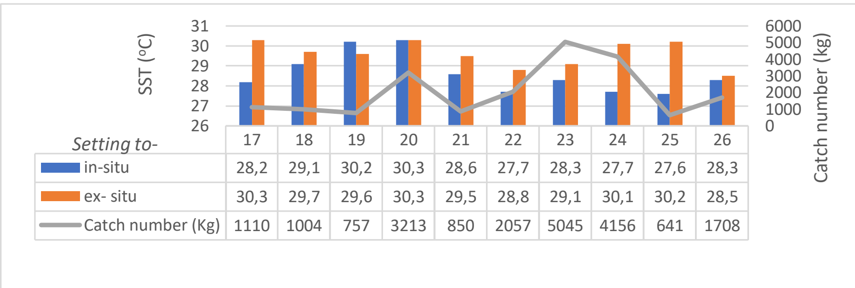


Figure 11. Comparison of SST with the catches number in May 2022 on the 3rd trip.

Chlorophyll-a concentration. One of the waters fertility factors is the availability of chlorophyll-a in the waters. According to Nufus et al (2017) the fertility level of coastal waters can be assessed from the biological and chemical characteristics, especially from the availability of essential nutrients. Based on the Table 5, the concentration of chlorophyll-a in Sadeng waters tends to experience fluctuations.

Table 5

Concentration of chlorophyll-a in Sadeng waters in 2017 to 2021

Period (Month/year)	*chlorophyll-a (mg m^{-3})*				
	2017	*2018*	*2019*	*2020*	*2021*
April	0.38	0.33	0.58	0.28	0.39
May	0.40	0.73	0.76	0.34	0.41

The highest value of chlorophyll-a, 0.76 mg m^{-3}, occurred in May 2019, while the lowest value occurred in April 2020, with a value of 0.28 mg m^{-3}, as observed in Figure 12. The high and low values of chlorophyll-a are influenced by the nutrients content in the waters, which is also closely related to the abundance of phytoplankton. If the nutrients in the waters are abundant, the chlorophyll-a value will also be high. In addition, other factors that can affect the level of chlorophyll-a in waters are the temperature and salinity.

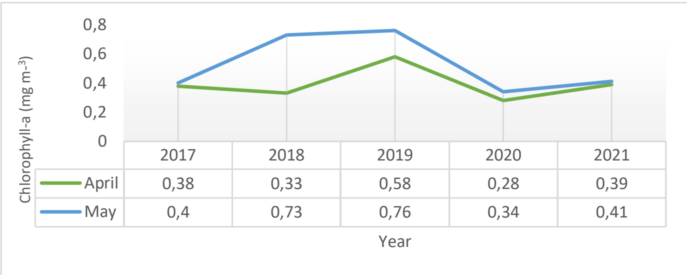


Figure 12. Chlorophyll-a concentration in 2017–2021.

1. Concentration of chlorophyll-a in April 2022, on the 1st trip: The distribution of chlorophyll-a concentration in April seemed to fluctuate. This can be seen from the 9 sampling points obtained from the NASA Ocean Color level 3, with a daily period, as it can be seen in Table 6.

Table 6

The concentration of chlorophyll-a in Sadeng waters in April 2022 for the 1st trip

Date	*Position*		*Chlorophyll-a (mg m^{-3})*	*Catch number (kg)*
	Latitude (S)	*Longitude (E)*		
01/04/2022	08°42'14''	110°31'22''	0.13	345
02/04/2022	08°46'05''	110°33'36''	0.15	1,013
03/04/2022	08°51'00''	110°35'12''	0.15	785
03/04/2022	08°49'07''	110°36'05''	0.12	2,010
04/04/2022	08°52'07''	110°36'10''	0.15	1,215
05/04/2022	08°41'47''	110°33'00''	0.14	1,080
06/04/2022	08°38'05''	110°51'51''	0.14	567
07/04/2022	08°47'00''	110°34'00''	0.15	2,050
08/04/2022	08°43'12''	110°33'26''	0.13	2,121
	Average		0.14	1,242

Based on Table 6 above, at the 9 sampling points observed during this trip, the highest increase in the value of chlorophyll-a occurred on 1st April 2022 with a concentration value of 0.15 mg m^{-3}. Meanwhile, the lowest chlorophyll-a value occurred on April 3rd 2022, with a chlorophyll-a concentration value of 0.12 mg m^{-3}. The average concentration of chlorophyll-a on the 1st of April trip was 0.14 mg m^{-3}.

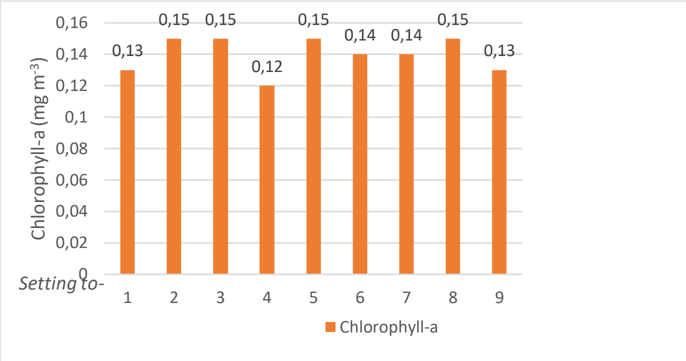
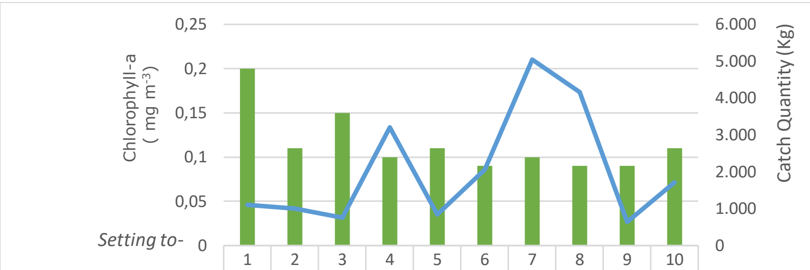


Figure 13. Chlorophyll-a concentration in April 2022, on the 1st trip.

In Figure 14 the comparison of the value of chlorophyll-a and the catches number in April 2022 shows that the highest catches number occurred in the 8th setting, with a total of 2,050 kg, at a high concentration of chlorophyll-a, of 0.15 mg m^{-3}. Meanwhile, the smallest catch number on the 1st trip occurred in the first setting, with the amount of 345 kg where the chlorophyll-a concentration value reached 0.13 mg m^{-3}. It can be concluded that in April 2022, if the concentration of chlorophyll-a is high then the catches number is high. Conversely, if the chlorophyll-a is low then the catches number is also low.



Setting to-	1	2	3	4	5	6	7	8	9	10
Chlorophyll-a	0,2	0,11	0,15	0,1	0,11	0,09	0,1	0,09	0,09	0,11
Catch number (kg)	1.110	1.004	757	3.213	850	2.057	5.045	4.156	641	1.708

Figure 14. Comparison graph of chlorophyll-a value with the catches quantity on the 1st April 2022 trip.

1. Concentration of chlorophyll-a in Sadeng waters in April 2022 on the second trip: In April 2022, we considered 7 sampling points during the fishing operations; data were obtained from the NASA Ocean Color satellite (NASA 2007). The detailed chlorophyll-a concentration values can be seen in Table 7:

Table 7
The concentration of chlorophyll-a in Sadeng waters in April 2022, for the second trip

Date	*Position*		*chlorophyll-a (mg m-^{3})*	*Catches number (kg)*
	Latitude (S)	Longitude (T)		
10/04/2022	08°36'38"	110°38'20"	0.11	1,070
11/04/2022	08°37'44"	110°29'54"	0.12	566
12/04/2022	08°35'20"	110°34'19"	0.11	2,053
13/04/2022	09°05'52"	110°09'27"	0.12	1,046
14/04/2022	08°32'25"	110°35'24"	0.10	781
15/04/2022	08°30'37"	110°38'14"	0.11	2,004
16/04/2022	08°30'25"	110°32'43"	0.09	953
Average			0.10	1,210

Figure 15 is a graph of the results of the 7 sampling points taken during the 2nd trip:

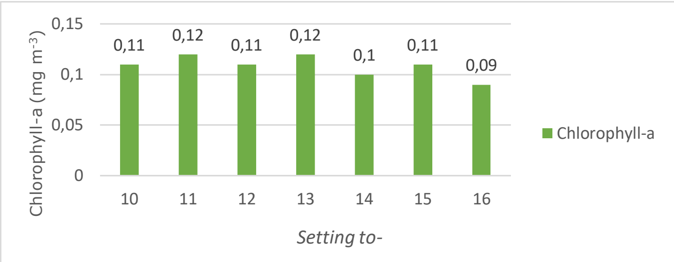


Figure 15. chlorophyll-a value in April 2022, on the 2nd trip.

Based on the data above, it can be seen that from 7 sampling points taken during this trip, the highest increase in the value of chlorophyll-a occurred on April 13th 2022, with a concentration value of 0.12 mg m^{-3}. Meanwhile, the lowest chlorophyll-a value occurred on April 16th 2022, with a chlorophyll-a concentration value of 0.09 mg m^{-3}. The average concentration of chlorophyll-a in April, at the 1st fishing operation trip, was of 0.10 mg m^{-3}.

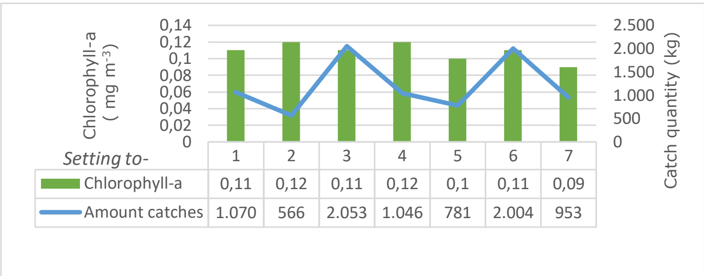


Figure 16. Comparison of the value of chlorophyll-a with the catches quantity, on the 2nd April 2022 trip.

In Figure 16 the comparison of the value of chlorophyll-a and the catch number in April 2022 shows that the highest catch number occurred at the 15th setting, with a total of ~~2,004~~2,053 kg, inversely proportional to the chlorophyll-a concentration (0.11 mg m^{-3}, the lowest value). The smallest catch on the 2nd fishing operation trip occurred at the 11th setting, with the amount of 566 kg, when the value of chlorophyll-a concentration was the highest (0.12 mg m-^{3}). From the findings above, it can be concluded that in April the catch quantities are inversely proportional to the values of chlorophyll-a concentrations.

Commented [WU1]: THE HIGHEST VALUE IS 2,053, NOT 2,004

Commented [AV2R1]: Corrected. Thank you

1. Concentration of chlorophyll-a in Sadeng waters in May 2022 on the third trip: The concentration of chlorophyll-a in May 2022 was observed to be stable, ranging from 0.09 to 0.15 mg m^{-3}. In May 2022, 10 sample points were taken using the satellite imagery obtained from NASA Ocean Color. The concentration of chlorophyll-a in Sadeng waters in May 2022 is presented in Table 8.

Table 8

The concentration of chlorophyll-a in Sadeng waters in May 2020, for the 3rd trip

Date	*Position*		*Chlorophyll-a (mg m^{-3})*	*Catch number (kg)*
	Latitude (S)	*Longitude (T)*		
09/05/2022	08°28'50"	110°08'51"	0.20	1,110
10/05/2022	08°44'19"	110°25'58"	0.11	1,004
11/05/2022	08°46'04"	110°54'56"	0.15	757
12/05/2022	09°09'10"	110°16'09"	0.10	3,213
13/05/2022	09°41'15"	109°59'03"	0.11	850
14/05/2022	09°27'33"	109°54'56"	0.09	2,057
15/05/2022	08°57'29"	110°06'22"	0.10	5,045
16/05/2022	08°46'14"	110°37'47"	0.09	4,156
17/05/2022	08°43'39"	110°46'36"	0.09	641
18/05/2022	08°33'23"	110°34'50"	0.11	1,708
	Average		0.11	2,054

The data was synthesized in Figure 17:

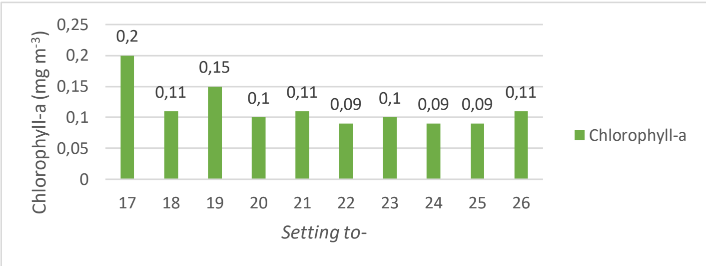


Figure 17. Chlorophyll-a concentration in May 2022, on the 3rd trip.

In Table 8 and Figure 17, it can be observed that the concentration of chlorophyll-a fluctuates in May. The highest chlorophyll-a value occurred on 11th of May 2022, of 0.15 mg m^{-3}, while the lowest chlorophyll-a value occurred on 14th, 16th, and 17th of May 2022, of 0.09 mg m^{-3}. The average concentration of chlorophyll-a in April 2022, on the fourth fishing operation trip, was 0.11 mg m^{-3}.

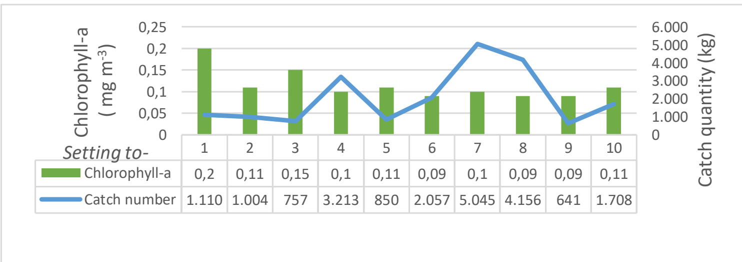


Figure 18. Comparison of chlorophyll-a concentration with the catching quantity in May 2022.

In Figure 18 the comparison of the value of chlorophyll-a and the catching quantity in May 2022 shows that the highest quantity of catches occurred at the setting 23, with a total of 5,045 kg, at a high concentration of chlorophyll-a, with a value of 0.10 mg m^{-3}. Meanwhile, the smallest catch number on the 1st fishing operation trip occurred at the 25th setting, with a total of 641 kg where the chlorophyll-a concentration value reached 0.09. Based on the previous findings, it can be concluded that in May, if the concentration of chlorophyll-a is high then the catch number is high or conversely, if the chlorophyll-a is low then the catch number is also low.

SST data is obtained based on the analysis of MODIS images. The data is then verified against the measurements. The verification results are shown in Table 9:

Table 9

Verification of in-situ SST data with satellite imagery

No. setting	*Data in-situ*	*Data ex-situ*	*Value of error (%)*
1	27.0	28.28	4.92
2	28.1	28.28	0.69
3	28.0	28.29	1.12
4	28.5	26.78	6.69
5	29.0	27.42	6.08
6	27.1	27.39	1.12
7	26.7	28.18	5.69
8	29.2	25.7	13.46
9	30.1	26.98	12.00
10	30.2	28.28	7.38
11	29.7	26.08	13.92
12	27.5	26.21	4.96
13	29.8	27.66	8.23
14	28.5	27.53	3.73
15	30.1	28.04	7.92
16	28.3	27.56	2.85
17	28.2	27.11	4.19
18	29.1	28.4	2.69
19	30.2	28.32	7.23
20	30.3	27.41	11.12
21	28.6	26.13	9.50
22	27.7	28.86	4.46
23	28.3	28.33	0.12
24	27.7	28.56	3.31
25	27.6	27.01	2.27
26	28.3	28.48	0.69
Mean relatives error	28.61	27.59	5.63

According to Fadika et al (2014), data verification is done by calculating the MRE. In-situ SST data verification against the Aqua MODIS satellite image data, at 26 sampling points, shows that the average relative error value is 5.63%. This value is included in the correct category, where the resulting value is no more than 30%. Jaelani et al (2013) in their journal stated that values with an average relative error of less than 30% in image data processing can be used for further analysis. Based on the previous statement, it can be concluded that the SST satellite image data can be further analyzed because it has an accuracy of 91.89%. According to Simanjuntak et al (2012), among the factors that cause errors in the satellite image datais a reading error at the time of observation.

Analysis of the effect of SST and chlorophyll-a on the total catch.

1. Normality test.

The normality test is part of the data analysis requirements. It is a classical assumption test: before performing a statistical analysis to test the hypothesis, a

regression analysis is used to determine whether the residual values are normally distributed or not. The residual is normally distributed if the significance is more than 0.05 (Gunawan 2020).

In Table 10, the test results, obtained with the SPSS software, can be seen. The asymptotic normality obtained had the significance value (sig.)0.200 (>0.05), so the residual values can be considered as normally distributed.

Table 10

Normality test

One-Sample Kolmogorov-Smirnov Test		
		Unstandardized residual
N		26
Normal Parameters[a,b]	Mean	.0000000
	Std. deviation	1016.50300169
Most extreme differences	Absolute	.108
	Positive	.108
	Negative	-.071
Test statistic		.108
Asymp. Sig. (2-fish)		.200[c,d]

[a] Test distribution is Normal; [b] Calculated from data; [c] Lilliefors Significance Correction; [d] This is a lower bound of the true significance.

The basis for decision making in the K - S Normality test is as follows:
- If the significance value (sig.) >0.05 then the data is normally distributed. On the contrary,
- If the significance value (sig.) <0.05, then the data is not normally distributed.

2. Linearity Test

In Table 11 of the SST - catches relationship's Deviation from Linearity, the significance value (sig.) obtained is 0.868, greater than 0.05. So it can be concluded that there is a significant linear relationship between the SST variable (X) and the number of catches (Y).

Table 11

Linearity test of the catch number with SST

ANOVA Table							
			Sum of squares	df	Mean square	F	Sig.
Catches * SST	Between groups	(Combined)	21329060.787	19	1122582.147	0.539	0.858
		Linearity	1812590.669	1	1812590.669	0.870	0.387
		Deviation from linearity	19516470.118	18	1084248.340	0.521	0.868
	Within groups		12497302.667	6	2082883.778		
	Total		33826363.454	25			

In Table 12 of the Chlorophyll-a catches relationship's Deviation from Linearity, the significance value is 0.889, greater than 0.05. So it can be concluded that there is a significant linear relationship between the chlorophyll-a variable (X) and the catch number (Y).

Table 12

Linearity test of total catch with chlorophyll-a

			Sum of squares	*df*	*Mean square*	*F*	*Sig.*
			ANOVA table				
Catches * Chlorophyll-a	Between groups	(Combined)	10614882.479	7	1516411.783	1.176	0.364
		Linearity	7753006.461	1	7753006.461	6.012	0.025
		Deviation from linearity	2861876.018	6	476979.336	0.370	0.889
	Within groups		23211480.975	18	1289526.721		
	Total		33826363.454	25			

The basis for decision making in the linearity test by comparing the significance value is as follows:

- If the value of Deviation from Linearity sig.>0.05, then there is a significant linear relationship between the independent variable and the dependent variable.
- If the value of Deviation from linearity sig.<0.05, then there is no significant linear relationship between the independent variable and the dependent variable.

3. Multicollinearity test

The multicollinearity test was used to test whether the regression model found a correlation between the independent variables. If a correlation exists, then there is a multicollinearity (multico) problem (Gunawan 2020). Multicollinearity is detected by examining the Variance Inflation Factor (VIF) value and tolerance, with reference to certain conditions: if the VIF value is less than 10 and the tolerance is more than 0.1, it is considered that there is no multicollinearity (Gunawan 2020).

In Table 13, it is shown that the value of the collinearity tolerance of the two variables is 0.90, more than 0.10, and the VIF statistic value of 1.11 is less than 10.

Table 13

Multicollinearity Test

Model		*Unstandardized coefficients*		*Standardized coefficients*	*t*	*Sig.*	*Collinearity statistics*	
		Coefficients[a]						
		B	*Std. Err.*	*Beta*			*Tolerance*	*VIF*
1	(Constant)	2421.912	998.784		2.425	0.024		
	SST	1.219	2.630	0.089	0.464	0.647	0.900	1.111
	Chlorophyll-a	-117.383	50.033	-0.451	-2.346	0.028	0.900	1.111

[a] Dependent variable: Catch number

So it can be concluded that the data above does not occur multicollinearity between independent variables. The basis for making decisions on the multicollinearity test with tolerance is as follows:

- If the tolerance value is greater than 0.10, it means that there is no multicollinearity in the regression model.
- If the tolerance value is less than 0.10, it means that there is multicollinearity in the regression model.

4. Heteroscedasticity Test

The heteroscedasticity test aims to test whether in the regression model there is an inequality of variance from one observation to another. A good regression model is one without heteroscedasticity or with homoscedasticity (Gunawan 2020).

Based on Table 14, it can be observed that the significance value (sig.) for the SST variable (X_1) is 0.811, while the significance value (sig.) for the chlorophyll-a variable (X_2) is 0.089.

Commented [WU3]: [a] must be defined

Commented [AV4R3]: added. Thank you.

Formatted: Justified

Table 14

Heteroscedasticity test

Coefficients[a]						
Model		*Unstandardized coefficients*		*Standardized coefficients*	*t*	*Sig.*
		B	*Std. Error*	*Beta*		
1	(Constant)	2825.294	3687.361		0.766	0.452
	SST	-30.753	126.844	-0.048	-0.242	0.811
	Chlorophyll-a	-9494.419	5333.793	-0.354	-1.780	0.089

a Dependent variable: Catch number

Because the significance value of the two variables above is greater than 0.05, according to the basis for decision making in the Glejser test, it can be concluded that there is no symptom of heteroscedasticity. The basis for decision making in the heteroscedasticity test, using the Glejser conditions, is as follows:

- If the significance value (Sig.) is greater than 0.05, then the conclusion is that there is no heteroscedasticity symptom in the regression model.
- On the other hand, if the significance value (sig.) is less than 0.05, the conclusion is that heteroscedasticity is occurring.

5. Multiple linear regression

This analysis is used to measure the magnitude of the influence between the independent and dependent variables. There are several eligibility requirements that must be met when regression analysis is used, namely: the number of samples used must be the same, the number of independent variables is 1, the residual value must be normally distributed, there is a linear relationship, there are no symptoms of heteroscedasticity.

Based on Table 15, it is explained that the correlation coefficient (R) of 0.471 between the variables sea surface temperature and chlorophyll-a with the catch means that there is a very strong positive relationship between SST and chlorophyll-a with the fish catch.

Table 15

Model summary

Model summary				
Model	*R*	*R Square*	*Adjusted R square*	*Std. Error of the estimate*
	.471[a]	0.221	0.154	1036.89027

[a] Predictors: (Constant), Chlorophyll-a, SST.

Meanwhile, the R square coefficient obtained is 0.221 or 22%, meaning that the independent variables (SST and chlorophyll-a) affect the Y variable (catch) by 22% while the rest of the catch is influenced by other variables.

Based on Table 16, it is observed that the coefficient test of the SST variable produces $t_{count} < t_{table}$ (0.598 < 2.069) and the significance value obtained is 0.556 (Sig > 0.05) so that SST only weakly affects the catch.

Table 16

t_{test}

Coefficients[a]						
Model		*Unstandardized coefficients*		*Standardized coefficients*	*t*	*Sig.*
		B	*Std. Error*	*Beta*		
1	(Constant)	2262.186	977.214		2.315	0.030
	SST	1.539	2.573	0.116	0.598	0.556
	Chlorophyll-a	-106.246	48,.953	-0.421	-2.170	0.041

[a] Dependent variable: Cathes. number.

Commented [WU5]: [a] must be defined

Commented [AV6R5]: added. Thank you

Meanwhile, by testing the coefficient of chlorophyll-a variable, it was found that $t_{count} > t_{table}$ (2.170>2.069), with a significance value of 0.041 (Sig<0.05) so that it is known thatchlorophyll-a has a strong influence on the catch.

$$Y = 2262,.186 + 1,.539\ X_1 + (-)106,.246\ X_2$$

Commented [WU7]: Correct the sign: it is either + or -. Explain how you decided

Commented [AV8R7]: Corrected thank you

The above equation describes the effect of changing the values of the independent variables, in the regression algorithm. The interpretation is as follows:

~~a. Each change by one unit in X_1 and X_2 produces an increase of 2262.186 units.~~
~~b. Every change by 1 degree in SST (X_1) results in an increase of 1,539 in the catch (Y).~~
~~c. Each change of 1 mg m^{-3} in chlorophyll-a (X_2) results in an increase of 106.246 in the catch (Y).~~

a. Every one - unit change of X_1 and X_2 is 2262,.186 unit.
b. Every 1 degree change in SST (X_1) results in an increase of 1,.539 in the catch (Y).
c. Every 1 mg m^{-3} in chlorophyll-a (X_2) results in an increase of 106,.246 in the catch (Y).

Commented [WU9]: What kind of change? Increase or decrease?

Commented [AV10R9]: Corrected.tks

Commented [WU11]: What kind of change? Increase or decrease?

Commented [AV12R11]: Corrected. tks

Commented [WU13]: Why is the coefficient negative?

Commented [AV14R13]: Corrected. Tks.

In Table 17, able it can be observed that $F_{count} < F_{table}$ (3.271<3.40), while the significance value obtained is 0.056 (Sig>0.05), so it can be concluded that there is an influence between the combined SST and chlorophyll-a variables on the catch quantities.

Table 17

Significance test (f_{test})

Model		*Sum of squares*	*df*	*Mean square*	*F*	*Sig.*
	Regression	7034292.282	2	3517146.141	3.271	.056[b]
1	Residual	24728253.103	23	1075141.439		
	Total	31762545.385	25			

ANOVA[a]

[a] Dependent variable: Catch number; [b] Predictors: (Constant), Chlorophyll-a, SST.

Conclusions. The results of the significance test showed that SST had a partial influence on the catch number, while chlorophyll-a had a significant effect on the catch quantity. Meanwhile, if the test was carried out simultaneously, the results would obtaine a significance of 0.056, which means that the combined SST and chlorophyll-a have an influence on the catch quantities.

Conflict of interest. The authors declare no conflict of interest.

References

Abidin A. F., Amron, Marzuki M. I., 2020 Relationship between chlorophyll-a and sea surface temperarure to tuna catch in the Southern Water of Java. Science Research Journal 22(2):55-68.

Alfajri A., Mubarak M., Mulyadi A., 2017 [Spatial and Temporal analysis of sea surface temperature distribution in West Sumatra waters]. Indonesian Environmental Dynamics 4(1): 65-74. [In Indonesian].

Anggraeni R., Solichin A., Saputra S. W., 2015 [Several biological aspects of skipjack tuna (*Katsuwonus pelamis*) in relation to fisheries management in PPP Sadeng, Gunungkidul Regency, Yogyakarta]. Management of Aquatic Resources Journal (MAQUARES) 4(3):230-239. [In Indonesian].

Azizah A., Wibisana H., 2020 [Temporal analysis of sea surface temperature distribution from 2018 to 2020 with Terra Modis image data]. Marine Journal: Indonesian Journal of Marine Science and Technology 13(3):196–205. [In Indonesian].

Fadika U., Rifai A., Rochaddi B., 2014 [Seasonal wind direction and speed and its relation to the distribution of sea surface temperature in Southern Pangandaran, West Java]. Journal of Oceanography 3(3):429–437. [In Indonesian].

Gunawan C., 2020 [Proficient in Mastering SPSS Practical Guide to Processing Research Data (Deeppublish)]. Deepublish, Yogyakarta 210 p. [In Indonesian].
Hastuti, Wirasatriya A., Maslukah L., Subardjo P., Kunarso, 2021 [The Effect of chlorophyll-a factors and sea surface temperature on anchovy catches (*Stelesphorus* sp) in Jepara]. Indonesian Journal of Oceanography 3(2):1-9. [In Indonesian].
Hendiarti N., Ohde T., 2004 Investigation of different processes in Indonesian waters using SeaWiFS data. Deep Sea Research Part II Topical Studies in Oceanography 51(1-3):85-97.
Jaelani L. M., Matsushita B., Yang W., Fukushima T., 2013 Evaluation of four MERIS atmospheric correction algorithms in Lake Kasumigaura, Japan. International Journal of Remote Sensing 34(24):8967–8985.
Jayawiguna M. H., Triyono, Wibowo S., 2019 [Overview of the potential, development and challenges of utilizing marine and fishery resources at FMA-RI 573]. AMAFRAD Press p. 3-10. [In Indonesian].
Kusmana C., Hikmat A., 2015 The biodiversity of flora in Indonesia. Journal of Natural Resources and Environmental Management 5(2):187–198.
Ma'mun A., Priatna A., Hidayat T., Nurulludin. 2017 Distribution and potential resources of pelagic fish in Fisheries Management Area of the Republic of Indonesia (FMA-RI 573) Indian Ocean. Indonesian Fisheries Research Journal (JPPI) 23:47–56.
Nufus H., Karina S., Agustina S., 2017 [Analysis of chlorophyll-a distribution and water quality in the Krueng Raba Lhoknga River, Aceh Besar]. Scientific Journal of Marine and Fisheries Students Unsyiah 2(1):58–65. [In Indonesian].
Nugraha E., Gunawan R., Danapraja S., Yusrizal, Kusdinar A., Waluyo A. S., Hutajulu J., Prayitno H., Halim S., Sutisna D. H., 2020 The sea surface temperature effect on the length and size of skipjack tuna (*Katsuwonus pelamis*) catches in the Banda Sea, Indonesia. AACL Bioflux 13(1):1-18.
Nikijuluw V., 2008 [The status of Indian Ocean tuna resources and its implications for Indonesia]. Journal of Indonesian Fisheries Policy 1(1):31-44. [In Indonesian].
Nurman A., 2010 [Utilization of fashionable data to detect fishing areas on the East and West Coasts of North Sumatra]. Journal of Geography 2(2):17-30. [In Indonesian].
Sidik A., Agussalim A., Ridho M. R., 2015 [The accuracy of the value of chlorophyll-a concentration and sea surface temperature using remote sensing data in the waters of Anggantang Island, Sembilang National Park]. Maspari 7(2):25–32. [In Indonesian].
Simanjuntak B. L., Handoyo G., Sugianto D. N., 2012 [Analysis of bathymetry and tidal components for determination of additional depth of jetty ponds in Tanjung Gundul Bengkayang Waters – West Kalimantan]. Journal of Oceanography 1(1):1-8. [In Indonesian].
Sugiyono, 2019 [Quantitative research methods]. Alphabet, 464 p. [In Indonesian].
Wahyuningrum P. I., Nurani T. W., Rahmi T. A., 2012 [Multi purpose capture fishery business in Sadeng, Gunungkidul Regency, Special Region of Yogyakarta]. Maspari Journal 4(1):10-22. [in Indonesian].
Wijopriono. 2012 [The carrying capacity of tuna fisheries resources in the Indian Ocean in relation to fisheries industrialization]. Journal of Indonesian Fisheries Policy 4(2):101-108. [In Indonesian].
Yeka A., Monika D., Rahmani R. M., Sarianto D., Fitri Y., Nurlaela E., Kusmedy B., Nugraha E., Hutajulu J., 2022 The effect of chlorophyll-a on the catches of skipjack tuna (Katsuwonus pelamis) in Banda Sea, Maluku, Indonesia. AACL Bioflux 15(3):1226-1237.

Received: 23 August 2021. Accepted:. Published online:.
Authors:
Priyantini Dewi, Jakarta Technical University of Fisheries, Faculty of Fishing Technology, AUP Street Pasarminggu 12520, South Jakarta, Indonesia, e-mail: prizt.dewi@gmail.com
Sutarjo, Jakarta Technical University of Fisheries, Faculty of Fishing Technology, AUP Street Pasarminggu 12520, South Jakarta, Indonesia, e-mail: sutarjoz79@gmail.com
Maman Hermawan, Jakarta Technical University of Fisheries, Faculty of Fishing Technology, AUP Street Pasarminggu 12520, South Jakarta, Indonesia, e-mail: mhermawan60@gmail.com
Bongbongan Kusmedy, Jakarta Technical University of Fisheries, Faculty of Fishing Technology, AUP Street Pasarminggu 12520, South Jakarta, Indonesia, e-mail: bkhutapea@gmail.com
Yusrizal, Jakarta Technical University of Fisheries, Faculty of Fishing Technology, AUP Street Pasarminggu 12520, South Jakarta, Indonesia, e-mail: buyung_trc@yahoo.co.id
Mira Maulita, Jakarta Technical University of Fisheries, Faculty of Aquatic Resources Management, AUP Street Pasarminggu 12520, South Jakarta, Indonesia, e-mail: maulita.stp@gmail.com
Eli Nurlaela, Jakarta Technical University of Fisheries, Faculty of Fishing Technology, AUP Street Pasarminggu 12520, South Jakarta, Indonesia, e-mail: elimumtaza@gmail.com
Sopiyan Danapraja, Jakarta Technical University of Fisheries, Faculty of Fisheries Extension, AUP Street Pasarminggu 12520, South Jakarta, Indonesia, e-mail: sopiyanraja@gmail.com
Erick Nugraha, Jakarta Technical University of Fisheries, Faculty of Fishing Technology, AUP Street Pasarminggu 12520, South Jakarta, Indonesia, e-mail: nugraha_eriq1@yahoo.co.id

How to cite this article:
Dewi P., Sutarjo, Hermawan M., Kusmedy B., Yusrizal, Maulita M., Nurlaela E., Danapraja S., Nugraha E., 2023 Study of sea surface temperature and chlorophyll-a to the number of fish caught in the waters of Sadeng, Yogyakarta, Indonesia. AACL Bioflux

← Kembali

Arsipkan Pindahkan Hapus Spam •••

Eni Kovacs <ek.bioflux@gmail.com>
Kepada: erick nugraha

Kam, 5 Jan jam 16.02

Dear Dr. Nugarah,

There are some issues with the corrections we received. Thus, please take into account the requests of the reviewers.

Thank you.

> Tampilkan pesan asli

--
Kind regards,
Editor AACL Bioflux
Eniko Kovacs

Nugraha_S... .docx
1.3MB

Study of sea surface temperature and chlorophyll-a influence on the quantity of fish caught in the waters of Sadeng, Yogyakarta, Indonesia

[1]Priyantini Dewi, [2]Sutarjo, [1]Maman Hermawan, [1]Yusrizal, [3]Mira Maulita, [1]Bongbongan Kusmedy, [1]Eli Nurlaela, [4]Sopiyan Danapraja, [1]Erick Nugraha

[1] Faculty of Fishing Technology, Jakarta Technical University of Fisheries, South Jakarta, Indonesia; [2] Fleet Monitoring and Operation, Directorate General of Marine and Fisheries Resources Surveillance, Jakarta, Indonesia; [3] Faculty of Aquatic Resources Management, Jakarta Technical University of Fisheries, South Jakarta, Indonesia; [4] Faculty of Fisheries Extension, Jakarta Technical University of Fisheries, South Jakarta, Indonesia. Corresponding author: E. Nugraha, nugraha_eriq1@yahoo.co.id

Abstract. Oceanographic factors can be an indicator in determining the potential of fishing areas. The sampling technique of Sea Surface Temperature (SST) and chlorophyll-a data in this study was carried out directly (in-situ) and using satellite image data that can be downloaded from NASA Ocean Color to obtain SST and chlorophyll-a data. The purpose of this study was to analyze the effect of SST and chlorophyll-a on the quantity of purse seine catches, based on multiple correlation tests and multiple linear regression analysis. Species of fish caught during the study included: yellowfin tuna *(Thunnus albacares),* skipjack tuna *(Katsuwonus pelamis),* dolphin fish *(Coryphaena hippurus),* starry triggerfish *(Abalistes stellaris)*, rainbow runner *(Elagatis bipinnulata),* scad mackerel *(Decapterus russelli)* and squid *(Loligo).* The SST was measured in-situ. In the waters of Sadeng, Yogyakarta, the SST is relatively homogeneous, ranging from 27° to 30.3°C. Data verification is carried out *ex-situ*, with the aim of testing the level of accuracy. Satellite image data was processed for as many as 26 sampling points. The relative error was of 5.63%. Correlation test results between SST variables, chlorophyll-a and catches in the waters of Sadeng, Yogyakarta were performed for the period April to May 2022. The analysis of the effect of SST and chlorophyll-a showed that SST had a weak effect, while chlorophyll-a had a significant effect on the catches), as indicated by their level of significance of 0.556 (>0.05) and 0.041 (<0.05), respectively. Meanwhile, if the test was carried out on the combination of SST and chlorophyll-a, the result would have a significance of 0.056, which means that the SST and chlorophyll-a variables together strongly influence the catch.

Key Words: Geographic Information System (GIS), satellite imagery, oceanography, MODIS.

Introduction. Sadeng waters which are included in FMA 573 have the potential as habitat for economically important fish such as skipjack tuna *(Katsuwonus pelamis)*, bigeye tuna *(Thunnus obesus),* yellowfin tuna *(Thunnus albacares),* mackerel tuna *(Euthynnus affinis),* mackerel scad *(Decapterus russelli)* and sardin *(Sardinella lemuru)* (Nikijuluw 2008; Wijopriono 2012; Wahyuningrum et al 2012; Jayawiguna et al 2019). Skipjack tuna *(Katsuwonus pelamis)* is the second largest commodity in the area (Anggraeni et al 2015; Ma'mun et al 2017). Its geographical condition favors Indonesia's biodiversity (Kusmana & Hikmat 2015). Hendiarti et al 2004 explained that Sea Surface Temperature (SST) can affect the metabolism and reproduction of organisms in the sea. The distribution of SST is very important to know because it can provide information about the front, upwelling, currents, weather/climate and fishing ground (Abidin et al 2020). Sidik et al (2015) and Azizah et al (2020) explained that the influence of SST on the growth of phytoplankton will indirectly affect the concentration of chlorophyll-a in waters. According to Alfajri et al (2017), the Aqua satellite created by NASA functions as an observation satellite in the marine field. The Aqua-Modis satellite can measure various types of water parameters, one of which is SST in the waters. Oceanographic factors that are often associated with catches are SST and chlorophyll-a (Hastuti et al 2021).

Based on the discussion above and given the lack of research on SST and chlorophyll-a influence on the catch number in Sadeng waters, we researched if there is a relationship between these variables. The results of this study are expected to help fishermen to determine fishing areas, based on oceanographic parameters.

Material and Method

Description of the study sites. The research was conducted from March 18 to May 30 2022, by participating in activities of fishing by purse seine operating in the Indian Ocean. The research locations are as shown in Figure 1 below:

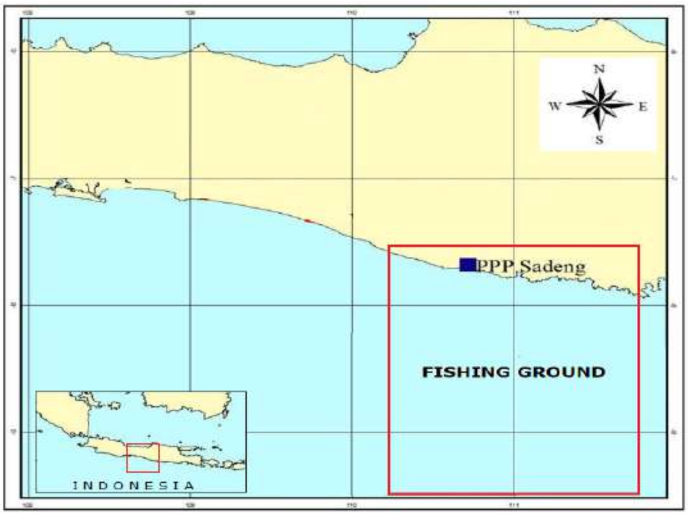


Figure 1. Map of fishing ground.

Method of collecting data. Data collection is done by collecting primary data and secondary data. Primary data concerned the fishing area position, the *in-situ* SST measured directly and the number of catches calculated for each trip. The secondary data were chlorophyll-a and SST images obtained by level 3 Aqua MODIS satellite imagery. Materials and tools used include: purse seine, GPS, compass, digital thermometer, software (.Excel, Seadas 7.5.3, Arcmap 10.8, SPSS), Camera, Chlorophyll-a Image, SST Image.

Data processing method. In processing MODIS data, SeaDas software is used. The results obtained are Aqua MODIS images at level 3, which produce SST values in degrees Celsius (°C) and chlorophyll-a (mg m^{-3}). Due to the relatively wider area, the projection system used is the Geographic Coordinate System (GCS) with the WGS84 datum. The processing of chlorophyll-a and SST values contained in the Aqua MODIS image map was carried out using the SeaDAS software. Data were filtered with Microsoft Excel, and a map of the distribution of chlorophyll-a and SST was made, using the IDW (Inverse Distance Weighted) analysis & the contouring menu, by interpolation, a simple deterministic method based on the surrounding points (Nurman 2010).

Data analysis method. Associative research methods were used with a quantitative approach to observe certain populations or samples (Sugiyono 2010). Analysis of the effect of SST and chlorophyll-a on the catch was tested by several methods including a verification test of satellite imagery data (ex-situ) and direct measuring (in-situ) data, a classical assumption test, and multiple linear regression analysis.

Results and Discussion

Catch production.
1. Catches number on the 1st trip: The 1st trip was held on 1 to 8 April 2022 by setting 9 times the gear, with the overall catch consisting of *T. albacares* (2,552 kg), *K. pelamis*

(3,023 kg), *D. russelli* (2,837 kg), *C. hippurus* (105 kg), *E. affinis* (337 kg) and *A. stellaris* (2,332 kg), with a total of 11,186 kg. The catches were dominated by *K. pelamis*.

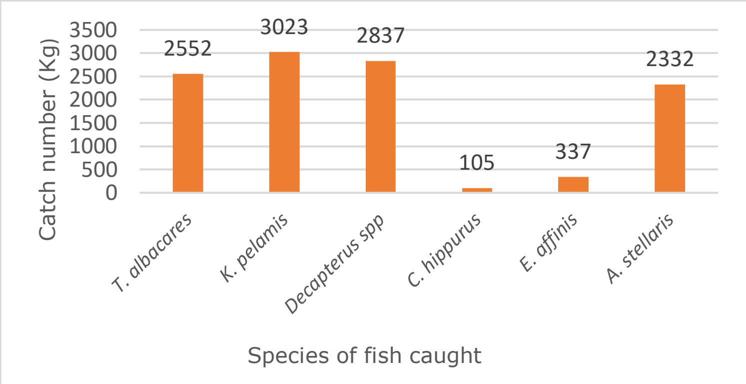


Figure 2. The number of catches on the 1st trip.

2. The number of catches of the 2nd trip: The 2nd trip was held on 10 to 16 April 2022 with 7 days of fishing operations or 7 settings. The catches of the 2nd trip consisted of *T. albacares* (2,002 kg), *K. pelamis* (5,237 kg), *D. russelli* (402 kg), *C. hippurus* (150 kg), *E. affinis* (644 kg), *A. stellaris* (38 kg), with a total of 8,473 kg. The catches on the 2nd trip were dominated by *T. albacares, K. pelamis,* and *D. russelli.*

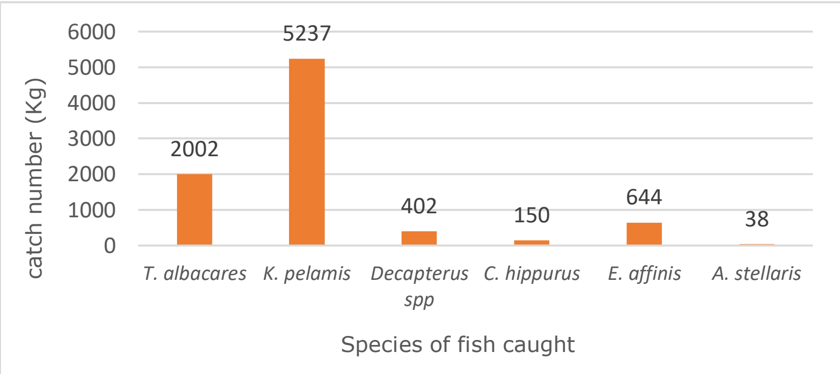


Figure 3. The number of catches on the 2nd trip.

3. The number of catches of the 3rd trip: The 3rd trip was held on 09 to 18 May 2022 with 10 days of catching and 10 settings. The catches on this trip were dominated by *K. pelamis*. The composition of the catch was: *T. albacares* (3,503 kg), *K. pelamis* (10,378 kg), *D. russelli* (5,866 kg), *C. hippurus* (143 kg), *Loligo* (497 kg), *E. bipinnulata* (154 kg), with a total of 20,541 kg.

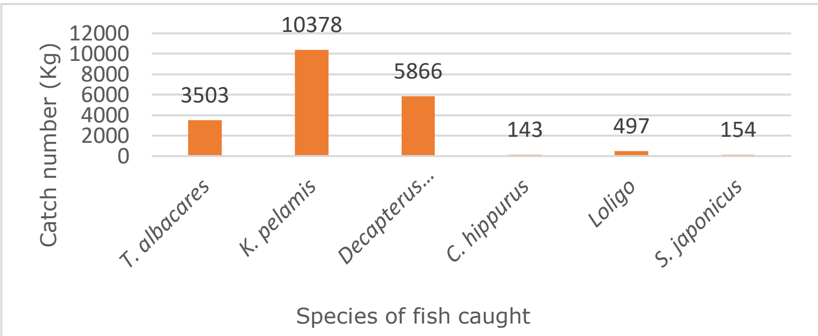


Figure 4. The catch of the 3rd trip.

Catch composition. In 3 trips with 26 catches, the catch was 40,200 kg. *K. pelamis* dominated with as much as 18,638 kg and an average of 716 kg per setting, the 2nd highest

catch was *D. russelli* with as much as 9,105 kg and an average of 350 kg per setting, and the 3rd was *T. albacares* with as much as 8,057 kg and an average per setting of 309 kg. Meanwhile, the lowest catches were *C. hippurus* with 398 kg and *E. bipinnulata* with 154 kg and an average of 15.3 kg and 5.9 kg, respectively, for each setting. Table 1 shows the composition of the catching trips:

Table 1

Fish composition and catch number

Species	*Catch number (Kg)*			Total	*Average*	*Percentage (%)*
	Trip 1	*Trip 2*	*Trip 3*			
T. albacares	2,552	2,002	3,503	8,057	309	20
K. pelamis	3,023	5,237	10,378	18,638	716	46.3
D. russelli	2,837	402	5,866	9,105	350	22.6
C. hippurus	105	150	143	398	15.30	1
A. stellaris	2,332	38	0	2,370	91.15	5.9
E. affinis	337	644	0	981	37.73	2.5
E. bipinnulata	0	0	154	154	5.92	0.4
Loligo	0	0	497	497	19.11	1.3

The diagram in Figure 6 synthesizes the composition if the fish species caught.

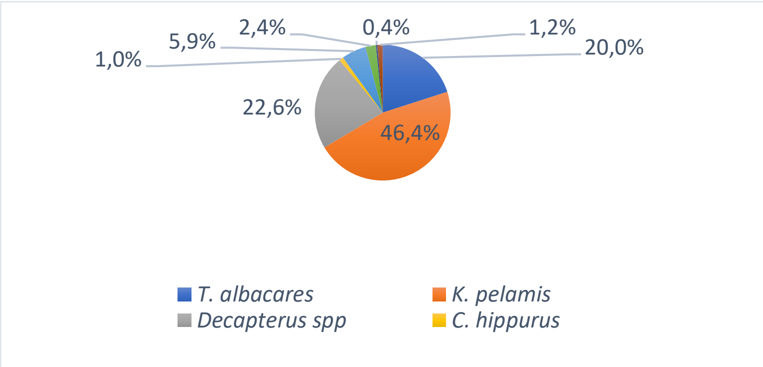


Figure 6. The composition of the caught fish species.

Distribution of Sea Surface Temperature (SST).

1. Distribution of SST in April 2022 for the 1st trip: The distribution of SST was observed to be stable, this can be seen from the 9 sampling points that were obtained during the 1st trip in April. Table 2 shows in-situ and ex-situ SST distribution values measured from 01 to 08 April 2022:

Table 2

The distribution of SST in Sadeng waters in April 2022, on the 1st trip

Date	*Position*		*SST (°C)*	
	Latitude (S)	*Longitude (T)*	*In-situ*	*ex-situ*
01/04/2022	08°42'14"	110°31'22"	27.0	31.7
02/04/2022	08°46'05"	110°33'36"	28.1	31.3
03/04/2022	08°51'00"	110°35'12"	28.0	31.3
03/04/2022	08°49'07"	110°36'05"	28.5	31.4
04/04/2022	08°52'07"	110°36'10"	29.0	31.5
05/04/2022	08°41'47"	110°33'00"	27.1	31.5
06/04/2022	08°38'05"	110°51'51"	26.7	31.2
07/04/2022	08°47'00"	110°34'00"	29.2	31.1
08/04/2022	08°43'12"	110°33'26"	30.1	31.7
	Average		28.1	31.4

Zulkhasyni (2015) stated that in general high SST occurs in the west season to the transition season, where the west season starts in September and ends in February, every year. The *K. pelamis* was caught at a temperature range of 29° to 30°C from November to March (Nugraha et al 2020). According to Yeka et al (2022), the potential area for catching *K. pelamis* has a close relationship with the environmental parameters, especially the chlorophyll-a, whose optimum ranges from 0.12 to 0.22 mg m^{-3}. SST in-situ of Sadeng waters in April 2022 ranged from 26.7° to 30.1°C. The highest SST occurred in April 8 2022, reaching 30.1°C, while the lowest temperature occurred on April 6, 2022, reaching 26.7°C. The average *in-situ* SST in April 2022 on the first trip was 28.1°C and the average *ex-situ* temperature was 31.4ºC, as illustrated in Figure 6..

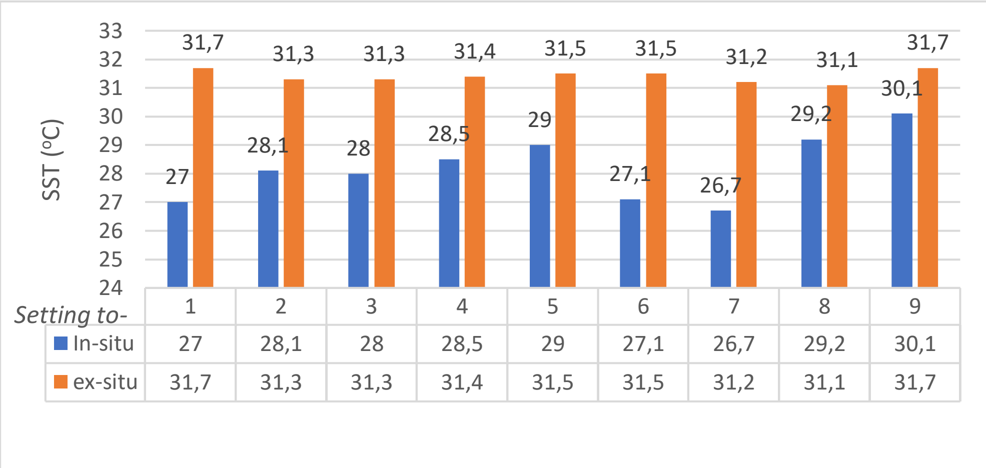


Figure 6. SST distribution in the 1st trip.

The highest number of catches occurred at the setting 9, with a total of 2,121 kg, at a high SST, reaching 30.1°C, while the least catch occurred at the setting 1, with a total catch of 345 kg, at a lower SST, of 27°C. This shows that in April 2022 if the SST value is high, the number of catches will be high and vice versa if the SST is low, the number of catches will also be low. The comparison of SST with the number of catches in April 2022 can be seen in Figure 7 below:

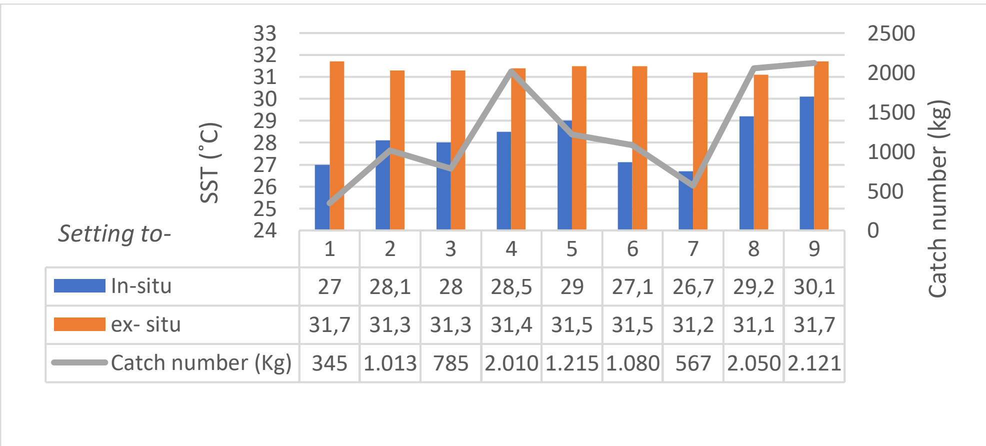


Figure 7. Comparison of SST with catch number in April 2022 on the 1st trip.

2. Distribution of the SST in April 2022 for the 2nd trip: This month, the SST data collection method was carried out in-situ and ex-situ at 7 points of the fishing ground, as observed in Table 3.

Table 3

The distribution of SST in Sadeng waters in April 2022 on the 2nd trip

Date	*Position*		*SST (°C)*	
	Latitude (S)	*Longitude (E)*	*in-situ*	*ex-situ*
10/04/2022	08°36'38"	110°38'20"	30.2	31.7
11/04/2022	08°37'44"	110°29'54"	29.7	29.9
12/04/2022	08°35'20"	110°34'19"	27.5	30.1
13/04/2022	09°05'52"	110°09'27"	29.8	30.1
14/04/2022	08°32'25"	110°35'24"	28.5	30.1
15/04/2022	08°30'37"	110°38'14"	30.1	30.3
16/04/2022	08°30'25"	110°32'43"	28.3	29.4
	Average		29.1	30.2

Based on the data above, it can be seen that for all 7 sampling points, the SST distribution in April 2022 looks stable, ranging from 27.5 to 30.2°C. The highest temperature increase occurred on 10th of April 2022, reaching 30.2°C, while the lowest temperature occurred on April 12th of 2022, with a temperature reaching 27.5°C. The in-situ average in April 2022, on the 2nd trip, was 29.1°C and the ex-situ average was 30.2°C.

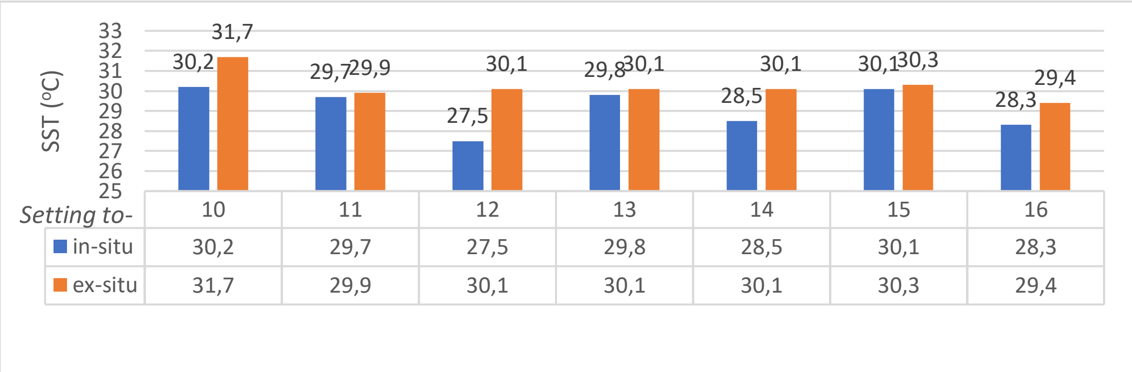


Figure 8. SST distribution on the 2nd trip.

In Figure 9, the comparison of the SST value with the catch in April 2022 shows that the highest of catch number occurred in the 12th setting, with as much as 2,053 kg, at an SST value reaching 27.5°C. Meanwhile, the smallest number of catches occurred in the 11th setting, with as much as 566 kg and an SST reaching 29.7°C. This shows that in April 2022, if the SST is high then the catch decreases and conversely, if the SST is low then the catch number is high, inversely proportional to the 1st trip.

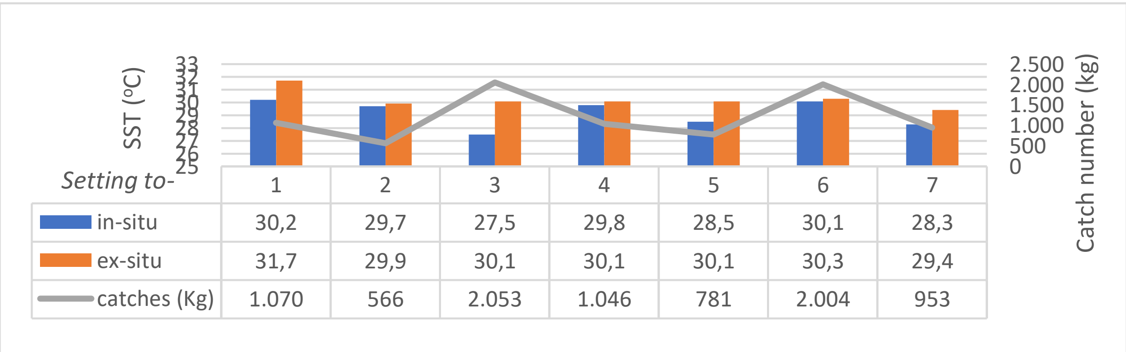


Figure 9. Comparison of the SST value and the catch quantity in April 2022, on the 2nd trip.

3. Distribution of the SST in May 2022, for the 3rd trip: In May 2022 the sampling point method was carried out directly on the satellite imagery, 10 times, as shown in Table 4:

Table 4

The distribution of SST in Sadeng waters in May 2022, on the 3rd trip

Date	Position		SST (°C)	
	Latitude (S)	*Longitude (E)*	*in-situ*	*ex-situ*
09/05/2022	08°28'50''	110°08'51''	28.2	30.3
10/05/2022	08°44'19''	110°25'58''	29.1	29.7
11/05/2022	08°46'04''	110°54'56''	30.2	29.6
12/05/2022	09°09'10''	110°16'09''	30.3	30.3
13/05/2022	09°41'15''	109°59'03''	28.6	29.5
14/05/2022	09°27'33''	109°54'56''	27.7	28.8
15/05/2022	08°57'29''	110°06'22''	28.3	29.1
16/05/2022	08°46'14''	110°37'47''	27.7	30.1
17/05/2022	08°43'39''	110°46'36''	27.6	30.2
18/05/2022	08°33'23''	110°34'50''	28.3	28.5
	Average		28.6	29.6

Based on Table 4 and Figure 10, SST fluctuations occurred in May 2022. The SST distribution was stable, ranging from 27.6 to 30.3°C. The highest SST occurred on 12 May 2022, reaching 30.3°C, while the lowest SST, of 27.6°C, occurred on 17 May 2022. The average SST in-situ in May, on the 3rd trip, was 28.6°C and the ex-situ average was 29.6ºC.

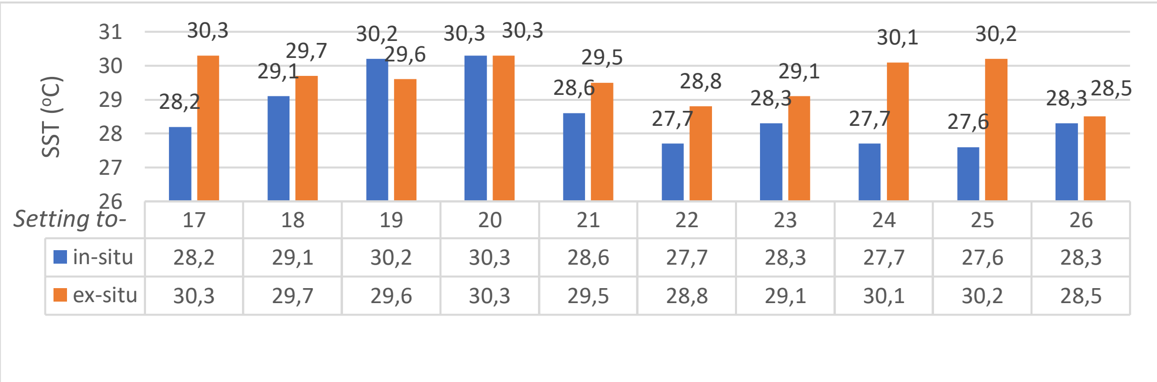


Figure 10. SST distribution in the 3rd trip.

In Figure 11, the comparison of SST with the highest catches number in May 2022, occurred at the setting 23, with a total of 5,045 kg, at a high SST value of 28.3°C. The lowest catches number on the 3rd trip occurred at the 25th setting, with a total of 641 kg and a SST reaching 27.6°C. Based on the previous findings, it can be concluded that in May 2022 if the SST is high, the catches number is high and if the SST is low, the catches number is low too.

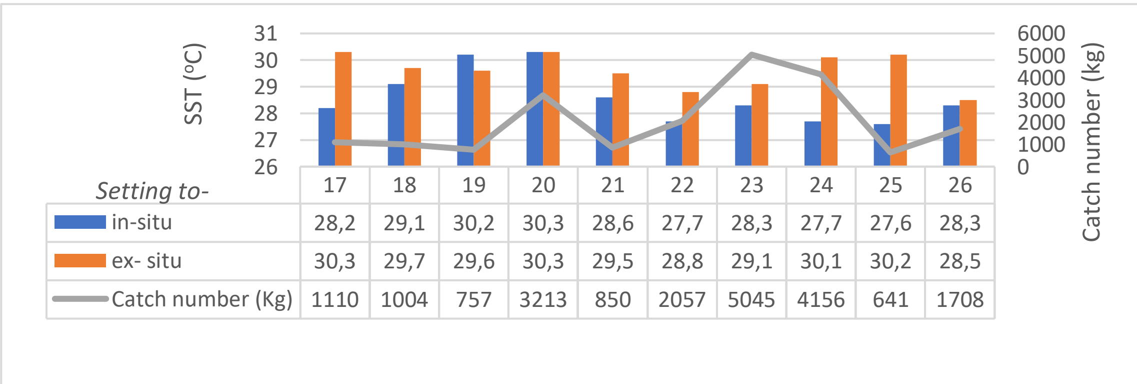


Figure 11. Comparison of SST with the catches number in May 2022 on the 3rd trip.

Chlorophyll-a concentration. One of the waters fertility factors is the availability of chlorophyll-a in the waters. According to Nufus et al (2017) the fertility level of coastal waters can be assessed from the biological and chemical characteristics, especially from the availability of essential nutrients. Based on the Table 5, the concentration of chlorophyll-a in Sadeng waters tends to experience fluctuations.

Table 5

Concentration of chlorophyll-a in Sadeng waters in 2017 to 2021

Period (Month/year)	*chlorophyll-a (mg m^{-3})*				
	2017	*2018*	*2019*	*2020*	*2021*
April	0.38	0.33	0.58	0.28	0.39
May	0.40	0.73	0.76	0.34	0.41

The highest value of chlorophyll-a, 0.76 mg m^{-3}, occurred in May 2019, while the lowest value occurred in April 2020, with a value of 0.28 mg m^{-3}, as observed in Figure 12. The high and low values of chlorophyll-a are influenced by the nutrients content in the waters, which is also closely related to the abundance of phytoplankton. If the nutrients in the waters are abundant, the chlorophyll-a value will also be high. In addition, other factors that can affect the level of chlorophyll-a in waters are the temperature and salinity.

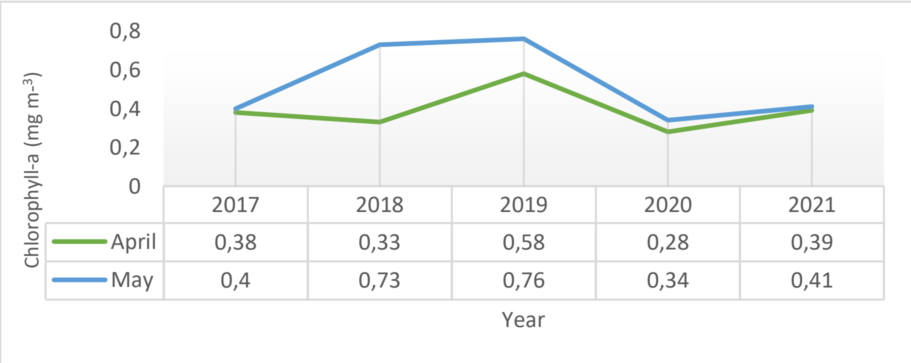


Figure 12. Chlorophyll-a concentration in 2017–2021.

1. Concentration of chlorophyll-a in April 2022, on the 1st trip: The distribution of chlorophyll-a concentration in April seemed to fluctuate. This can be seen from the 9 sampling points obtained from the NASA Ocean Color level 3, with a daily period, as it can be seen in Table 6.

Table 6

The concentration of chlorophyll-a in Sadeng waters in April 2022 for the 1st trip

Date	*Position*		*Chlorophyll-a (mg m^{-3})*	*Catch number (kg)*
	Latitude (S)	*Longitude (E)*		
01/04/2022	08°42'14''	110°31'22''	0.13	345
02/04/2022	08°46'05''	110°33'36''	0.15	1,013
03/04/2022	08°51'00''	110°35'12''	0.15	785
03/04/2022	08°49'07''	110°36'05''	0.12	2,010
04/04/2022	08°52'07''	110°36'10''	0.15	1,215
05/04/2022	08°41'47''	110°33'00''	0.14	1,080
06/04/2022	08°38'05''	110°51'51''	0.14	567
07/04/2022	08°47'00''	110°34'00''	0.15	2,050
08/04/2022	08°43'12''	110°33'26''	0.13	2,121
	Average		0.14	1,242

Based on Table 6 above, at the 9 sampling points observed during this trip, the highest increase in the value of chlorophyll-a occurred on 1st April 2022 with a concentration value of 0.15 mg m^{-3}. Meanwhile, the lowest chlorophyll-a value occurred on April 3rd 2022, with a chlorophyll-a concentration value of 0.12 mg m^{-3}. The average concentration of chlorophyll-a on the 1st of April trip was 0.14 mg m^{-3}.

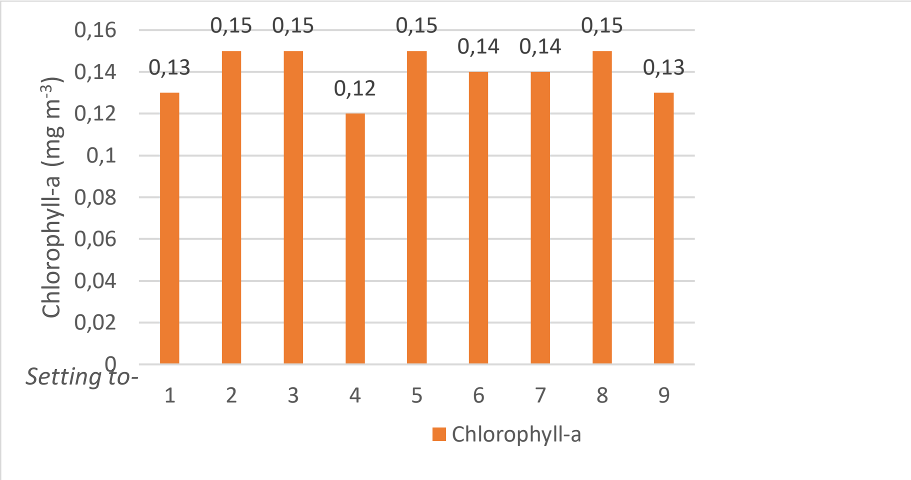
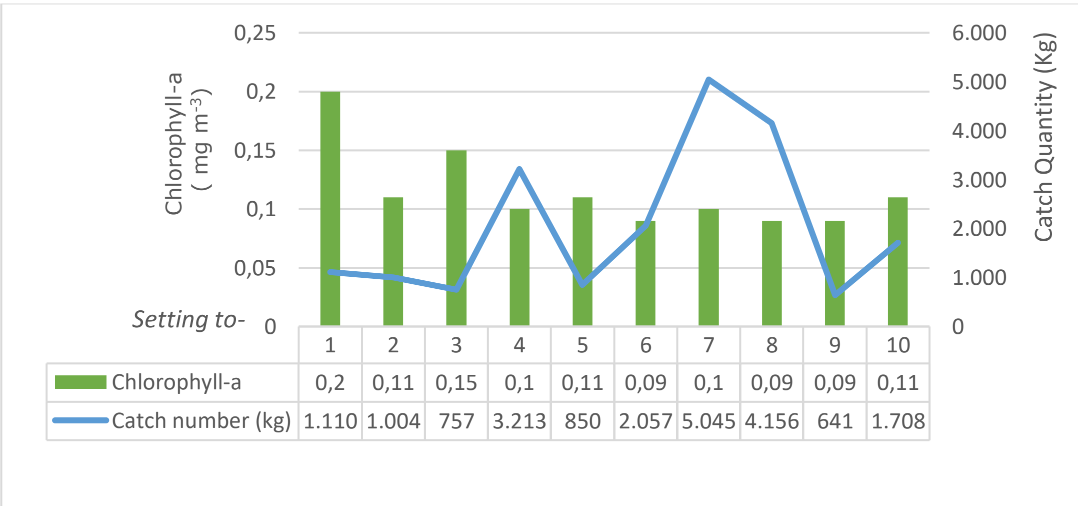


Figure 13. Chlorophyll-a concentration in April 2022, on the 1st trip.

In Figure 14 the comparison of the value of chlorophyll-a and the catches number in April 2022 shows that the highest catches number occurred in the 8th setting, with a total of 2,050 kg, at a high concentration of chlorophyll-a, of 0.15 mg m^{-3}. Meanwhile, the smallest catch number on the 1st trip occurred in the first setting, with the amount of 345 kg where the chlorophyll-a concentration value reached 0.13 mg m^{-3}. It can be concluded that in April 2022, if the concentration of chlorophyll-a is high then the catches number is high. Conversely, if the chlorophyll-a is low then the catches number is also low.



Setting to-	1	2	3	4	5	6	7	8	9	10
Chlorophyll-a	0,2	0,11	0,15	0,1	0,11	0,09	0,1	0,09	0,09	0,11
Catch number (kg)	1.110	1.004	757	3.213	850	2.057	5.045	4.156	641	1.708

Figure 14. Comparison graph of chlorophyll-a value with the catches quantity on the 1st April 2022 trip.

1. Concentration of chlorophyll-a in Sadeng waters in April 2022 on the second trip: In April 2022, we considered 7 sampling points during the fishing operations; data were obtained from the NASA Ocean Color satellite (NASA 2007). The detailed chlorophyll-a concentration values can be seen in Table 7:

Table 7

The concentration of chlorophyll-a in Sadeng waters in April 2022, for the second trip

Date	*Position*		*chlorophyll-a (mg m-^{3})*	*Catches number (kg)*
	Latitude (S)	Longitude (T)		
10/04/2022	08°36'38"	110°38'20"	0.11	1,070
11/04/2022	08°37'44"	110°29'54"	0.12	566
12/04/2022	08°35'20"	110°34'19"	0.11	2,053
13/04/2022	09°05'52"	110°09'27"	0.12	1,046
14/04/2022	08°32'25"	110°35'24"	0.10	781
15/04/2022	08°30'37"	110°38'14"	0.11	2,004
16/04/2022	08°30'25"	110°32'43"	0.09	953
	Average		0.10	1,210

Figure 15 is a graph of the results of the 7 sampling points taken during the 2nd trip:

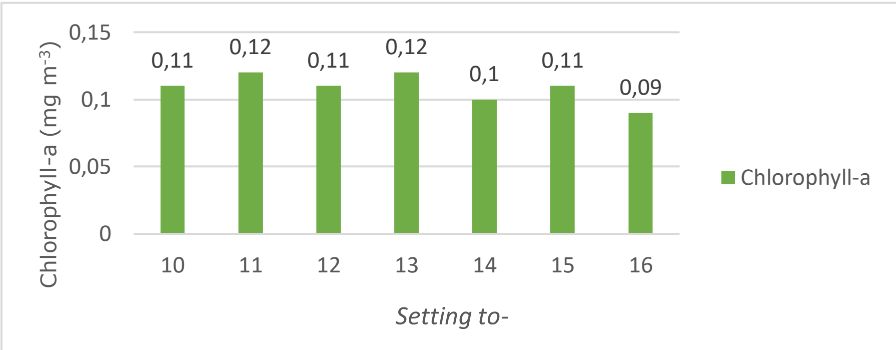


Figure 15. chlorophyll-a value in April 2022, on the 2nd trip.

Based on the data above, it can be seen that from 7 sampling points taken during this trip, the highest increase in the value of chlorophyll-a occurred on April 13th 2022, with a concentration value of 0.12 mg m^{-3}. Meanwhile, the lowest chlorophyll-a value occurred on April 16th 2022, with a chlorophyll-a concentration value of 0.09 mg m^{-3}. The average concentration of chlorophyll-a in April, at the 1st fishing operation trip, was of 0.10 mg m^{-3}.

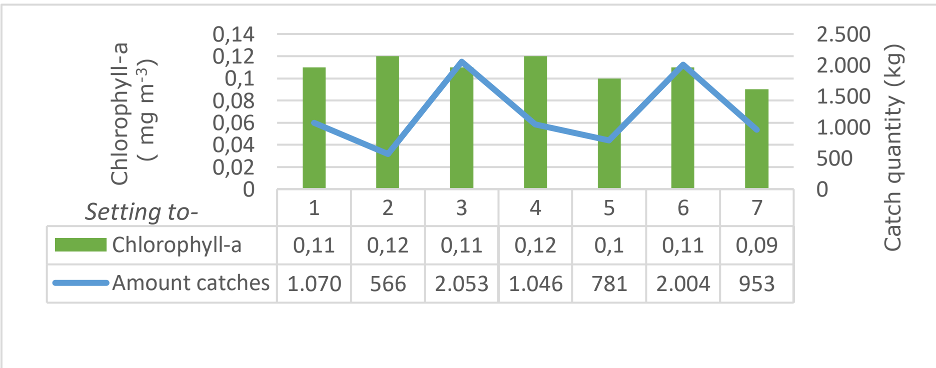


Figure 16. Comparison of the value of chlorophyll-a with the catches quantity, on the 2nd April 2022 trip.

In Figure 16 the comparison of the value of chlorophyll-a and the catch number in April 2022 shows that the highest catch number occurred at the 15th setting, with a total of 2,053 kg, inversely proportional to the chlorophyll-a concentration (0.11 mg m^{-3}, the lowest value). The smallest catch on the 2nd fishing operation trip occurred at the 11th setting, with the amount of 566 kg, when the value of chlorophyll-a concentration was the highest (0.12 mg m-^{3}). From the findings above, it can be concluded that in April the catch quantities are inversely proportional to the values of chlorophyll-a concentrations.

1. Concentration of chlorophyll-a in Sadeng waters in May 2022 on the third trip: The concentration of chlorophyll-a in May 2022 was observed to be stable, ranging from 0.09 to 0.15 mg m^{-3}. In May 2022, 10 sample points were taken using the satellite imagery obtained from NASA Ocean Color. The concentration of chlorophyll-a in Sadeng waters in May 2022 is presented in Table 8.

Table 8

The concentration of chlorophyll-a in Sadeng waters in May 2020, for the 3rd trip

Date	*Position*		*Chlorophyll-a (mg m^{-3})*	*Catch number (kg)*
	Latitude (S)	*Longitude (T)*		
09/05/2022	08°28'50''	110°08'51''	0.20	1,110
10/05/2022	08°44'19''	110°25'58''	0.11	1,004
11/05/2022	08°46'04''	110°54'56''	0.15	757
12/05/2022	09°09'10''	110°16'09''	0.10	3,213
13/05/2022	09°41'15''	109°59'03''	0.11	850
14/05/2022	09°27'33''	109°54'56''	0.09	2,057
15/05/2022	08°57'29''	110°06'22''	0.10	5,045
16/05/2022	08°46'14''	110°37'47''	0.09	4,156
17/05/2022	08°43'39''	110°46'36''	0.09	641
18/05/2022	08°33'23''	110°34'50''	0.11	1,708
Average			0.11	2,054

The data was synthesized in Figure 17:

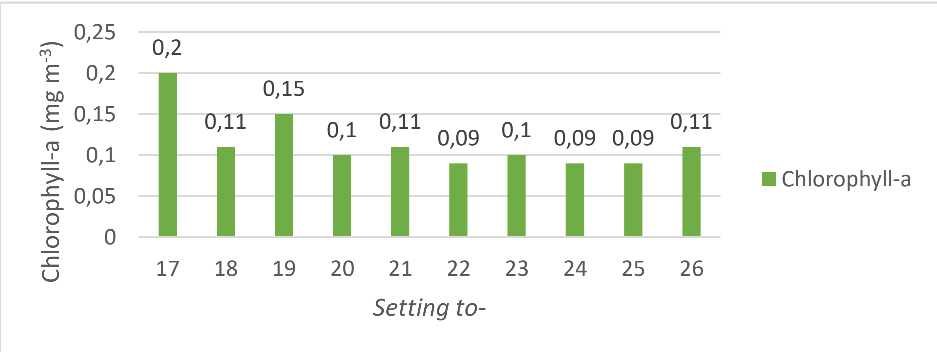


Figure 17. Chlorophyll-a concentration in May 2022, on the 3rd trip.

In Table 8 and Figure 17, it can be observed that the concentration of chlorophyll-a fluctuates in May. The highest chlorophyll-a value occurred on 11th of May 2022, of 0.15 mg m^{-3}, while the lowest chlorophyll-a value occurred on 14th, 16th, and 17th of May 2022, of 0.09 mg m^{-3}. The average concentration of chlorophyll-a in April 2022, on the fourth fishing operation trip, was 0.11 mg m^{-3}.

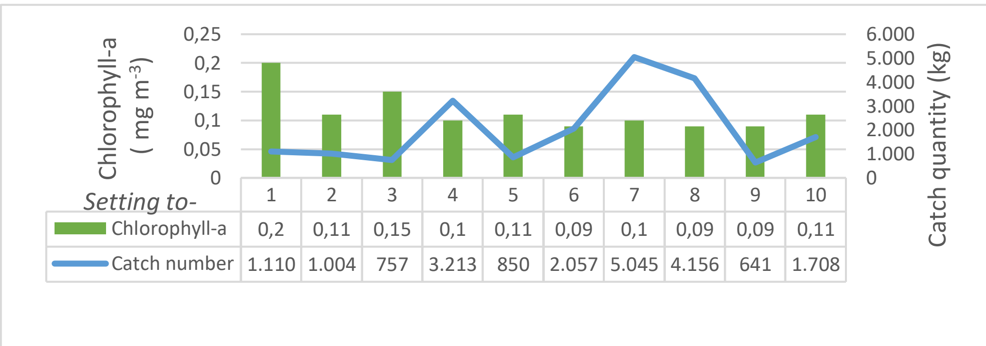


Figure 18. Comparison of chlorophyll-a concentration with the catching quantity in May 2022.

In Figure 18 the comparison of the value of chlorophyll-a and the catching quantity in May 2022 shows that the highest quantity of catches occurred at the setting 23, with a total of 5,045 kg, at a high concentration of chlorophyll-a, with a value of 0.10 mg m^{-3}. Meanwhile, the smallest catch number on the 1st fishing operation trip occurred at the 25th setting, with a total of 641 kg where the chlorophyll-a concentration value reached 0.09. Based on the previous findings, it can be concluded that in May, if the concentration of chlorophyll-a is high then the catch number is high or conversely, if the chlorophyll-a is low then the catch number is also low.

SST data is obtained based on the analysis of MODIS images. The data is then verified against the measurements. The verification results are shown in Table 9:

Table 9

Verification of in-situ SST data with satellite imagery

No. setting	*Data in-situ*	*Data ex-situ*	*Value of error (%)*
1	27.0	28.28	4.92
2	28.1	28.28	0.69
3	28.0	28.29	1.12
4	28.5	26.78	6.69
5	29.0	27.42	6.08
6	27.1	27.39	1.12
7	26.7	28.18	5.69
8	29.2	25.7	13.46
9	30.1	26.98	12.00
10	30.2	28.28	7.38
11	29.7	26.08	13.92
12	27.5	26.21	4.96
13	29.8	27.66	8.23
14	28.5	27.53	3.73
15	30.1	28.04	7.92
16	28.3	27.56	2.85
17	28.2	27.11	4.19
18	29.1	28.4	2.69
19	30.2	28.32	7.23
20	30.3	27.41	11.12
21	28.6	26.13	9.50
22	27.7	28.86	4.46
23	28.3	28.33	0.12
24	27.7	28.56	3.31
25	27.6	27.01	2.27
26	28.3	28.48	0.69
Mean relatives error	28.61	27.59	5.63

According to Fadika et al (2014), data verification is done by calculating the MRE. In-situ SST data verification against the Aqua MODIS satellite image data, at 26 sampling points, shows that the average relative error value is 5.63%. This value is included in the correct category, where the resulting value is no more than 30%. Jaelani et al (2013) in their journal stated that values with an average relative error of less than 30% in image data processing can be used for further analysis. Based on the previous statement, it can be concluded that the SST satellite image data can be further analyzed because it has an accuracy of 91.89%. According to Simanjuntak et al (2012), among the factors that cause errors in the satellite image datais a reading error at the time of observation.

Analysis of the effect of SST and chlorophyll-a on the total catch.

1. Normality test.

The normality test is part of the data analysis requirements. It is a classical assumption test: before performing a statistical analysis to test the hypothesis, a

regression analysis is used to determine whether the residual values are normally distributed or not. The residual is normally distributed if the significance is more than 0.05 (Gunawan 2020).

In Table 10, the test results, obtained with the SPSS software, can be seen. The asymptotic normality obtained had the significance value (sig.)0.200 (>0.05), so the residual values can be considered as normally distributed.

Table 10

Normality test

One-Sample Kolmogorov-Smirnov Test		
		Unstandardized residual
N		26
Normal Parameters[a,b]	Mean	.0000000
	Std. deviation	1016.50300169
Most extreme differences	Absolute	.108
	Positive	.108
	Negative	-.071
Test statistic		.108
Asymp. Sig. (2-fish)		.200[c,d]

[a] Test distribution is Normal; [b] Calculated from data; [c] Lilliefors Significance Correction; [d] This is a lower bound of the true significance.

The basis for decision making in the K - S Normality test is as follows:
- If the significance value (sig.) >0.05 then the data is normally distributed. On the contrary,
- If the significance value (sig.) <0.05, then the data is not normally distributed.

2. Linearity Test

In Table 11 of the SST - catches relationship's Deviation from Linearity, the significance value (sig.) obtained is 0.868, greater than 0.05. So it can be concluded that there is a significant linear relationship between the SST variable (X) and the number of catches (Y).

Table 11

Linearity test of the catch number with SST

ANOVA Table							
			Sum of squares	df	Mean square	F	Sig.
Catches * SST	Between groups	(Combined)	21329060.787	19	1122582.147	0.539	0.858
		Linearity	1812590.669	1	1812590.669	0.870	0.387
		Deviation from linearity	19516470.118	18	1084248.340	0.521	0.868
	Within groups		12497302.667	6	2082883.778		
	Total		33826363.454	25			

In Table 12 of the Chlorophyll-a catches relationship's Deviation from Linearity, the significance value is 0.889, greater than 0.05. So it can be concluded that there is a significant linear relationship between the chlorophyll-a variable (X) and the catch number (Y).

Table 12

Linearity test of total catch with chlorophyll-a

ANOVA table							
			Sum of squares	*df*	*Mean square*	*F*	*Sig.*
Catches * Chlorophyll-a	Between groups	(Combined)	10614882.479	7	1516411.783	1.176	0.364
		Linearity	7753006.461	1	7753006.461	6.012	0.025
		Deviation from linearity	2861876.018	6	476979.336	0.370	0.889
	Within groups		23211480.975	18	1289526.721		
	Total		33826363.454	25			

The basis for decision making in the linearity test by comparing the significance value is as follows:

- If the value of Deviation from Linearity sig.>0.05, then there is a significant linear relationship between the independent variable and the dependent variable.
- If the value of Deviation from linearity sig.<0.05, then there is no significant linear relationship between the independent variable and the dependent variable.

3. Multicollinearity test

The multicollinearity test was used to test whether the regression model found a correlation between the independent variables. If a correlation exists, then there is a multicollinearity (multico) problem (Gunawan 2020). Multicollinearity is detected by examining the Variance Inflation Factor (VIF) value and tolerance, with reference to certain conditions: if the VIF value is less than 10 and the tolerance is more than 0.1, it is considered that there is no multicollinearity (Gunawan 2020).

In Table 13, it is shown that the value of the collinearity tolerance of the two variables is 0.90, more than 0.10, and the VIF statistic value of 1.11 is less than 10.

Table 13

Multicollinearity Test

Coefficients[a]								
Model		*Unstandardized coefficients*		*Standardized coefficients*	*t*	*Sig.*	*Collinearity statistics*	
		B	*Std. Err.*	*Beta*			*Tolerance*	*VIF*
1	(Constant)	2421.912	998.784		2.425	0.024		
	SST	1.219	2.630	0.089	0.464	0.647	0.900	1.111
	Chlorophyll-a	-117.383	50.033	-0.451	-2.346	0.028	0.900	1.111

[a] Dependent variable: Cathes.

So it can be concluded that the data above does not occur multicollinearity between independent variables. The basis for making decisions on the multicollinearity test with tolerance is as follows:

- If the tolerance value is greater than 0.10, it means that there is no multicollinearity in the regression model.
- If the tolerance value is less than 0.10, it means that there is multicollinearity in the regression model.

4. Heteroscedasticity Test

The heteroscedasticity test aims to test whether in the regression model there is an inequality of variance from one observation to another. A good regression model is one without heteroscedasticity or with homoscedasticity (Gunawan 2020).
Based on Table 14, it can be observed that the significance value (sig.) for the SST variable (X_1) is 0.811, while the significance value (sig.) for the chlorophyll-a variable (X_2) is 0.089.

Table 14

Heteroscedasticity test

Coefficients[a]						
Model		Unstandardized coefficients		Standardized coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	2825.294	3687.361		0.766	0.452
	SST	-30.753	126.844	-0.048	-0.242	0.811
	Chlorophyll-a	-9494.419	5333.793	-0.354	-1.780	0.089

[a] Dependent variable: Cathes.

Because the significance value of the two variables above is greater than 0.05, according to the basis for decision making in the Glejser test, it can be concluded that there is no symptom of heteroscedasticity. The basis for decision making in the heteroscedasticity test, using the Glejser conditions, is as follows:

- If the significance value (Sig.) is greater than 0.05, then the conclusion is that there is no heteroscedasticity symptom in the regression model.
- On the other hand, if the significance value (sig.) is less than 0.05, the conclusion is that heteroscedasticity is occurring.

5. Multiple linear regression

This analysis is used to measure the magnitude of the influence between the independent and dependent variables. There are several eligibility requirements that must be met when regression analysis is used, namely: the number of samples used must be the same, the number of independent variables is 1, the residual value must be normally distributed, there is a linear relationship, there are no symptoms of heteroscedasticity.

Based on Table 15, it is explained that the correlation coefficient (R) of 0.471 between the variables sea surface temperature and chlorophyll-a with the catch means that there is a very strong positive relationship between SST and chlorophyll-a with the fish catch.

Table 15

Model summary

Model summary				
Model	R	R Square	Adjusted R square	Std. Error of the estimate
	.471[a]	0.221	0.154	1036.89027

[a] Predictors: (Constant), Chlorophyll-a, SST.

Meanwhile, the R square coefficient obtained is 0.221 or 22%, meaning that the independent variables (SST and chlorophyll-a) affect the Y variable (catch) by 22% while the rest of the catch is influenced by other variables.

Based on Table 16, it is observed that the coefficient test of the SST variable produces $t_{count} < t_{table}$ (0.598 < 2.069) and the significance value obtained is 0.556 (Sig > 0.05) so that SST only weakly affects the catch.

Table 16

t_{test}

Coefficients[a]						
Model		Unstandardized coefficients		Standardized coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	2262.186	977.214		2.315	0.030
	SST	1.539	2.573	0.116	0.598	0.556
	Chlorophyll-a	-106.246	48,953	-0.421	-2.170	0.041

[a] Dependent variable: Cathes.

Meanwhile, by testing the coefficient of chlorophyll-a variable, it was found that $t_{count}>t_{table}$ (2.170>2.069), with a significance value of 0.041 (Sig<0.05) so that it is known thatchlorophyll-a has a strong influence on the catch.

$$Y = 2262.186 + 1.539\ X_1 + (-)106.246\ X_2$$

The above equation describes the effect of changing the values of the independent variables, in the regression algorithm. The interpretation is as follows:

a. Each change by one unit in X_1 and X_2 produces an increase of 2262.186 units.
b. Every change by 1 degree in SST (X_1) results in an increase of 1,539 in the catch (Y).
c. Each change of 1 mg m^{-3} in chlorophyll-a (X_2) results in an increase of 106.246 in the catch (Y).

In Table 17, able it can be observed that $F_{count}<F_{table}$ (3.271<3.40), while the significance value obtained is 0.056 (Sig>0.05), so it can be concluded that there is an influence between the combined SST and chlorophyll-a variables on the catch quantities.

Table 17

Significance test (f_{test})

	ANOVA[a]					
	Model	*Sum of squares*	*df*	*Mean square*	*F*	*Sig.*
1	Regression	7034292.282	2	3517146.141	3.271	.056[b]
	Residual	24728253.103	23	1075141.439		
	Total	31762545.385	25			

[a] Dependent variable: Catch number; [b] Predictors: (Constant), Chlorophyll-a, SST.

Conclusions. The results of the significance test showed that SST had a partial influence on the catch number, while chlorophyll-a had a significant effect on the catch quantity. Meanwhile, if the test was carried out simultaneously, the results would obtaine a significance of 0.056, which means that the combined SST and chlorophyll-a have an influence on the catch quantities.

Conflict of interest. The authors declare no conflict of interest.

References

Abidin A. F., Amron, Marzuki M. I., 2020 Relationship between chlorophyll-a and sea surface temperarure to tuna catch in the Southern Water of Java. Science Research Journal 22(2):55-68.

Alfajri A., Mubarak M., Mulyadi A., 2017 [Spatial and Temporal analysis of sea surface temperature distribution in West Sumatra waters]. Indonesian Environmental Dynamics 4(1): 65-74. [In Indonesian].

Anggraeni R., Solichin A., Saputra S. W., 2015 [Several biological aspects of skipjack tuna (*Katsuwonus pelamis*) in relation to fisheries management in PPP Sadeng, Gunungkidul Regency, Yogyakarta]. Management of Aquatic Resources Journal (MAQUARES) 4(3):230-239. [In Indonesian].

Azizah A., Wibisana H., 2020 [Temporal analysis of sea surface temperature distribution from 2018 to 2020 with Terra Modis image data]. Marine Journal: Indonesian Journal of Marine Science and Technology 13(3):196–205. [In Indonesian].

Fadika U., Rifai A., Rochaddi B., 2014 [Seasonal wind direction and speed and its relation to the distribution of sea surface temperature in Southern Pangandaran, West Java]. Journal of Oceanography 3(3):429–437. [In Indonesian].

Gunawan C., 2020 [Proficient in Mastering SPSS Practical Guide to Processing Research Data (Deeppublish)]. Deepublish, Yogyakarta 210 p. [In Indonesian].

Hastuti, Wirasatriya A., Maslukah L., Subardjo P., Kunarso, 2021 [The Effect of chlorophyll-a factors and sea surface temperature on anchovy catches (*Stelesphorus* sp) in Jepara]. Indonesian Journal of Oceanography 3(2):1-9. [In Indonesian].

Hendiarti N., Ohde T., 2004 Investigation of different processes in Indonesian waters using SeaWiFS data. Deep Sea Research Part II Topical Studies in Oceanography 51(1-3):85-97.
Jaelani L. M., Matsushita B., Yang W., Fukushima T., 2013 Evaluation of four MERIS atmospheric correction algorithms in Lake Kasumigaura, Japan. International Journal of Remote Sensing 34(24):8967–8985.
Jayawiguna M. H., Triyono, Wibowo S., 2019 [Overview of the potential, development and challenges of utilizing marine and fishery resources at FMA-RI 573]. AMAFRAD Press p. 3-10. [In Indonesian].
Kusmana C., Hikmat A., 2015 The biodiversity of flora in Indonesia. Journal of Natural Resources and Environmental Management 5(2):187–198.
Ma'mun A., Priatna A., Hidayat T., Nurulludin. 2017 Distribution and potential resources of pelagic fish in Fisheries Management Area of the Republic of Indonesia (FMA-RI 573) Indian Ocean. Indonesian Fisheries Research Journal (JPPI) 23:47–56.
Nufus H., Karina S., Agustina S., 2017 [Analysis of chlorophyll-a distribution and water quality in the Krueng Raba Lhoknga River, Aceh Besar]. Scientific Journal of Marine and Fisheries Students Unsyiah 2(1):58–65. [In Indonesian].
Nugraha E., Gunawan R., Danapraja S., Yusrizal, Kusdinar A., Waluyo A. S., Hutajulu J., Prayitno H., Halim S., Sutisna D. H., 2020 The sea surface temperature effect on the length and size of skipjack tuna (*Katsuwonus pelamis*) catches in the Banda Sea, Indonesia. AACL Bioflux 13(1):1-18.
Nikijuluw V., 2008 [The status of Indian Ocean tuna resources and its implications for Indonesia]. Journal of Indonesian Fisheries Policy 1(1):31-44. [In Indonesian].
Nurman A., 2010 [Utilization of fashionable data to detect fishing areas on the East and West Coasts of North Sumatra]. Journal of Geography 2(2):17-30. [In Indonesian].
Sidik A., Agussalim A., Ridho M. R., 2015 [The accuracy of the value of chlorophyll-a concentration and sea surface temperature using remote sensing data in the waters of Anggantang Island, Sembilang National Park]. Maspari 7(2):25–32. [In Indonesian].
Simanjuntak B. L., Handoyo G., Sugianto D. N., 2012 [Analysis of bathymetry and tidal components for determination of additional depth of jetty ponds in Tanjung Gundul Bengkayang Waters – West Kalimantan]. Journal of Oceanography 1(1):1-8. [In Indonesian].
Sugiyono, 2019 [Quantitative research methods]. Alphabet, 464 p. [In Indonesian].
Wahyuningrum P. I., Nurani T. W., Rahmi T. A., 2012 [Multi purpose capture fishery business in Sadeng, Gunungkidul Regency, Special Region of Yogyakarta]. Maspari Journal 4(1):10-22. [in Indonesian].
Wijopriono. 2012 [The carrying capacity of tuna fisheries resources in the Indian Ocean in relation to fisheries industrialization]. Journal of Indonesian Fisheries Policy 4(2):101-108. [In Indonesian].
Yeka A., Monika D., Rahmani R. M., Sarianto D., Fitri Y., Nurlaela E., Kusmedy B., Nugraha E., Hutajulu J., 2022 The effect of chlorophyll-a on the catches of skipjack tuna (Katsuwonus pelamis) in Banda Sea, Maluku, Indonesia. AACL Bioflux 15(3):1226-1237.

Received: 23 August 2021. Accepted:. Published online:.
Authors:
Priyantini Dewi, Jakarta Technical University of Fisheries, Faculty of Fishing Technology, AUP Street Pasarminggu 12520, South Jakarta, Indonesia, e-mail: prizt.dewi@gmail.com
Sutarjo, Jakarta Technical University of Fisheries, Faculty of Fishing Technology, AUP Street Pasarminggu 12520, South Jakarta, Indonesia, e-mail: sutarjoz79@gmail.com
Maman Hermawan, Jakarta Technical University of Fisheries, Faculty of Fishing Technology, AUP Street Pasarminggu 12520, South Jakarta, Indonesia, e-mail: mhermawan60@gmail.com
Bongbongan Kusmedy, Jakarta Technical University of Fisheries, Faculty of Fishing Technology, AUP Street Pasarminggu 12520, South Jakarta, Indonesia, e-mail: bkhutapea@gmail.com
Yusrizal, Jakarta Technical University of Fisheries, Faculty of Fishing Technology, AUP Street Pasarminggu 12520, South Jakarta, Indonesia, e-mail: buyung_trc@yahoo.co.id
Mira Maulita, Jakarta Technical University of Fisheries, Faculty of Aquatic Resources Management, AUP Street Pasarminggu 12520, South Jakarta, Indonesia, e-mail: maulita.stp@gmail.com
Eli Nurlaela, Jakarta Technical University of Fisheries, Faculty of Fishing Technology, AUP Street Pasarminggu 12520, South Jakarta, Indonesia, e-mail: elimumtaza@gmail.com
Sopiyan Danapraja, Jakarta Technical University of Fisheries, Faculty of Fisheries Extension, AUP Street Pasarminggu 12520, South Jakarta, Indonesia, e-mail: sopiyanraja@gmail.com
Erick Nugraha, Jakarta Technical University of Fisheries, Faculty of Fishing Technology, AUP Street Pasarminggu 12520, South Jakarta, Indonesia, e-mail: nugraha_eriq1@yahoo.co.id

How to cite this article:
Dewi P., Sutarjo, Hermawan M., Kusmedy B., Yusrizal, Maulita M., Nurlaela E., Danapraja S., Nugraha E., 2023 Study of sea surface temperature and chlorophyll-a to the number of fish caught in the waters of Sadeng, Yogyakarta, Indonesia. AACL Bioflux

Eni Kovacs <ek.bioflux@gmail.com>
Kepada: erick nugraha

Sab, 7 Jan jam 13.24

Dear Dr. Nugraha,

Could you please check the final form of the article attached, some adjustments were operated.

If you have any final observations and instructions prior to the article publishing, please inform us, any changes should be clearly highlighted. Change requests cannot be considered after publishing the material.

If all the authors agree with the final form of the article, could you please send us your acceptance for publishing, signed by all the authors. It should contain the title, name of the authors, a few lines stating that all the authors agree with the publishing, signature of all the authors.

> Tampilkan pesan asli

--
Kind regards,
Editor AACL Bioflux
Eniko Kovacs

Nugraha_S... .docx
1.3MB

Study of sea surface temperature and chlorophyll-a influence on the quantity of fish caught in the waters of Sadeng, Yogyakarta, Indonesia

[1]Priyantini Dewi, [2]Sutarjo, [1]Maman Hermawan, [1]Yusrizal, [3]Mira Maulita, [1]Eli Nurlaela, [1]Bongbongan Kusmedy, [4]Sopiyan Danapraja, [1]Erick Nugraha

[1] Faculty of Fishing Technology, Jakarta Technical University of Fisheries, South Jakarta, Indonesia; [2] Fleet Monitoring and Operation, Directorate General of Marine and Fisheries Resources Surveillance, Central Jakarta, Indonesia; [3] Faculty of Aquatic Resources Management, Jakarta Technical University of Fisheries, South Jakarta, Indonesia; [4] Faculty of Fisheries Extension, Jakarta Technical University of Fisheries, South Jakarta, Indonesia. Corresponding author: E. Nugraha, nugraha_eriq1@yahoo.co.id

Abstract. Oceanographic factors can be an indicator in determining the potential of fishing areas. The sampling technique of Sea Surface Temperature (SST) and chlorophyll-a data in this study was carried out directly (in-situ) and using satellite image data that can be downloaded from NASA Ocean Color to obtain SST and chlorophyll-a data. The purpose of this study was to analyze the effect of SST and chlorophyll-a on the quantity of purse seine catches, based on multiple correlation tests and multiple linear regression analysis. Species of fish caught during the study included: yellowfin tuna *(Thunnus albacares),* skipjack tuna *(Katsuwonus pelamis),* dolphin fish *(Coryphaena hippurus),* starry triggerfish *(Abalistes stellaris)*, rainbow runner *(Elagatis bipinnulata),* scad mackerel *(Decapterus russelli)* and squid *(Loligo).* The SST was measured in-situ. In the waters of Sadeng, Yogyakarta, the SST is relatively homogeneous, ranging from 27° to 30.3°C. Data verification is carried out *ex-situ*, with the aim of testing the level of accuracy. Satellite image data was processed for as many as 26 sampling points. The relative error was of 5.63%. Correlation test results between SST variables, chlorophyll-a and catches in the waters of Sadeng, Yogyakarta were performed for the period April to May 2022. The analysis of the effect of SST and chlorophyll-a showed that SST had a weak effect, while chlorophyll-a had a significant effect on the catches), as indicated by their level of significance of 0.556 (>0.05) and 0.041 (<0.05), respectively. Meanwhile, if the test was carried out on the combination of SST and chlorophyll-a, the result would have a significance of 0.056, which means that the SST and chlorophyll-a variables together strongly influence the catch.
Key Words: Geographic Information System (GIS), satellite imagery, oceanography, MODIS.

Introduction. Sadeng waters which are included in FMA 573 have the potential as habitat for economically important fish such as skipjack tuna *(Katsuwonus pelamis)*, bigeye tuna *(Thunnus obesus),* yellowfin tuna *(Thunnus albacares),* mackerel tuna *(Euthynnus affinis),* mackerel scad *(Decapterus russelli)* and sardin *(Sardinella lemuru)* (Nikijuluw 2008; Wijopriono 2012; Wahyuningrum et al 2012; Jayawiguna et al 2019). Skipjack tuna *(Katsuwonus pelamis)* is the second largest commodity in the area (Anggraeni et al 2015; Ma'mun et al 2017). Its geographical condition favors Indonesia's biodiversity (Kusmana & Hikmat 2015). Hendiarti et al (2004) explained that Sea Surface Temperature (SST) can affect the metabolism and reproduction of organisms in the sea. The distribution of SST is very important to know because it can provide information about the front, upwelling, currents, weather/climate and fishing ground (Abidin et al 2020). Sidik et al (2015) and Azizah et al (2020) explained that the influence of SST on the growth of phytoplankton will indirectly affect the concentration of chlorophyll-a in waters. According to Alfajri et al (2017), the Aqua satellite created by NASA functions as an observation satellite in the marine field. The Aqua-Modis satellite can measure various types of water parameters, one of which is SST in the waters. Oceanographic factors that are often associated with catches are SST and chlorophyll-a (Hastuti et al 2021).

Based on the discussion above and given the lack of research on SST and chlorophyll-a influence on the catch number in Sadeng waters, the study researched if there is a relationship between these variables. The results of this research are expected to help fishermen to determine fishing areas, based on oceanographic parameters.

Material and Method

Description of the study sites. The research was conducted from March 18 to May 30 2022, by participating in activities of fishing by purse seine operating in the Indian Ocean. The research locations are as shown in Figure 1 below:

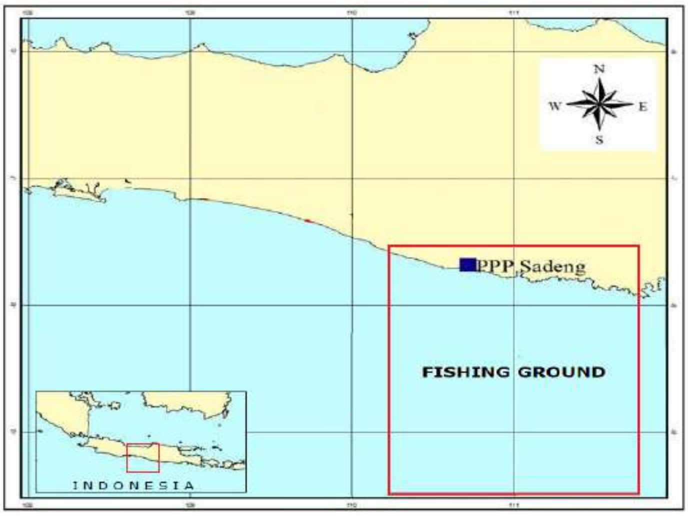


Figure 1. Map of fishing ground.

Method of collecting data. Data collection is done by collecting primary data and secondary data. Primary data concerned the fishing area position, the in-situ SST measured directly and the number of catches calculated for each trip. The secondary data were chlorophyll-a and SST images obtained by level 3 Aqua MODIS satellite imagery. Materials and tools used include: purse seine, GPS, compass, digital thermometer, software (.Excel, Seadas 7.5.3, Arcmap 10.8, SPSS), Camera, Chlorophyll-a Image, SST Image.

Data processing method. In processing MODIS data, SeaDas software was used. The results obtained are Aqua MODIS images at level 3, which produce SST values in degrees Celsius (°C) and chlorophyll-a (mg m^{-3}). Due to the relatively wider area, the projection system used is the Geographic Coordinate System (GCS) with the WGS84 datum. The processing of chlorophyll-a and SST values contained in the Aqua MODIS image map was carried out using the SeaDAS software. Data were filtered with Microsoft Excel, and a map of the distribution of chlorophyll-a and SST was made, using the IDW (Inverse Distance Weighted) analysis & the contouring menu, by interpolation, a simple deterministic method based on the surrounding points (Nurman 2010).

Data analysis method. Associative research methods were used with a quantitative approach to observe certain populations or samples (Sugiyono 2010). Analysis of the effect of SST and chlorophyll-a on the catch was tested by several methods including a verification test of satellite imagery data (ex-situ) and direct measuring (in-situ) data, a classical assumption test, and multiple linear regression analysis.

Results and Discussion

Catch production.
1. Catches number on the 1st trip: The 1st trip was held on 1 to 8 April 2022 by setting 9 times the gear, with the overall catch consisting of *T. albacares* (2,552 kg), *K. pelamis*

(3,023 kg), *D. russelli* (2,837 kg), *C. hippurus* (105 kg), *E. affinis* (337 kg) and *A. stellaris* (2,332 kg), with a total of 11,186 kg. The catches were dominated by *K. pelamis*.

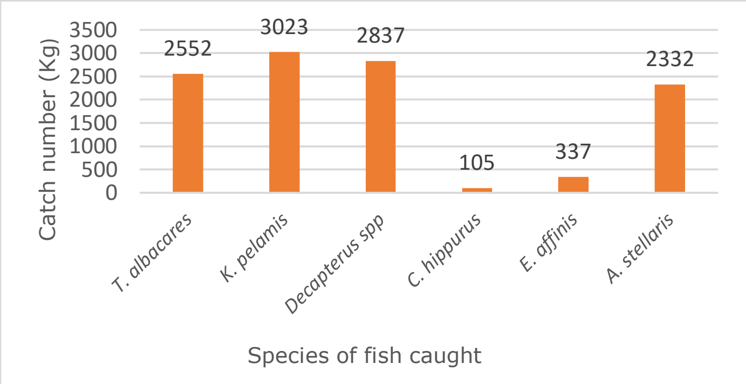


Figure 2. The number of catches on the 1st trip.

2. The number of catches of the 2nd trip: The 2nd trip was held on 10 to 16 April 2022 with 7 days of fishing operations or 7 settings. The catches of the 2nd trip consisted of *T. albacares* (2,002 kg), *K. pelamis* (5,237 kg), *D. russelli* (402 kg), *C. hippurus* (150 kg), *E. affinis* (644 kg), *A. stellaris* (38 kg), with a total of 8,473 kg. The catches on the 2nd trip were dominated by *T. albacares, K. pelamis,* and *D. russelli.*

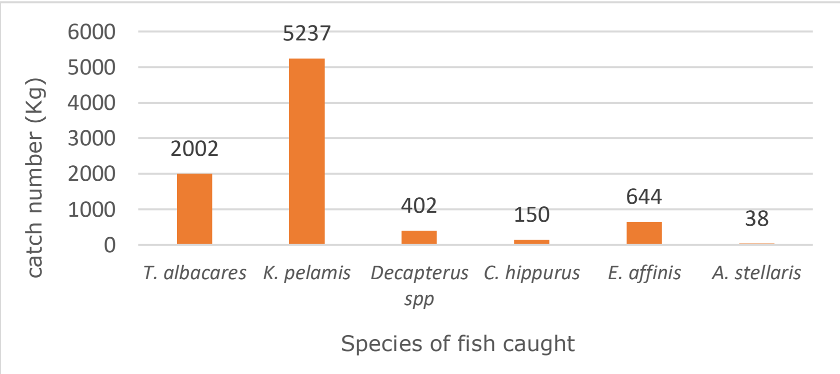


Figure 3. The number of catches on the 2nd trip.

3. The number of catches of the 3rd trip: The 3rd trip was held on 09 to 18 May 2022 with 10 days of catching and 10 settings. The catches on this trip were dominated by *K. pelamis*. The composition of the catch was: *T. albacares* (3,503 kg), *K. pelamis* (10,378 kg), *D. russelli* (5,866 kg), *C. hippurus* (143 kg), *Loligo* (497 kg), *E. bipinnulata* (154 kg), with a total of 20,541 kg.

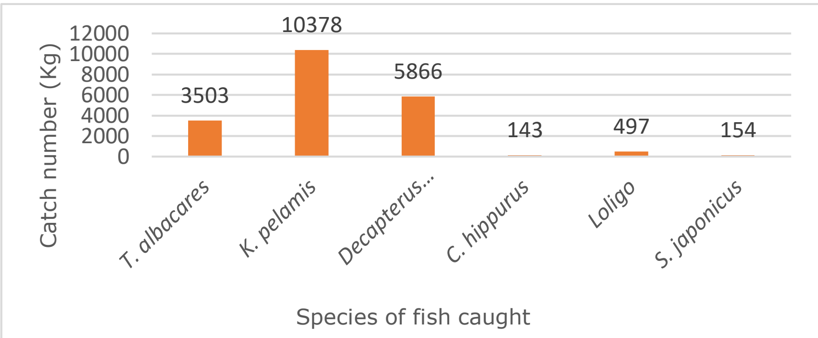


Figure 4. The catch of the 3rd trip.

Catch composition. In 3 trips with 26 catches, the catch was 40,200 kg. *K. pelamis* dominated with as much as 18,638 kg and an average of 716 kg per setting, the 2nd highest

catch was *D. russelli* with as much as 9,105 kg and an average of 350 kg per setting, and the 3rd was *T. albacares* with as much as 8,057 kg and an average per setting of 309 kg. Meanwhile, the lowest catches were *C. hippurus* with 398 kg and *E. bipinnulata* with 154 kg and an average of 15.3 kg and 5.9 kg, respectively, for each setting. Table 1 shows the composition of the catching trips:

Table 1

Fish composition and catch number

Species	*Catch number (Kg)*			*Total*	*Average*	*Percentage (%)*
	Trip 1	*Trip 2*	*Trip 3*			
T. albacares	2,552	2,002	3,503	8,057	309	20
K. pelamis	3,023	5,237	10,378	18,638	716	46.3
D. russelli	2,837	402	5,866	9,105	350	22.6
C. hippurus	105	150	143	398	15.30	1
A. stellaris	2,332	38	0	2,370	91.15	5.9
E. affinis	337	644	0	981	37.73	2.5
E. bipinnulata	0	0	154	154	5.92	0.4
Loligo	0	0	497	497	19.11	1.3

The diagram in Figure 6 synthesizes the composition of the fish species caught.

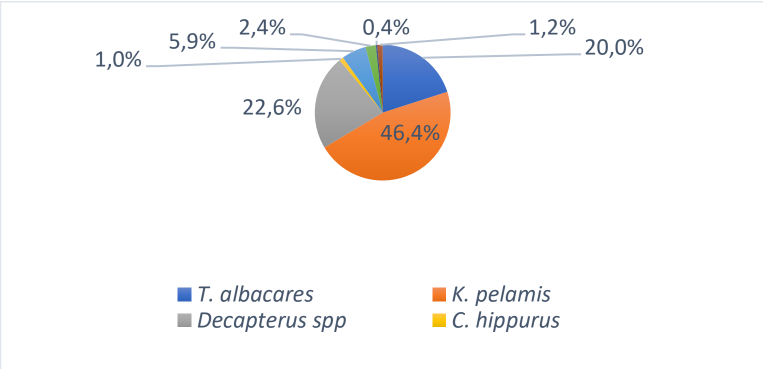


Figure 6. The composition of the caught fish species.

Distribution of Sea Surface Temperature (SST).

1. Distribution of SST in April 2022 for the 1st trip: The distribution of SST was observed to be stable, this can be seen from the 9 sampling points that were obtained during the 1st trip in April. Table 2 shows in-situ and ex-situ SST distribution values measured from 01 to 08 April 2022:

Table 2

The distribution of SST in Sadeng waters in April 2022, on the 1st trip

Date	*Position*		*SST (°C)*	
	Latitude (S)	*Longitude (T)*	*In-situ*	*Ex-situ*
01/04/2022	08°42'14''	110°31'22''	27.0	31.7
02/04/2022	08°46'05''	110°33'36''	28.1	31.3
03/04/2022	08°51'00''	110°35'12''	28.0	31.3
03/04/2022	08°49'07''	110°36'05''	28.5	31.4
04/04/2022	08°52'07''	110°36'10''	29.0	31.5
05/04/2022	08°41'47''	110°33'00''	27.1	31.5
06/04/2022	08°38'05''	110°51'51''	26.7	31.2
07/04/2022	08°47'00''	110°34'00''	29.2	31.1
08/04/2022	08°43'12''	110°33'26''	30.1	31.7
	Average		28.1	31.4

Zulkhasyni (2015) stated that in general high SST occurs in the west season to the transition season, where the west season starts in September and ends in February, every year. The *K. pelamis* was caught at a temperature range of 29 to 30°C from November to March (Nugraha et al 2020). According to Yeka et al (2022), the potential area for catching *K. pelamis* has a close relationship with the environmental parameters, especially the chlorophyll-a, whose optimum ranges from 0.12 to 0.22 mg m^{-3}. SST in-situ of Sadeng waters in April 2022 ranged from 26.7 to 30.1°C. The highest SST occurred in April 8 2022, reaching 30.1°C, while the lowest temperature occurred on April 6, 2022, reaching 26.7°C. The average *in-situ* SST in April 2022 on the first trip was 28.1°C and the average *ex-situ* temperature was 31.4°C, as illustrated in Figure 6.

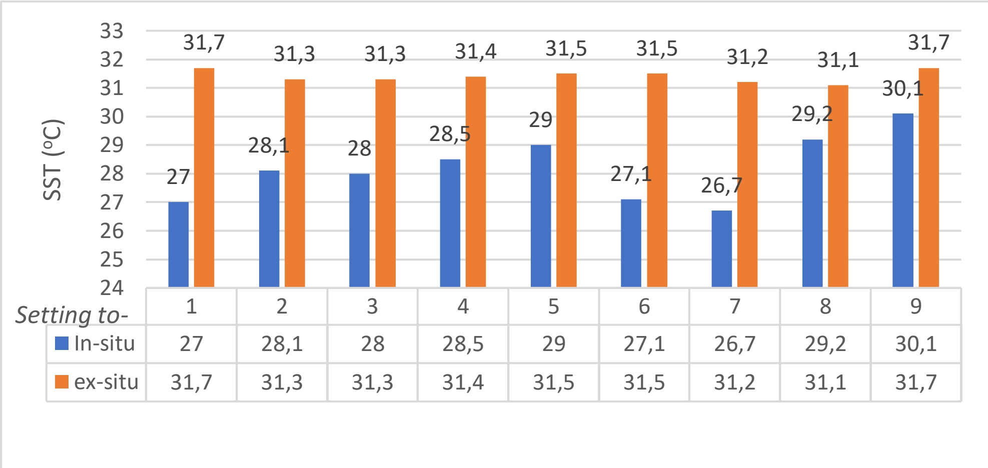


Figure 6. SST distribution in the 1st trip.

The highest number of catches occurred at the setting 9, with a total of 2,121 kg, at a high SST, reaching 30.1°C, while the least catch occurred at the setting 1, with a total catch of 345 kg, at a lower SST, of 27°C. This shows that in April 2022 if the SST value is high, the number of catches will be high and vice versa if the SST is low, the number of catches will also be low. The comparison of SST with the number of catches in April 2022 can be seen in Figure 7 below:

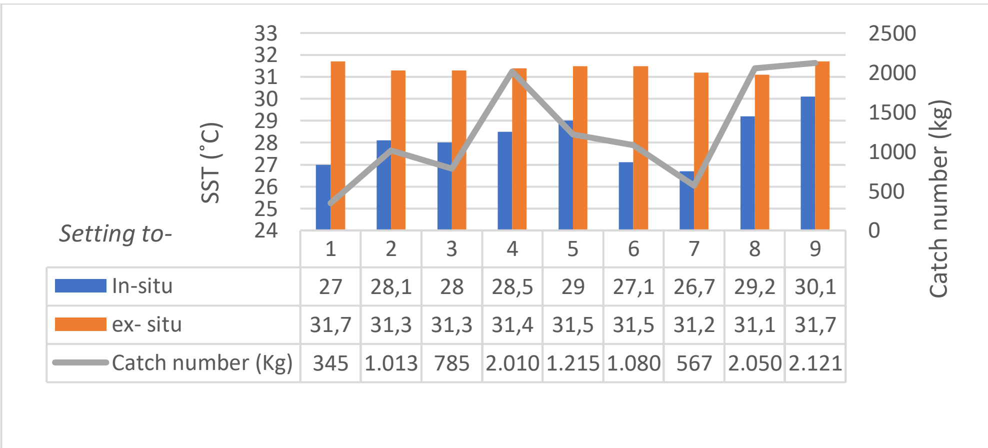


Figure 7. Comparison of SST with catch number in April 2022 on the 1st trip.

2. Distribution of the SST in April 2022 for the 2nd trip: This month, the SST data collection method was carried out in-situ and ex-situ at 7 points of the fishing ground, as observed in Table 3.

Table 3

The distribution of SST in Sadeng waters in April 2022 on the 2nd trip

Date	*Position*		*SST (°C)*	
	Latitude (S)	*Longitude (E)*	*In-situ*	*Ex-situ*
10/04/2022	08°36'38"	110°38'20"	30.2	31.7
11/04/2022	08°37'44"	110°29'54"	29.7	29.9
12/04/2022	08°35'20"	110°34'19"	27.5	30.1
13/04/2022	09°05'52"	110°09'27"	29.8	30.1
14/04/2022	08°32'25"	110°35'24"	28.5	30.1
15/04/2022	08°30'37"	110°38'14"	30.1	30.3
16/04/2022	08°30'25"	110°32'43"	28.3	29.4
	Average		29.1	30.2

Based on the data above, it can be seen that for all 7 sampling points, the SST distribution in April 2022 looks stable, ranging from 27.5 to 30.2°C. The highest temperature increase occurred on 10th of April 2022, reaching 30.2°C, while the lowest temperature occurred on April 12th of 2022, with a temperature reaching 27.5°C. The in-situ average in April 2022, on the 2nd trip, was 29.1°C and the ex-situ average was 30.2°C.

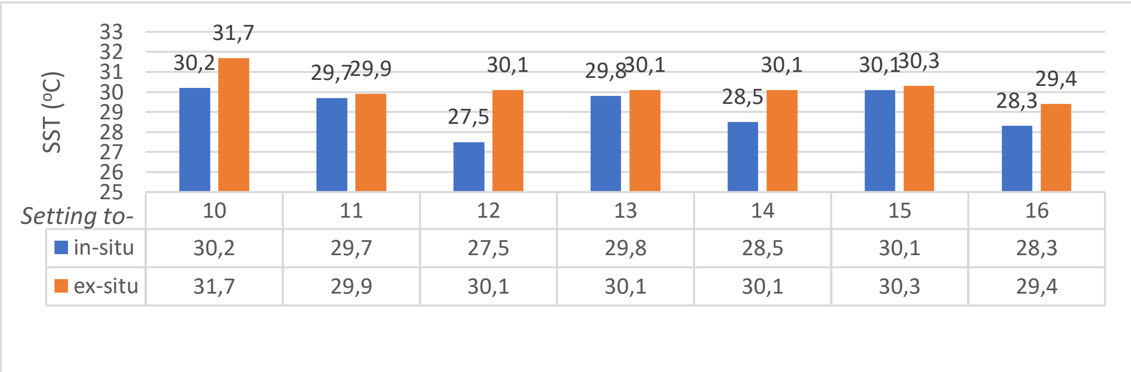


Figure 8. SST distribution on the 2nd trip.

In Figure 9, the comparison of the SST value with the catch in April 2022 shows that the highest of catch number occurred in the 12th setting, with as much as 2,053 kg, at an SST value reaching 27.5°C. Meanwhile, the smallest number of catches occurred in the 11th setting, with as much as 566 kg and an SST reaching 29.7°C. This shows that in April 2022, if the SST is high then the catch decreases and conversely, if the SST is low then the catch number is high, inversely proportional to the 1st trip.

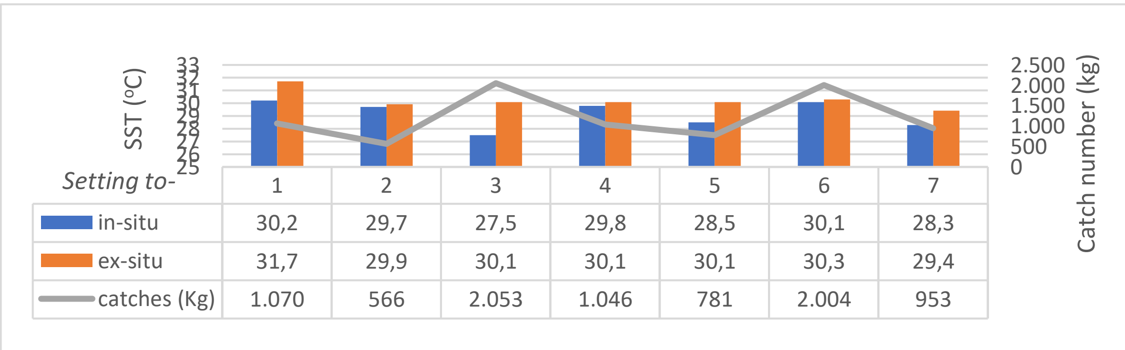


Figure 9. Comparison of the SST value and the catch quantity in April 2022, on the 2nd trip.

3. Distribution of the SST in May 2022, for the 3rd trip: In May 2022 the sampling point method was carried out directly on the satellite imagery, 10 times, as shown in Table 4:

Table 4

The distribution of SST in Sadeng waters in May 2022, on the 3rd trip

Date	*Position*		*SST (°C)*	
	Latitude (S)	*Longitude (E)*	*in-situ*	*Ex-situ*
09/05/2022	08°28'50"	110°08'51"	28.2	30.3
10/05/2022	08°44'19"	110°25'58"	29.1	29.7
11/05/2022	08°46'04"	110°54'56"	30.2	29.6
12/05/2022	09°09'10"	110°16'09"	30.3	30.3
13/05/2022	09°41'15"	109°59'03"	28.6	29.5
14/05/2022	09°27'33"	109°54'56"	27.7	28.8
15/05/2022	08°57'29"	110°06'22"	28.3	29.1
16/05/2022	08°46'14"	110°37'47"	27.7	30.1
17/05/2022	08°43'39"	110°46'36"	27.6	30.2
18/05/2022	08°33'23"	110°34'50"	28.3	28.5
Average			28.6	29.6

Based on Table 4 and Figure 10, SST fluctuations occurred in May 2022. The SST distribution was stable, ranging from 27.6 to 30.3°C. The highest SST occurred on 12 May 2022, reaching 30.3°C, while the lowest SST, of 27.6°C, occurred on 17 May 2022. The average SST in-situ in May, on the 3rd trip, was 28.6°C and the ex-situ average was 29.6°C.

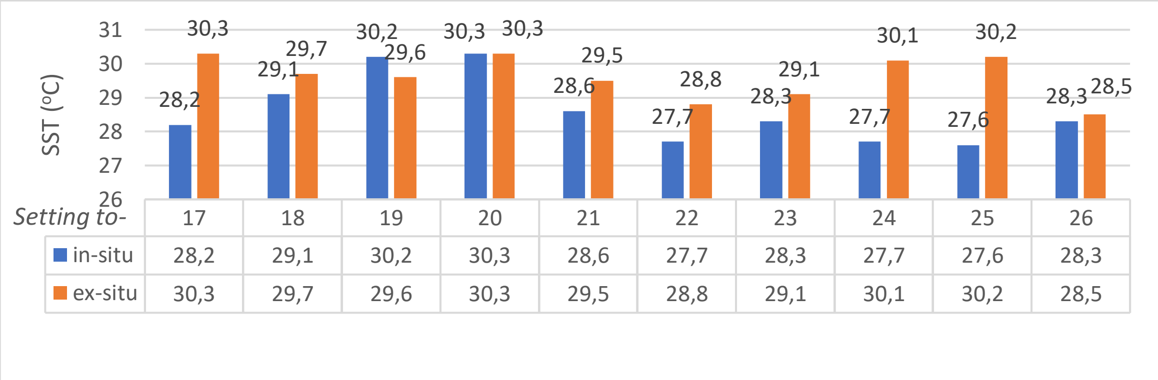


Figure 10. SST distribution in the 3rd trip.

In Figure 11, the comparison of SST with the highest catches number in May 2022, occurred at the setting 23, with a total of 5,045 kg, at a high SST value of 28.3°C. The lowest catches number on the 3rd trip occurred at the 25th setting, with a total of 641 kg and a SST reaching 27.6°C. Based on the previous findings, it can be concluded that in May 2022 if the SST is high, the catches number is high and if the SST is low, the catches number is low too.

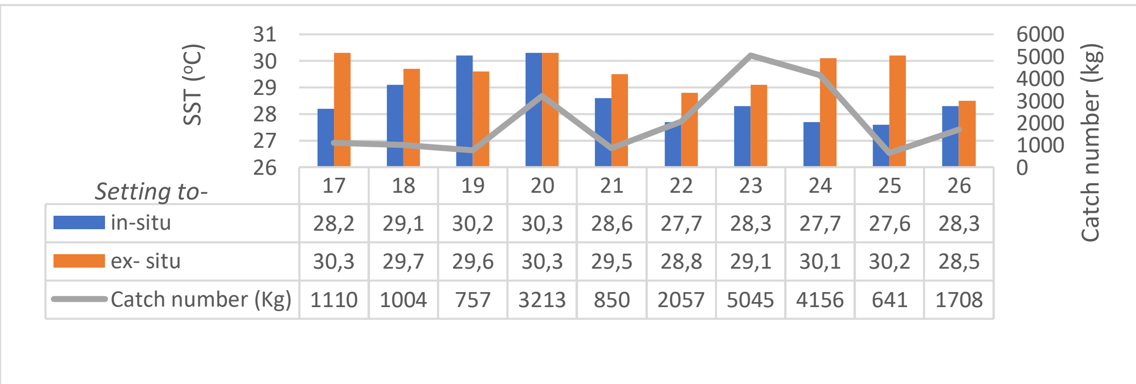


Figure 11. Comparison of SST with the catches number in May 2022 on the 3rd trip.

Chlorophyll-a concentration. One of the waters fertility factors is the availability of chlorophyll-a in the waters. According to Nufus et al (2017), the fertility level of coastal waters can be assessed from the biological and chemical characteristics, especially from the availability of essential nutrients. Based on the Table 5, the concentration of chlorophyll-a in Sadeng waters tends to experience fluctuations.

Table 5

Concentration of chlorophyll-a in Sadeng waters in 2017 to 2021

Period	*Chlorophyll-a (mg m^{-3})*				
(Month/year)	*2017*	*2018*	*2019*	*2020*	*2021*
April	0.38	0.33	0.58	0.28	0.39
May	0.40	0.73	0.76	0.34	0.41

The highest value of chlorophyll-a, 0.76 mg m^{-3}, occurred in May 2019, while the lowest value occurred in April 2020, with a value of 0.28 mg m^{-3}, as observed in Figure 12. The high and low values of chlorophyll-a are influenced by the nutrients content in the waters, which is also closely related to the abundance of phytoplankton. If the nutrients in the waters are abundant, the chlorophyll-a value will also be high. In addition, other factors that can affect the level of chlorophyll-a in waters are the temperature and salinity.

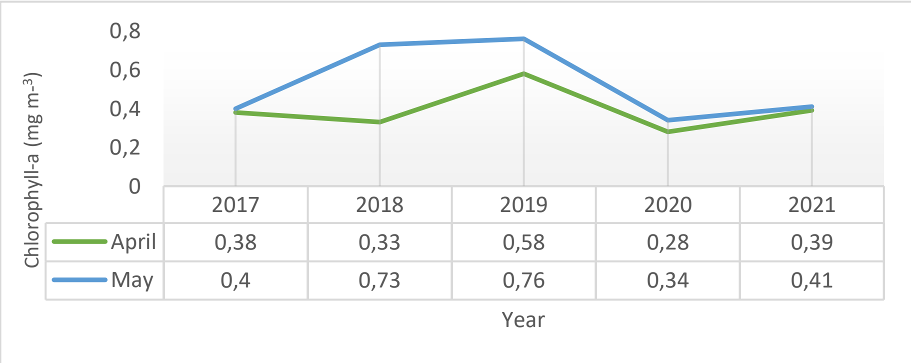


Figure 12. Chlorophyll-a concentration in 2017–2021.

1. Concentration of chlorophyll-a in April 2022, on the 1st trip: The distribution of chlorophyll-a concentration in April seemed to fluctuate. This can be seen from the 9 sampling points obtained from the NASA Ocean Color level 3, with a daily period, as it can be seen in Table 6.

Table 6

The concentration of chlorophyll-a in Sadeng waters in April 2022 for the 1st trip

Date	*Position*		*Chlorophyll-a*	*Catch*
	Latitude (S)	*Longitude (E)*	*(mg m^{-3})*	*number (kg)*
01/04/2022	08°42'14''	110°31'22''	0.13	345
02/04/2022	08°46'05''	110°33'36''	0.15	1,013
03/04/2022	08°51'00''	110°35'12''	0.15	785
03/04/2022	08°49'07''	110°36'05''	0.12	2,010
04/04/2022	08°52'07''	110°36'10''	0.15	1,215
05/04/2022	08°41'47''	110°33'00''	0.14	1,080
06/04/2022	08°38'05''	110°51'51''	0.14	567
07/04/2022	08°47'00''	110°34'00''	0.15	2,050
08/04/2022	08°43'12''	110°33'26''	0.13	2,121
	Average		0.14	1,242

Based on Table 6 above, at the 9 sampling points observed during this trip, the highest increase in the value of chlorophyll-a occurred on 1st April 2022 with a concentration value of 0.15 mg m^{-3}. Meanwhile, the lowest chlorophyll-a value occurred on April 3rd 2022, with a chlorophyll-a concentration value of 0.12 mg m^{-3}. The average concentration of chlorophyll-a on the 1st of April trip was 0.14 mg m^{-3}.

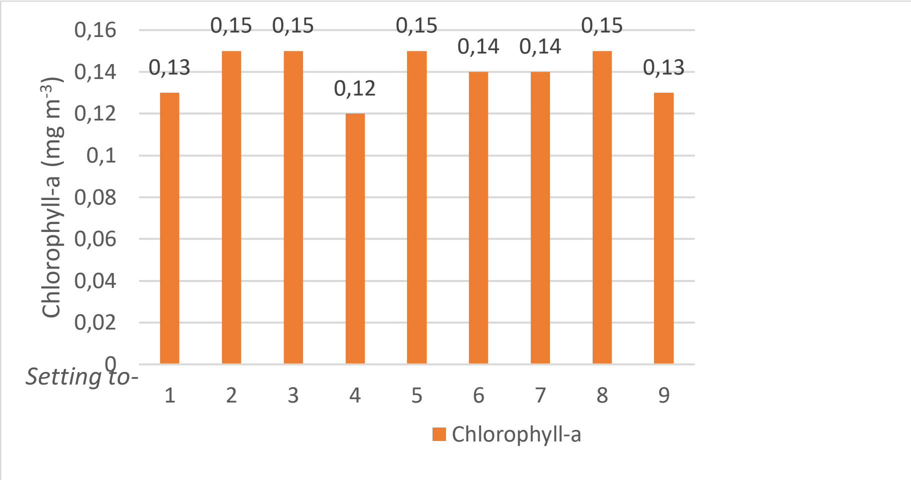


Figure 13. Chlorophyll-a concentration in April 2022, on the 1st trip.

In Figure 14 the comparison of the value of chlorophyll-a and the catches number in April 2022 shows that the highest catches number occurred in the 8th setting, with a total of 2,050 kg, at a high concentration of chlorophyll-a, of 0.15 mg m^{-3}. Meanwhile, the smallest catch number on the 1st trip occurred in the first setting, with the amount of 345 kg where the chlorophyll-a concentration value reached 0.13 mg m^{-3}. It can be concluded that in April 2022, if the concentration of chlorophyll-a is high then the catches number is high. Conversely, if the chlorophyll-a is low then the catches number is also low.

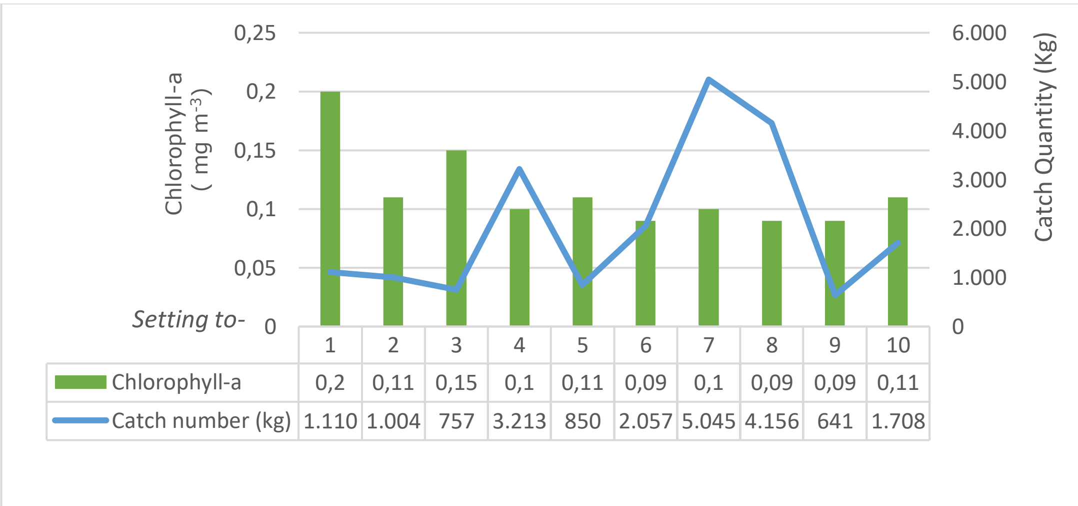


Figure 14. Comparison graph of chlorophyll-a value with the catches quantity on the 1st April 2022 trip.

1. Concentration of chlorophyll-a in Sadeng waters in April 2022 on the second trip: In April 2022, we considered 7 sampling points during the fishing operations; data were obtained from the NASA Ocean Color satellite (NASA 2007). The detailed chlorophyll-a concentration values can be seen in Table 7:

Table 7

The concentration of chlorophyll-a in Sadeng waters in April 2022, for the second trip

Date	*Position*		*Chlorophyll-a (mg m-³)*	*Catches number (kg)*
	Latitude (S)	*Longitude (T)*		
10/04/2022	08°36'38"	110°38'20"	0.11	1,070
11/04/2022	08°37'44"	110°29'54"	0.12	566
12/04/2022	08°35'20"	110°34'19"	0.11	2,053
13/04/2022	09°05'52"	110°09'27"	0.12	1,046
14/04/2022	08°32'25"	110°35'24"	0.10	781
15/04/2022	08°30'37"	110°38'14"	0.11	2,004
16/04/2022	08°30'25"	110°32'43"	0.09	953
	Average		0.10	1,210

Figure 15 is a graph of the results of the 7 sampling points taken during the 2nd trip:

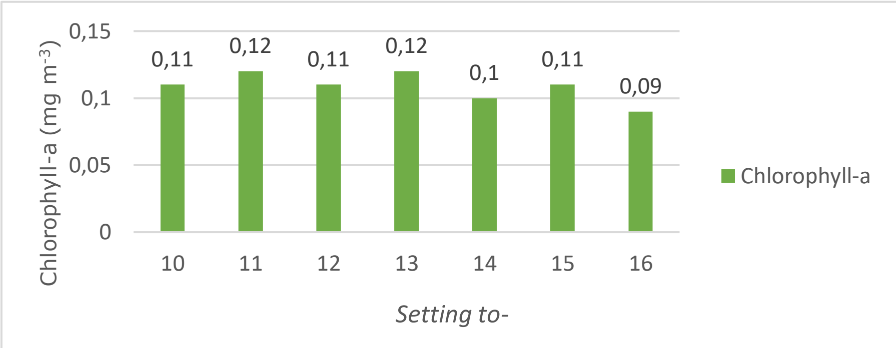


Figure 15. chlorophyll-a value in April 2022, on the 2nd trip.

Based on the data above, it can be seen that from 7 sampling points taken during this trip, the highest increase in the value of chlorophyll-a occurred on April 13th 2022, with a concentration value of 0.12 mg m^{-3}. Meanwhile, the lowest chlorophyll-a value occurred on April 16th 2022, with a chlorophyll-a concentration value of 0.09 mg m^{-3}. The average concentration of chlorophyll-a in April, at the 1st fishing operation trip, was of 0.10 mg m^{-3}.

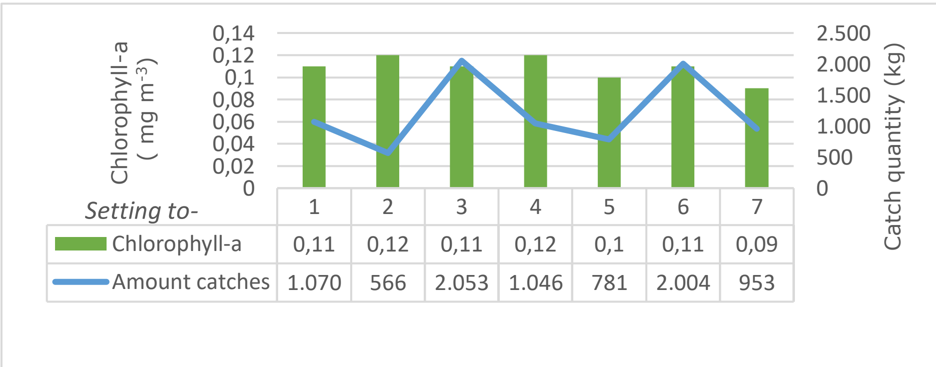


Figure 16. Comparison of the value of chlorophyll-a with the catches quantity, on the 2nd April 2022 trip.

In Figure 16 the comparison of the value of chlorophyll-a and the catch number in April 2022 shows that the highest catch number occurred at the 15th setting, with a total of 2,053 kg, inversely proportional to the chlorophyll-a concentration (0.11 mg m^{-3}, the lowest value). The smallest catch on the 2nd fishing operation trip occurred at the 11th setting, with the amount of 566 kg, when the value of chlorophyll-a concentration was the highest (0.12 mg m^{-3}). From the findings above, it can be concluded that in April the catch quantities are inversely proportional to the values of chlorophyll-a concentrations.

1. Concentration of chlorophyll-a in Sadeng waters in May 2022 on the third trip: The concentration of chlorophyll-a in May 2022 was observed to be stable, ranging from 0.09 to 0.15 mg m^{-3}. In May 2022, 10 sample points were taken using the satellite imagery obtained from NASA Ocean Color. The concentration of chlorophyll-a in Sadeng waters in May 2022 is presented in Table 8.

Table 8

The concentration of chlorophyll-a in Sadeng waters in May 2020, for the 3rd trip

Date	*Position*		*Chlorophyll-a (mg m^{-3})*	*Catch number (kg)*
	Latitude (S)	*Longitude (T)*		
09/05/2022	08°28'50''	110°08'51''	0.20	1,110
10/05/2022	08°44'19''	110°25'58''	0.11	1,004
11/05/2022	08°46'04''	110°54'56''	0.15	757
12/05/2022	09°09'10''	110°16'09''	0.10	3,213
13/05/2022	09°41'15''	109°59'03''	0.11	850
14/05/2022	09°27'33''	109°54'56''	0.09	2,057
15/05/2022	08°57'29''	110°06'22''	0.10	5,045
16/05/2022	08°46'14''	110°37'47''	0.09	4,156
17/05/2022	08°43'39''	110°46'36''	0.09	641
18/05/2022	08°33'23''	110°34'50''	0.11	1,708
	Average		0.11	2,054

The data was synthesized in Figure 17:

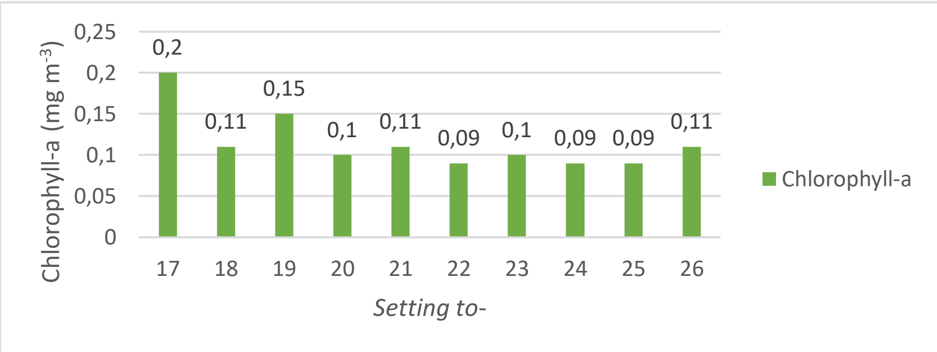


Figure 17. Chlorophyll-a concentration in May 2022, on the 3rd trip.

In Table 8 and Figure 17, it can be observed that the concentration of chlorophyll-a fluctuates in May. The highest chlorophyll-a value occurred on 11th of May 2022, of 0.15 mg m^{-3}, while the lowest chlorophyll-a value occurred on 14th, 16th, and 17th of May 2022, of 0.09 mg m^{-3}. The average concentration of chlorophyll-a in April 2022, on the fourth fishing operation trip, was 0.11 mg m^{-3}.

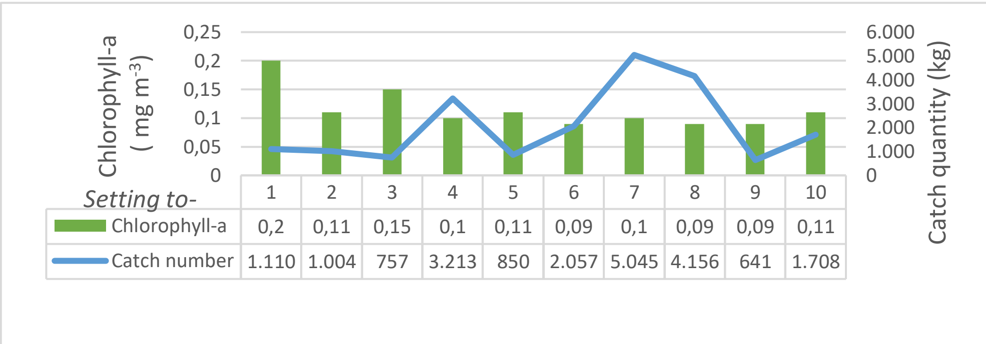


Figure 18. Comparison of chlorophyll-a concentration with the catching quantity in May 2022.

In Figure 18, the comparison of the value of chlorophyll-a and the catching quantity in May 2022 shows that the highest quantity of catches occurred at the setting 23, with a total of 5,045 kg, at a high concentration of chlorophyll-a, with a value of 0.10 mg m^{-3}. Meanwhile, the smallest catch number on the 1st fishing operation trip occurred at the 25th setting, with a total of 641 kg where the chlorophyll-a concentration value reached 0.09. Based on the previous findings, it can be concluded that in May, if the concentration of chlorophyll-a is high then the catch number is high or conversely, if the chlorophyll-a is low then the catch number is also low.

SST data is obtained based on the analysis of MODIS images. The data is then verified against the measurements. The verification results are shown in Table 9:

Table 9

Verification of in-situ SST data with satellite imagery

No. setting	*Data in-situ*	*Data ex-situ*	*Value of error (%)*
1	27.0	28.28	4.92
2	28.1	28.28	0.69
3	28.0	28.29	1.12
4	28.5	26.78	6.69
5	29.0	27.42	6.08
6	27.1	27.39	1.12
7	26.7	28.18	5.69
8	29.2	25.7	13.46
9	30.1	26.98	12.00
10	30.2	28.28	7.38
11	29.7	26.08	13.92
12	27.5	26.21	4.96
13	29.8	27.66	8.23
14	28.5	27.53	3.73
15	30.1	28.04	7.92
16	28.3	27.56	2.85
17	28.2	27.11	4.19
18	29.1	28.4	2.69
19	30.2	28.32	7.23
20	30.3	27.41	11.12
21	28.6	26.13	9.50
22	27.7	28.86	4.46
23	28.3	28.33	0.12
24	27.7	28.56	3.31
25	27.6	27.01	2.27
26	28.3	28.48	0.69
Mean relatives error	28.61	27.59	5.63

According to Fadika et al (2014), data verification is done by calculating the MRE. In-situ SST data verification against the Aqua MODIS satellite image data, at 26 sampling points, shows that the average relative error value is 5.63%. This value is included in the correct category, where the resulting value is no more than 30%. Jaelani et al (2013) stated that values with an average relative error of less than 30% in image data processing can be used for further analysis. Based on the previous statement, it can be concluded that the SST satellite image data can be further analyzed because it has an accuracy of 91.89%. According to Simanjuntak et al (2012), among the factors that cause errors in the satellite image datais a reading error at the time of observation.

Analysis of the effect of SST and chlorophyll-a on the total catch.

1. Normality test

The normality test is part of the data analysis requirements. It is a classical assumption test: before performing a statistical analysis to test the hypothesis, a

regression analysis is used to determine whether the residual values are normally distributed or not. The residual is normally distributed if the significance is more than 0.05 (Gunawan 2020).

In Table 10, the test results, obtained with the SPSS software, can be seen. The asymptotic normality obtained had the significance value (sig.)0.200 (>0.05), so the residual values can be considered as normally distributed.

Table 10

Normality test

One-Sample Kolmogorov-Smirnov Test		
		Unstandardized residual
N		26
Normal parameters[a,b]	Mean	.0000000
	Std. deviation	1016.50300169
Most extreme differences	Absolute	.108
	Positive	.108
	Negative	-.071
Test statistic		.108
Asymp. Sig. (2-fish)		.200[c,d]

[a] Test distribution is Normal; [b] Calculated from data; [c] Lilliefors Significance Correction; [d] This is a lower bound of the true significance.

The basis for decision making in the K - S Normality test is as follows:
- If the significance value (sig.) >0.05 then the data is normally distributed. On the contrary,
- If the significance value (sig.) <0.05, then the data is not normally distributed.

2. Linearity test

In Table 11 of the SST - catches relationship’s Deviation from Linearity, the significance value (sig.) obtained is 0.868, greater than 0.05. So it can be concluded that there is a significant linear relationship between the SST variable (X) and the number of catches (Y).

Table 11

Linearity test of the catch number with SST

ANOVA Table							
			Sum of squares	*df*	*Mean square*	*F*	*Sig.*
Catches * SST	Between groups	(Combined)	21329060.787	19	1122582.147	0.539	0.858
		Linearity	1812590.669	1	1812590.669	0.870	0.387
		Deviation from linearity	19516470.118	18	1084248.340	0.521	0.868
	Within groups		12497302.667	6	2082883.778		
	Total		33826363.454	25			

In Table 12 of the chlorophyll-a catches relationship’s Deviation from Linearity, the significance value is 0.889, greater than 0.05. So it can be concluded that there is a significant linear relationship between the chlorophyll-a variable (X) and the catch number (Y).

Table 12

Linearity test of total catch with chlorophyll-a

ANOVA table							
			Sum of squares	*df*	*Mean square*	*F*	*Sig.*
Catches * Chlorophyll-a	Between groups	(Combined)	10614882.479	7	1516411.783	1.176	0.364
		Linearity	7753006.461	1	7753006.461	6.012	0.025
		Deviation from linearity	2861876.018	6	476979.336	0.370	0.889
	Within groups		23211480.975	18	1289526.721		
	Total		33826363.454	25			

The basis for decision making in the linearity test by comparing the significance value is as follows:

- If the value of Deviation from Linearity sig.>0.05, then there is a significant linear relationship between the independent variable and the dependent variable.
- If the value of Deviation from linearity sig.<0.05, then there is no significant linear relationship between the independent variable and the dependent variable.

3. Multicollinearity test

The multicollinearity test was used to test whether the regression model found a correlation between the independent variables. If a correlation exists, then there is a multicollinearity (multico) problem (Gunawan 2020). Multicollinearity is detected by examining the Variance Inflation Factor (VIF) value and tolerance, with reference to certain conditions: if the VIF value is less than 10 and the tolerance is more than 0.1, it is considered that there is no multicollinearity (Gunawan 2020).

In Table 13 it is shown that the value of the collinearity tolerance of the two variables is 0.90, more than 0.10, and the VIF statistic value of 1.11 is less than 10.

Table 13

Multicollinearity test

Coefficients[a]								
Model		*Unstandardized coefficients*		*Standardized coefficients*	*t*	*Sig.*	*Collinearity statistics*	
		B	*Std. err.*	*Beta*			*Tolerance*	*VIF*
1	(Constant)	2421.912	998.784		2.425	0.024		
	SST	1.219	2.630	0.089	0.464	0.647	0.900	1.111
	Chlorophyll-a	-117.383	50.033	-0.451	-2.346	0.028	0.900	1.111

[a] Dependent variable: Cathes.

So it can be concluded that the data above does not occur multicollinearity between independent variables. The basis for making decisions on the multicollinearity test with tolerance is as follows:

- If the tolerance value is greater than 0.10, it means that there is no multicollinearity in the regression model.
- If the tolerance value is less than 0.10, it means that there is multicollinearity in the regression model.

4. Heteroscedasticity test

The heteroscedasticity test aims to test whether in the regression model there is an inequality of variance from one observation to another. A good regression model is one without heteroscedasticity or with homoscedasticity (Gunawan 2020). Based on Table 14, it can be observed that the significance value (sig.) for the SST variable (X_1) is 0.811, while the significance value (sig.) for the chlorophyll-a variable (X_2) is 0.089.

Table 14

Heteroscedasticity test

	Coefficients[a]					
	Model	*Unstandardized coefficients*		*Standardized coefficients*	*t*	*Sig.*
		B	*Std. Error*	*Beta*		
1	(Constant)	2825.294	3687.361		0.766	0.452
	SST	-30.753	126.844	-0.048	-0.242	0.811
	Chlorophyll-a	-9494.419	5333.793	-0.354	-1.780	0.089

[a] Dependent variable: Cathes.

Because the significance value of the two variables above is greater than 0.05, according to the basis for decision making in the Glejser test, it can be concluded that there is no symptom of heteroscedasticity. The basis for decision making in the heteroscedasticity test, using the Glejser conditions, is as follows:

- If the significance value (Sig.) is greater than 0.05, then the conclusion is that there is no heteroscedasticity symptom in the regression model.
- On the other hand, if the significance value (sig.) is less than 0.05, the conclusion is that heteroscedasticity is occurring.

5. Multiple linear regression

This analysis is used to measure the magnitude of the influence between the independent and dependent variables. There are several eligibility requirements that must be met when regression analysis is used, namely: the number of samples used must be the same, the number of independent variables is 1, the residual value must be normally distributed, there is a linear relationship, there are no symptoms of heteroscedasticity.

Based on Table 15, it is explained that the correlation coefficient (R) of 0.471 between the variables sea surface temperature and chlorophyll-a with the catch means that there is a very strong positive relationship between SST and chlorophyll-a with the fish catch.

Table 15

Model summary

Model summary				
Model	*R*	*R Square*	*Adjusted R square*	*Std. error of the estimate*
	.471[a]	0.221	0.154	1036.89027

[a] Predictors: (Constant), Chlorophyll-a, SST.

Meanwhile, the R square coefficient obtained is 0.221 or 22%, meaning that the independent variables (SST and chlorophyll-a) affect the Y variable (catch) by 22% while the rest of the catch is influenced by other variables. Based on Table 16, it is observed that the coefficient test of the SST variable produces $t_{count} < t_{table}$ (0.598<2.069) and the significance value obtained is 0.556 (Sig>0.05) so that SST only weakly affects the catch.

Table 16

t_{test}

	Coefficients[a]					
	Model	*Unstandardized coefficients*		*Standardized coefficients*	*t*	*Sig.*
		B	*Std. error*	*Beta*		
1	(Constant)	2262.186	977.214		2.315	0.030
	SST	1.539	2.573	0.116	0.598	0.556
	Chlorophyll-a	-106.246	48,953	-0.421	-2.170	0.041

[a] Dependent variable: Cathes.

Meanwhile, by testing the coefficient of chlorophyll-a variable, it was found that $t_{count}>t_{table}$ (2.170>2.069), with a significance value of 0.041 (Sig<0.05) so that it is known thatchlorophyll-a has a strong influence on the catch.

$$Y = 2262.186 + 1.539\ X_1 - 106.246\ X_2$$

The above equation describes the effect of changing the values of the independent variables, in the regression algorithm. The interpretation is as follows:

a. The intercept (2262.186) in this regression model represents the mean value of the catch (the response variable) when SST and Chlorophyll a (predictor variables) are equal to zero.
b. Every increase of 1^0 in SST (X_1) results in an increase of 1.539 in the catch (Y).
c. Every 1 mg m^{-3} increase in chlorophyll-a (X_2) results in a decrease of 106.246 in the catch (Y) since the Chlorophyll has a negative regression coefficient with the catches.

In Table 17, able it can be observed that $F_{count}<F_{table}$ (3.271<3.40), while the significance value obtained is 0.056 (Sig>0.05), so it can be concluded that there is an influence between the combined SST and chlorophyll-a variables on the catch quantities.

Table 17

Significance test (f_{test})

ANOVA[a]						
Model		*Sum of squares*	*df*	*Mean square*	*F*	*Sig.*
1	Regression	7034292.282	2	3517146.141	3.271	.056[b]
	Residual	24728253.103	23	1075141.439		
	Total	31762545.385	25			

[a] Dependent variable: Catch number; [b] Predictors: (Constant), Chlorophyll-a, SST.

Conclusions. The results of the significance test showed that SST had a partial influence on the catch number, while chlorophyll-a had a significant effect on the catch quantity. Meanwhile, if the test was carried out simultaneously, the results would obtaine a significance of 0.056, which means that the combined SST and chlorophyll-a have an influence on the catch quantities.

Conflict of interest. The authors declare no conflict of interest.

References

Abidin A. F., Amron, Marzuki M. I., 2020 Relationship between chlorophyll-a and sea surface temperarure to tuna catch in the Southern Water of Java. Science Research Journal 22(2):55-68.

Alfajri A., Mubarak M., Mulyadi A., 2017 [Spatial and Temporal analysis of sea surface temperature distribution in West Sumatra waters]. Indonesian Environmental Dynamics 4(1):65-74. [In Indonesian].

Anggraeni R., Solichin A., Saputra S. W., 2015 [Several biological aspects of skipjack tuna (*Katsuwonus pelamis*) in relation to fisheries management in PPP Sadeng, Gunungkidul Regency, Yogyakarta]. Management of Aquatic Resources Journal (MAQUARES) 4(3):230-239. [In Indonesian].

Azizah A., Wibisana H., 2020 [Temporal analysis of sea surface temperature distribution from 2018 to 2020 with Terra Modis image data]. Marine Journal: Indonesian Journal of Marine Science and Technology 13(3):196–205. [In Indonesian].

Fadika U., Rifai A., Rochaddi B., 2014 [Seasonal wind direction and speed and its relation to the distribution of sea surface temperature in Southern Pangandaran, West Java]. Journal of Oceanography 3(3):429–437. [In Indonesian].

Gunawan C., 2020 [Proficient in Mastering SPSS practical guide to processing research data (Deeppublish)]. Deepublish, Yogyakarta 210 p. [In Indonesian].

Hastuti, Wirasatriya A., Maslukah L., Subardjo P., Kunarso, 2021 [The effect of chlorophyll-a factors and sea surface temperature on anchovy catches (*Stelesphorus* sp) in Jepara]. Indonesian Journal of Oceanography 3(2):1-9. [In Indonesian].
Hendiarti N., Ohde T., 2004 Investigation of different processes in Indonesian waters using SeaWiFS data. Deep Sea Research Part II Topical Studies in Oceanography 51(1-3):85-97.
Jaelani L. M., Matsushita B., Yang W., Fukushima T., 2013 Evaluation of four MERIS atmospheric correction algorithms in Lake Kasumigaura, Japan. International Journal of Remote Sensing 34(24):8967–8985.
Jayawiguna M. H., Triyono, Wibowo S., 2019 [Overview of the potential, development and challenges of utilizing marine and fishery resources at FMA-RI 573]. AMAFRAD Press p. 3-10. [In Indonesian].
Kusmana C., Hikmat A., 2015 The biodiversity of flora in Indonesia. Journal of Natural Resources and Environmental Management 5(2):187–198.
Ma'mun A., Priatna A., Hidayat T., Nurulludin. 2017 Distribution and potential resources of pelagic fish in Fisheries Management Area of the Republic of Indonesia (FMA-RI 573) Indian Ocean. Indonesian Fisheries Research Journal (JPPI) 23:47–56.
Nufus H., Karina S., Agustina S., 2017 [Analysis of chlorophyll-a distribution and water quality in the Krueng Raba Lhoknga River, Aceh Besar]. Scientific Journal of Marine and Fisheries Students Unsyiah 2(1):58–65. [In Indonesian].
Nugraha E., Gunawan R., Danapraja S., Yusrizal, Kusdinar A., Waluyo A. S., Hutajulu J., Prayitno H., Halim S., Sutisna D. H., 2020 The sea surface temperature effect on the length and size of skipjack tuna (*Katsuwonus pelamis*) catches in the Banda Sea, Indonesia. AACL Bioflux 13(1):1-18.
Nikijuluw V., 2008 [The status of Indian Ocean tuna resources and its implications for Indonesia]. Journal of Indonesian Fisheries Policy 1(1):31-44. [In Indonesian].
Nurman A., 2010 [Utilization of fashionable data to detect fishing areas on the East and West Coasts of North Sumatra]. Journal of Geography 2(2):17-30. [In Indonesian].
Sidik A., Agussalim A., Ridho M. R., 2015 [The accuracy of the value of chlorophyll-a concentration and sea surface temperature using remote sensing data in the waters of Anggantang Island, Sembilang National Park]. Maspari 7(2):25–32. [In Indonesian].
Simanjuntak B. L., Handoyo G., Sugianto D. N., 2012 [Analysis of bathymetry and tidal components for determination of additional depth of jetty ponds in Tanjung Gundul Bengkayang Waters – West Kalimantan]. Journal of Oceanography 1(1):1-8. [In Indonesian].
Sugiyono, 2019 [Quantitative research methods]. Alphabet, 464 p. [In Indonesian].
Wahyuningrum P. I., Nurani T. W., Rahmi T. A., 2012 [Multi purpose capture fishery business in Sadeng, Gunungkidul Regency, Special Region of Yogyakarta]. Maspari Journal 4(1):10-22. [In Indonesian].
Wijopriono. 2012 [The carrying capacity of tuna fisheries resources in the Indian Ocean in relation to fisheries industrialization]. Journal of Indonesian Fisheries Policy 4(2):101-108. [In Indonesian].
Yeka A., Monika D., Rahmani R. M., Sarianto D., Fitri Y., Nurlaela E., Kusmedy B., Nugraha E., Hutajulu J., 2022 The effect of chlorophyll-a on the catches of skipjack tuna (*Katsuwonus pelamis*) in Banda Sea, Maluku, Indonesia. AACL Bioflux 15(3):1226-1237.

Received: 23 August 2021. Accepted:2022. Published online:2023.
Authors:
Priyantini Dewi, Jakarta Technical University of Fisheries, Faculty of Fishing Technology, AUP Street Pasarminggu 12520, South Jakarta, Indonesia, e-mail: prizt.dewi@gmail.com
Sutarjo, Fleet Monitoring and Operation, Directorate General of Marine and Fisheries Resources Surveillance, Medan Merdeka Timur Street No. 16, Central Jakarta, Jakarta, Indonesia, e-mail: sutarjoz79@gmail.com
Maman Hermawan, Jakarta Technical University of Fisheries, Faculty of Fishing Technology, AUP Street Pasarminggu 12520, South Jakarta, Indonesia, e-mail: mhermawan60@gmail.com
Yusrizal, Jakarta Technical University of Fisheries, Faculty of Fishing Technology, AUP Street Pasarminggu 12520, South Jakarta, Indonesia, e-mail: buyung_trc@yahoo.co.id
Mira Maulita, Jakarta Technical University of Fisheries, Faculty of Aquatic Resources Management, AUP Street Pasarminggu 12520, South Jakarta, Indonesia, e-mail: maulita.stp@gmail.com
Eli Nurlaela, Jakarta Technical University of Fisheries, Faculty of Fishing Technology, AUP Street Pasarminggu 12520, South Jakarta, Indonesia, e-mail: elimumtaza@gmail.com
Bongbongan Kusmedy, Jakarta Technical University of Fisheries, Faculty of Fishing Technology, AUP Street Pasarminggu 12520, South Jakarta, Indonesia, e-mail: bkhutapea@gmail.com
Sopiyan Danapraja, Jakarta Technical University of Fisheries, Faculty of Fisheries Extension, AUP Street Pasarminggu 12520, South Jakarta, Indonesia, e-mail: sopiyanraja@gmail.com
Erick Nugraha, Jakarta Technical University of Fisheries, Faculty of Fishing Technology, AUP Street Pasarminggu 12520, South Jakarta, Indonesia, e-mail: nugraha_eriq1@yahoo.co.id

How to cite this article:
Dewi P., Sutarjo, Hermawan M., Kusmedy B., Yusrizal, Maulita M., Nurlaela E., Danapraja S., Nugraha E., 2023 Study of sea surface temperature and chlorophyll-a to the number of fish caught in the waters of Sadeng, Yogyakarta, Indonesia. AACL Bioflux 16(1):

erick nugraha <nugraha_eriq1@yahoo.co.id>
Kepada: Eni Kovacs

Sab, 7 Jan jam 14.34

Dear Dr. Eni

I send You Final manuscript with letter of acceptance for publishing
thank you.

Erick Nugraha
Indonesia

Tampilkan pesan asli

Unduh semua lampiran sebagai file zip

Nugraha_S... .docx
1.3MB

Surat perny... .pdf
181.4kB

Study of sea surface temperature and chlorophyll-a influence on the quantity of fish caught in the waters of Sadeng, Yogyakarta, Indonesia

[1]Priyantini Dewi, [2]Sutarjo, [1]Maman Hermawan, [1]Yusrizal, [3]Mira Maulita, [1]Eli Nurlaela, [1]Bongbongan Kusmedy, [4]Sopiyan Danapraja, [1]Erick Nugraha

[1] Faculty of Fishing Technology, Jakarta Technical University of Fisheries, South Jakarta, Indonesia; [2] Fleet Monitoring and Operation, Directorate General of Marine and Fisheries Resources Surveillance, Central Jakarta, Indonesia; [3] Faculty of Aquatic Resources Management, Jakarta Technical University of Fisheries, South Jakarta, Indonesia; [4] Faculty of Fisheries Extension, Jakarta Technical University of Fisheries, South Jakarta, Indonesia. Corresponding author: E. Nugraha, nugraha_eriq1@yahoo.co.id

Abstract. Oceanographic factors can be an indicator in determining the potential of fishing areas. The sampling technique of Sea Surface Temperature (SST) and chlorophyll-a data in this study was carried out directly (in-situ) and using satellite image data that can be downloaded from NASA Ocean Color to obtain SST and chlorophyll-a data. The purpose of this study was to analyze the effect of SST and chlorophyll-a on the quantity of purse seine catches, based on multiple correlation tests and multiple linear regression analysis. Species of fish caught during the study included: yellowfin tuna *(Thunnus albacares),* skipjack tuna *(Katsuwonus pelamis),* dolphin fish *(Coryphaena hippurus),* starry triggerfish *(Abalistes stellaris)*, rainbow runner *(Elagatis bipinnulata),* scad mackerel *(Decapterus russelli)* and squid *(Loligo).* The SST was measured in-situ. In the waters of Sadeng, Yogyakarta, the SST is relatively homogeneous, ranging from 27° to 30.3°C. Data verification is carried out *ex-situ*, with the aim of testing the level of accuracy. Satellite image data was processed for as many as 26 sampling points. The relative error was of 5.63%. Correlation test results between SST variables, chlorophyll-a and catches in the waters of Sadeng, Yogyakarta were performed for the period April to May 2022. The analysis of the effect of SST and chlorophyll-a showed that SST had a weak effect, while chlorophyll-a had a significant effect on the catches), as indicated by their level of significance of 0.556 (>0.05) and 0.041 (<0.05), respectively. Meanwhile, if the test was carried out on the combination of SST and chlorophyll-a, the result would have a significance of 0.056, which means that the SST and chlorophyll-a variables together strongly influence the catch.
Key Words: Geographic Information System (GIS), satellite imagery, oceanography, MODIS.

Introduction. Sadeng waters which are included in FMA 573 have the potential as habitat for economically important fish such as skipjack tuna *(Katsuwonus pelamis)*, bigeye tuna *(Thunnus obesus),* yellowfin tuna *(Thunnus albacares),* mackerel tuna *(Euthynnus affinis),* mackerel scad *(Decapterus russelli)* and sardin *(Sardinella lemuru)* (Nikijuluw 2008; Wijopriono 2012; Wahyuningrum et al 2012; Jayawiguna et al 2019). Skipjack tuna *(Katsuwonus pelamis)* is the second largest commodity in the area (Anggraeni et al 2015; Ma'mun et al 2017). Its geographical condition favors Indonesia's biodiversity (Kusmana & Hikmat 2015). Hendiarti et al (2004) explained that Sea Surface Temperature (SST) can affect the metabolism and reproduction of organisms in the sea. The distribution of SST is very important to know because it can provide information about the front, upwelling, currents, weather/climate and fishing ground (Abidin et al 2020). Sidik et al (2015) and Azizah et al (2020) explained that the influence of SST on the growth of phytoplankton will indirectly affect the concentration of chlorophyll-a in waters. According to Alfajri et al (2017), the Aqua satellite created by NASA functions as an observation satellite in the marine field. The Aqua-Modis satellite can measure various types of water parameters, one of which is SST in the waters. Oceanographic factors that are often associated with catches are SST and chlorophyll-a (Hastuti et al 2021).

Based on the discussion above and given the lack of research on SST and chlorophyll-a influence on the catch number in Sadeng waters, the study researched if there is a relationship between these variables. The results of this research are expected to help fishermen to determine fishing areas, based on oceanographic parameters.

Material and Method

Description of the study sites. The research was conducted from March 18 to May 30 2022, by participating in activities of fishing by purse seine operating in the Indian Ocean. The research locations are as shown in Figure 1 below:

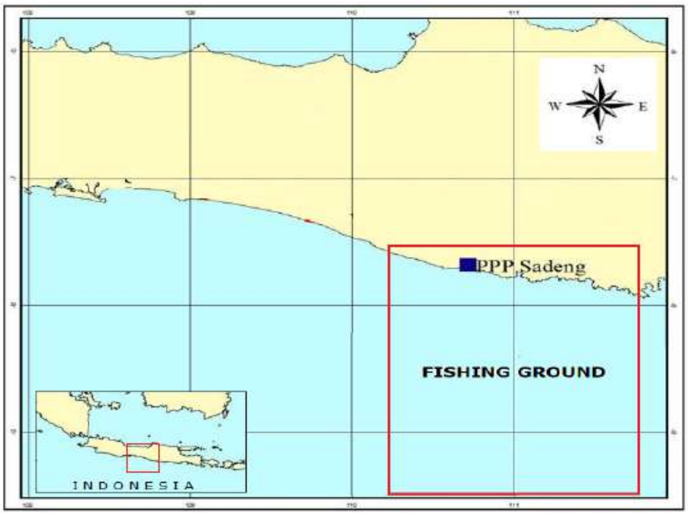


Figure 1. Map of fishing ground.

Method of collecting data. Data collection is done by collecting primary data and secondary data. Primary data concerned the fishing area position, the in-situ SST measured directly and the number of catches calculated for each trip. The secondary data were chlorophyll-a and SST images obtained by level 3 Aqua MODIS satellite imagery. Materials and tools used include: purse seine, GPS, compass, digital thermometer, software (.Excel, Seadas 7.5.3, Arcmap 10.8, SPSS), Camera, Chlorophyll-a Image, SST Image.

Data processing method. In processing MODIS data, SeaDas software was used. The results obtained are Aqua MODIS images at level 3, which produce SST values in degrees Celsius (°C) and chlorophyll-a (mg m^{-3}). Due to the relatively wider area, the projection system used is the Geographic Coordinate System (GCS) with the WGS84 datum. The processing of chlorophyll-a and SST values contained in the Aqua MODIS image map was carried out using the SeaDAS software. Data were filtered with Microsoft Excel, and a map of the distribution of chlorophyll-a and SST was made, using the IDW (Inverse Distance Weighted) analysis & the contouring menu, by interpolation, a simple deterministic method based on the surrounding points (Nurman 2010).

Data analysis method. Associative research methods were used with a quantitative approach to observe certain populations or samples (Sugiyono 2010). Analysis of the effect of SST and chlorophyll-a on the catch was tested by several methods including a verification test of satellite imagery data (ex-situ) and direct measuring (in-situ) data, a classical assumption test, and multiple linear regression analysis.

Results and Discussion

Catch production.
1. Catches number on the 1st trip: The 1st trip was held on 1 to 8 April 2022 by setting 9 times the gear, with the overall catch consisting of *T. albacares* (2,552 kg), *K. pelamis*

(3,023 kg), *D. russelli* (2,837 kg), *C. hippurus* (105 kg), *E. affinis* (337 kg) and *A. stellaris* (2,332 kg), with a total of 11,186 kg. The catches were dominated by *K. pelamis*.

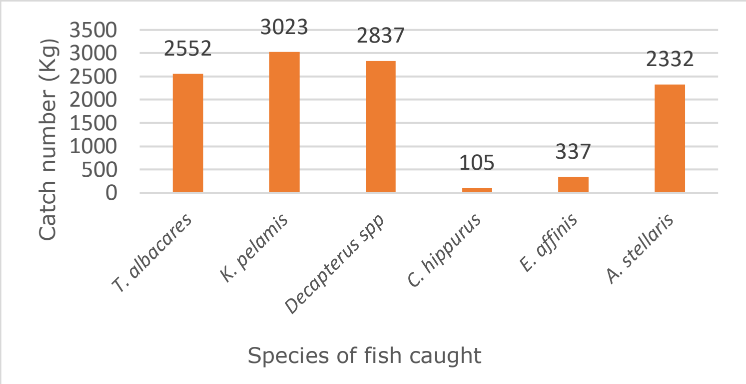


Figure 2. The number of catches on the 1st trip.

2. The number of catches of the 2nd trip: The 2nd trip was held on 10 to 16 April 2022 with 7 days of fishing operations or 7 settings. The catches of the 2nd trip consisted of *T. albacares* (2,002 kg), *K. pelamis* (5,237 kg), *D. russelli* (402 kg), *C. hippurus* (150 kg), *E. affinis* (644 kg), *A. stellaris* (38 kg), with a total of 8,473 kg. The catches on the 2nd trip were dominated by *T. albacares, K. pelamis,* and *D. russelli.*

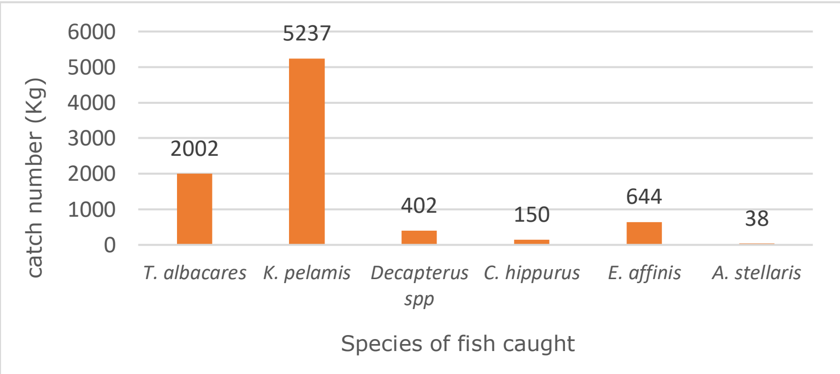


Figure 3. The number of catches on the 2nd trip.

3. The number of catches of the 3rd trip: The 3rd trip was held on 09 to 18 May 2022 with 10 days of catching and 10 settings. The catches on this trip were dominated by *K. pelamis*. The composition of the catch was: *T. albacares* (3,503 kg), *K. pelamis* (10,378 kg), *D. russelli* (5,866 kg), *C. hippurus* (143 kg), *Loligo* (497 kg), *E. bipinnulata* (154 kg), with a total of 20,541 kg.

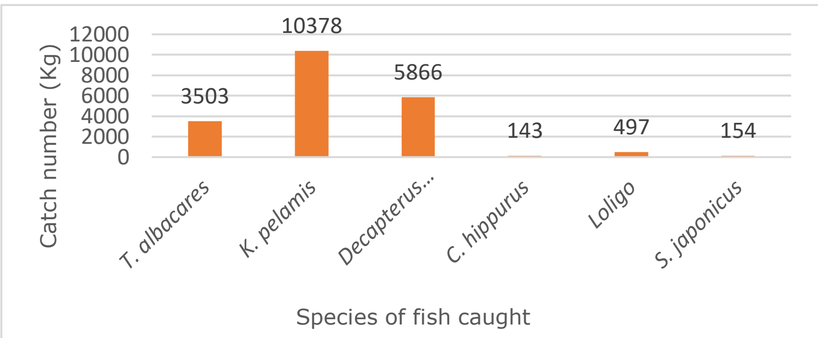


Figure 4. The catch of the 3rd trip.

Catch composition. In 3 trips with 26 catches, the catch was 40,200 kg. *K. pelamis* dominated with as much as 18,638 kg and an average of 716 kg per setting, the 2nd highest

catch was *D. russelli* with as much as 9,105 kg and an average of 350 kg per setting, and the 3rd was *T. albacares* with as much as 8,057 kg and an average per setting of 309 kg. Meanwhile, the lowest catches were *C. hippurus* with 398 kg and *E. bipinnulata* with 154 kg and an average of 15.3 kg and 5.9 kg, respectively, for each setting. Table 1 shows the composition of the catching trips:

Table 1

Fish composition and catch number

Species	*Catch number (Kg)*			*Total*	*Average*	*Percentage (%)*
	Trip 1	*Trip 2*	*Trip 3*			
T. albacares	2,552	2,002	3,503	8,057	309	20
K. pelamis	3,023	5,237	10,378	18,638	716	46.3
D. russelli	2,837	402	5,866	9,105	350	22.6
C. hippurus	105	150	143	398	15.30	1
A. stellaris	2,332	38	0	2,370	91.15	5.9
E. affinis	337	644	0	981	37.73	2.5
E. bipinnulata	0	0	154	154	5.92	0.4
Loligo	0	0	497	497	19.11	1.3

The diagram in Figure 6 synthesizes the composition of the fish species caught.

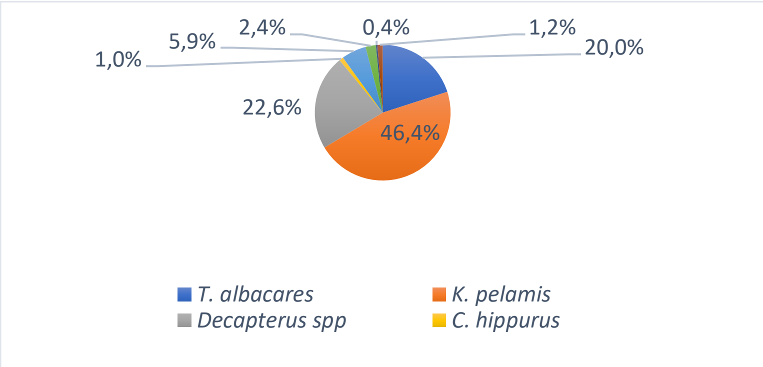


Figure 6. The composition of the caught fish species.

Distribution of Sea Surface Temperature (SST).

1. Distribution of SST in April 2022 for the 1st trip: The distribution of SST was observed to be stable, this can be seen from the 9 sampling points that were obtained during the 1st trip in April. Table 2 shows in-situ and ex-situ SST distribution values measured from 01 to 08 April 2022:

Table 2

The distribution of SST in Sadeng waters in April 2022, on the 1st trip

Date	*Position*		*SST (°C)*	
	Latitude (S)	*Longitude (T)*	*In-situ*	*Ex-situ*
01/04/2022	08°42'14''	110°31'22''	27.0	31.7
02/04/2022	08°46'05''	110°33'36''	28.1	31.3
03/04/2022	08°51'00''	110°35'12''	28.0	31.3
03/04/2022	08°49'07''	110°36'05''	28.5	31.4
04/04/2022	08°52'07''	110°36'10''	29.0	31.5
05/04/2022	08°41'47''	110°33'00''	27.1	31.5
06/04/2022	08°38'05''	110°51'51''	26.7	31.2
07/04/2022	08°47'00''	110°34'00''	29.2	31.1
08/04/2022	08°43'12''	110°33'26''	30.1	31.7
	Average		28.1	31.4

Zulkhasyni (2015) stated that in general high SST occurs in the west season to the transition season, where the west season starts in September and ends in February, every year. The *K. pelamis* was caught at a temperature range of 29 to 30°C from November to March (Nugraha et al 2020). According to Yeka et al (2022), the potential area for catching *K. pelamis* has a close relationship with the environmental parameters, especially the chlorophyll-a, whose optimum ranges from 0.12 to 0.22 mg m^{-3}. SST in-situ of Sadeng waters in April 2022 ranged from 26.7 to 30.1°C. The highest SST occurred in April 8 2022, reaching 30.1°C, while the lowest temperature occurred on April 6, 2022, reaching 26.7°C. The average *in-situ* SST in April 2022 on the first trip was 28.1°C and the average *ex-situ* temperature was 31.4°C, as illustrated in Figure 6.

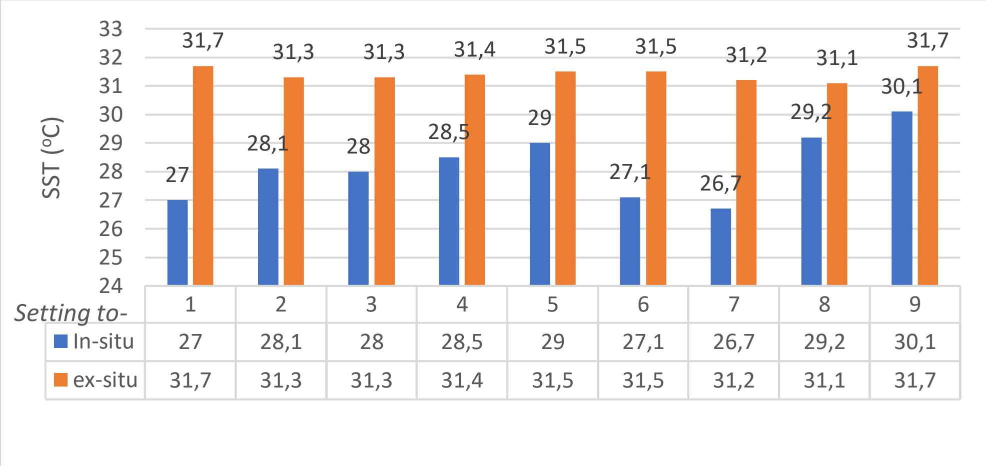


Figure 6. SST distribution in the 1st trip.

The highest number of catches occurred at the setting 9, with a total of 2,121 kg, at a high SST, reaching 30.1°C, while the least catch occurred at the setting 1, with a total catch of 345 kg, at a lower SST, of 27°C. This shows that in April 2022 if the SST value is high, the number of catches will be high and vice versa if the SST is low, the number of catches will also be low. The comparison of SST with the number of catches in April 2022 can be seen in Figure 7 below:

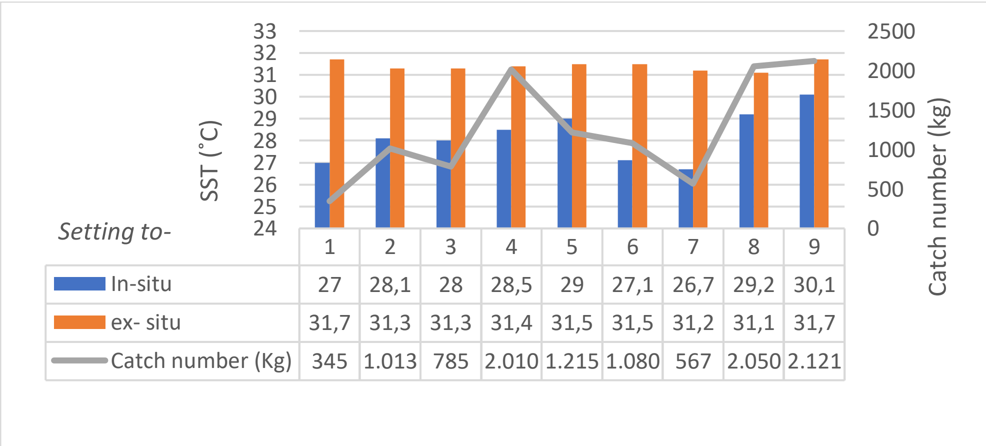


Figure 7. Comparison of SST with catch number in April 2022 on the 1st trip.

2. Distribution of the SST in April 2022 for the 2nd trip: This month, the SST data collection method was carried out in-situ and ex-situ at 7 points of the fishing ground, as observed in Table 3.

Table 3

The distribution of SST in Sadeng waters in April 2022 on the 2nd trip

Date	Position		SST (°C)	
	Latitude (S)	Longitude (E)	In-situ	Ex-situ
10/04/2022	08°36'38"	110°38'20"	30.2	31.7
11/04/2022	08°37'44"	110°29'54"	29.7	29.9
12/04/2022	08°35'20"	110°34'19"	27.5	30.1
13/04/2022	09°05'52"	110°09'27"	29.8	30.1
14/04/2022	08°32'25"	110°35'24"	28.5	30.1
15/04/2022	08°30'37"	110°38'14"	30.1	30.3
16/04/2022	08°30'25"	110°32'43"	28.3	29.4
	Average		29.1	30.2

Based on the data above, it can be seen that for all 7 sampling points, the SST distribution in April 2022 looks stable, ranging from 27.5 to 30.2°C. The highest temperature increase occurred on 10th of April 2022, reaching 30.2°C, while the lowest temperature occurred on April 12th of 2022, with a temperature reaching 27.5°C. The in-situ average in April 2022, on the 2nd trip, was 29.1°C and the ex-situ average was 30.2°C.

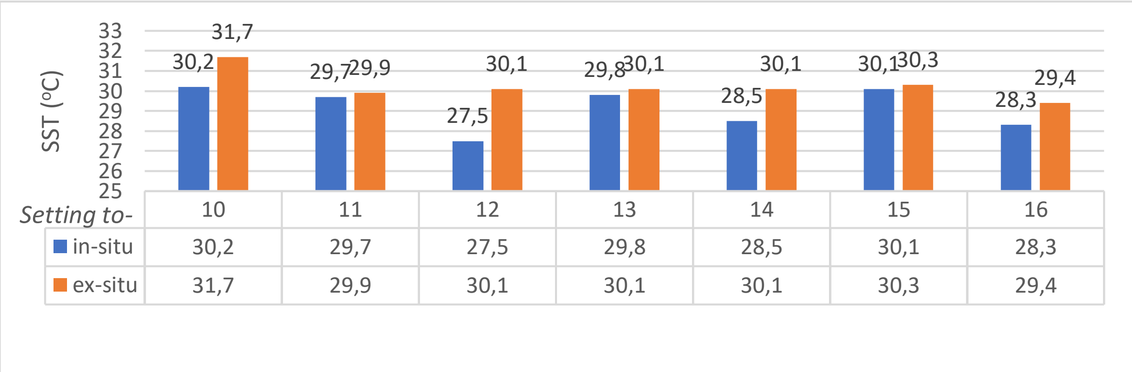


Figure 8. SST distribution on the 2nd trip.

In Figure 9, the comparison of the SST value with the catch in April 2022 shows that the highest of catch number occurred in the 12th setting, with as much as 2,053 kg, at an SST value reaching 27.5°C. Meanwhile, the smallest number of catches occurred in the 11th setting, with as much as 566 kg and an SST reaching 29.7°C. This shows that in April 2022, if the SST is high then the catch decreases and conversely, if the SST is low then the catch number is high, inversely proportional to the 1st trip.

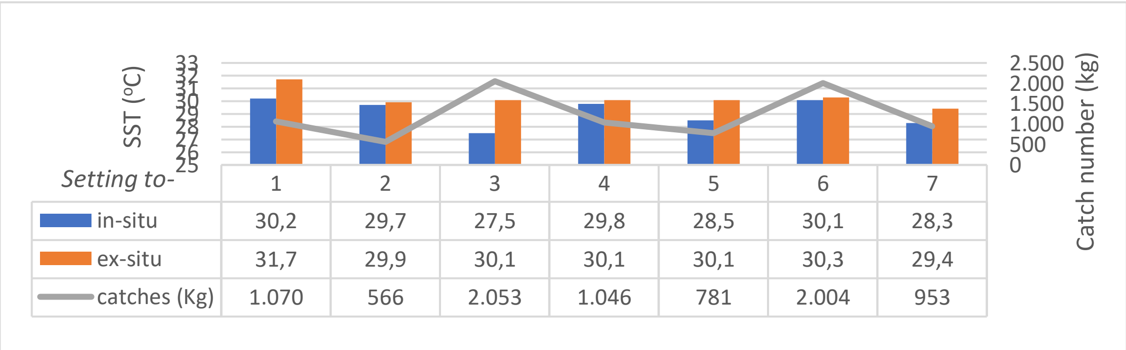


Figure 9. Comparison of the SST value and the catch quantity in April 2022, on the 2nd trip.

3. Distribution of the SST in May 2022, for the 3rd trip: In May 2022 the sampling point method was carried out directly on the satellite imagery, 10 times, as shown in Table 4:

Table 4

The distribution of SST in Sadeng waters in May 2022, on the 3rd trip

Date	*Position*		*SST (°C)*	
	Latitude (S)	*Longitude (E)*	*in-situ*	*Ex-situ*
09/05/2022	08°28'50''	110°08'51''	28.2	30.3
10/05/2022	08°44'19''	110°25'58''	29.1	29.7
11/05/2022	08°46'04''	110°54'56''	30.2	29.6
12/05/2022	09°09'10''	110°16'09''	30.3	30.3
13/05/2022	09°41'15''	109°59'03''	28.6	29.5
14/05/2022	09°27'33''	109°54'56''	27.7	28.8
15/05/2022	08°57'29''	110°06'22''	28.3	29.1
16/05/2022	08°46'14''	110°37'47''	27.7	30.1
17/05/2022	08°43'39''	110°46'36''	27.6	30.2
18/05/2022	08°33'23''	110°34'50''	28.3	28.5
	Average		28.6	29.6

Based on Table 4 and Figure 10, SST fluctuations occurred in May 2022. The SST distribution was stable, ranging from 27.6 to 30.3°C. The highest SST occurred on 12 May 2022, reaching 30.3°C, while the lowest SST, of 27.6°C, occurred on 17 May 2022. The average SST in-situ in May, on the 3rd trip, was 28.6°C and the ex-situ average was 29.6°C.

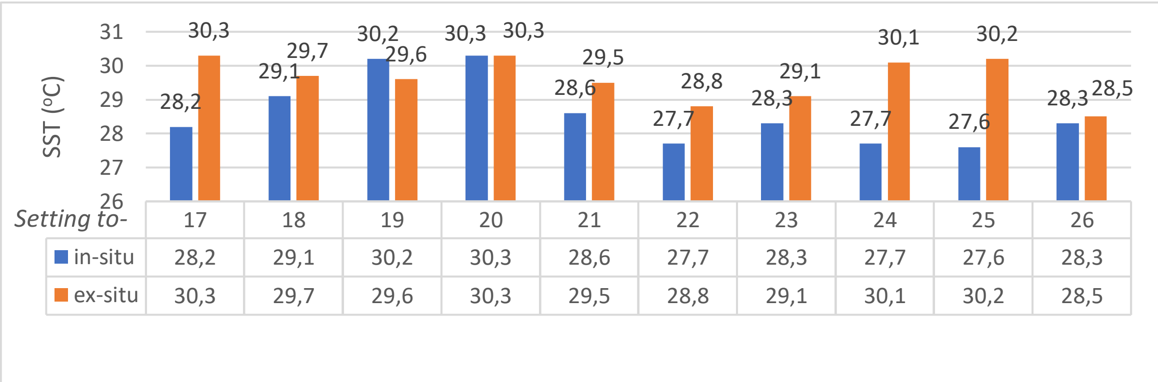


Figure 10. SST distribution in the 3rd trip.

In Figure 11, the comparison of SST with the highest catches number in May 2022, occurred at the setting 23, with a total of 5,045 kg, at a high SST value of 28.3°C. The lowest catches number on the 3rd trip occurred at the 25th setting, with a total of 641 kg and a SST reaching 27.6°C. Based on the previous findings, it can be concluded that in May 2022 if the SST is high, the catches number is high and if the SST is low, the catches number is low too.

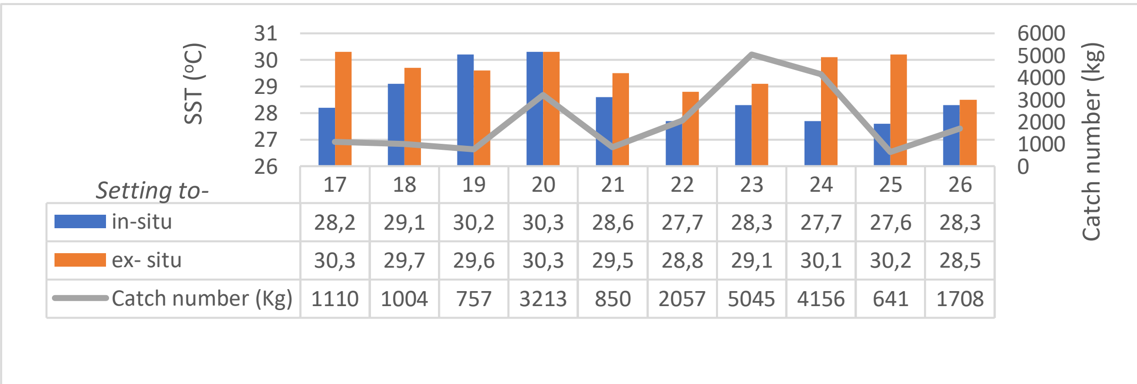


Figure 11. Comparison of SST with the catches number in May 2022 on the 3rd trip.

Chlorophyll-a concentration. One of the waters fertility factors is the availability of chlorophyll-a in the waters. According to Nufus et al (2017), the fertility level of coastal waters can be assessed from the biological and chemical characteristics, especially from the availability of essential nutrients. Based on the Table 5, the concentration of chlorophyll-a in Sadeng waters tends to experience fluctuations.

Table 5

Concentration of chlorophyll-a in Sadeng waters in 2017 to 2021

Period (Month/year)	*Chlorophyll-a (mg m^{-3})*				
	2017	*2018*	*2019*	*2020*	*2021*
April	0.38	0.33	0.58	0.28	0.39
May	0.40	0.73	0.76	0.34	0.41

The highest value of chlorophyll-a, 0.76 mg m^{-3}, occurred in May 2019, while the lowest value occurred in April 2020, with a value of 0.28 mg m^{-3}, as observed in Figure 12. The high and low values of chlorophyll-a are influenced by the nutrients content in the waters, which is also closely related to the abundance of phytoplankton. If the nutrients in the waters are abundant, the chlorophyll-a value will also be high. In addition, other factors that can affect the level of chlorophyll-a in waters are the temperature and salinity.

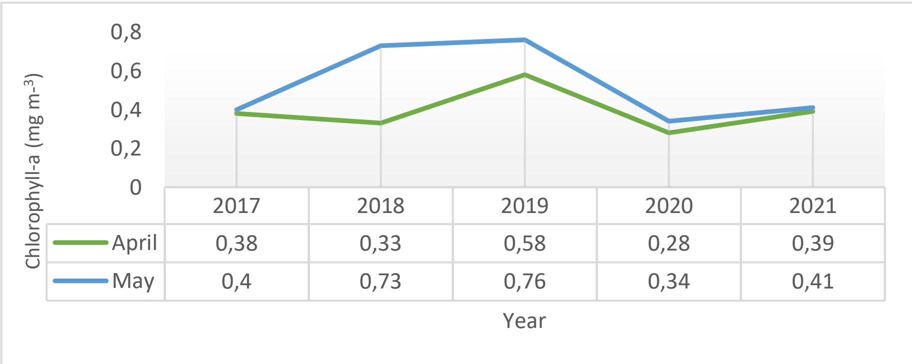


Figure 12. Chlorophyll-a concentration in 2017–2021.

1. Concentration of chlorophyll-a in April 2022, on the 1st trip: The distribution of chlorophyll-a concentration in April seemed to fluctuate. This can be seen from the 9 sampling points obtained from the NASA Ocean Color level 3, with a daily period, as it can be seen in Table 6.

Table 6

The concentration of chlorophyll-a in Sadeng waters in April 2022 for the 1st trip

Date	*Position*		*Chlorophyll-a (mg m^{-3})*	*Catch number (kg)*
	Latitude (S)	*Longitude (E)*		
01/04/2022	08°42'14''	110°31'22''	0.13	345
02/04/2022	08°46'05''	110°33'36''	0.15	1,013
03/04/2022	08°51'00''	110°35'12''	0.15	785
03/04/2022	08°49'07''	110°36'05''	0.12	2,010
04/04/2022	08°52'07''	110°36'10''	0.15	1,215
05/04/2022	08°41'47''	110°33'00''	0.14	1,080
06/04/2022	08°38'05''	110°51'51''	0.14	567
07/04/2022	08°47'00''	110°34'00''	0.15	2,050
08/04/2022	08°43'12''	110°33'26''	0.13	2,121
	Average		0.14	1,242

Based on Table 6 above, at the 9 sampling points observed during this trip, the highest increase in the value of chlorophyll-a occurred on 1st April 2022 with a concentration value of 0.15 mg m^{-3}. Meanwhile, the lowest chlorophyll-a value occurred on April 3rd 2022, with a chlorophyll-a concentration value of 0.12 mg m^{-3}. The average concentration of chlorophyll-a on the 1st of April trip was 0.14 mg m^{-3}.

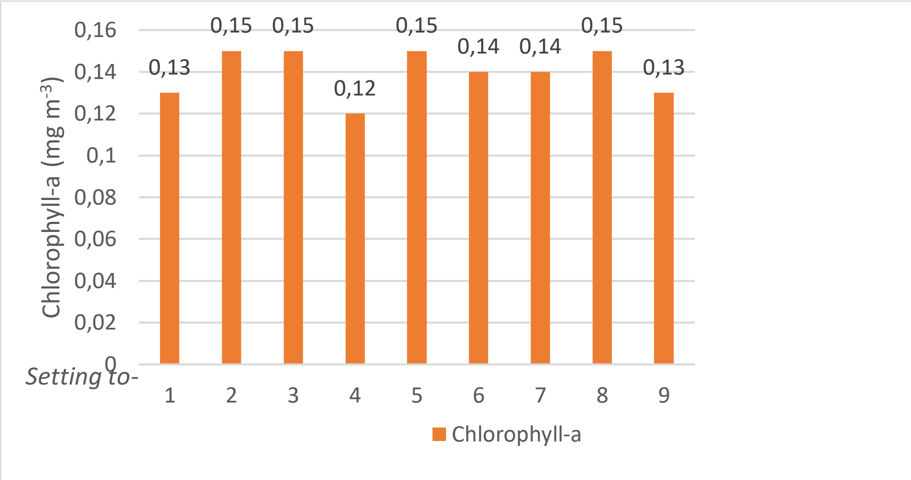


Figure 13. Chlorophyll-a concentration in April 2022, on the 1st trip.

In Figure 14 the comparison of the value of chlorophyll-a and the catches number in April 2022 shows that the highest catches number occurred in the 8th setting, with a total of 2,050 kg, at a high concentration of chlorophyll-a, of 0.15 mg m^{-3}. Meanwhile, the smallest catch number on the 1st trip occurred in the first setting, with the amount of 345 kg where the chlorophyll-a concentration value reached 0.13 mg m^{-3}. It can be concluded that in April 2022, if the concentration of chlorophyll-a is high then the catches number is high. Conversely, if the chlorophyll-a is low then the catches number is also low.

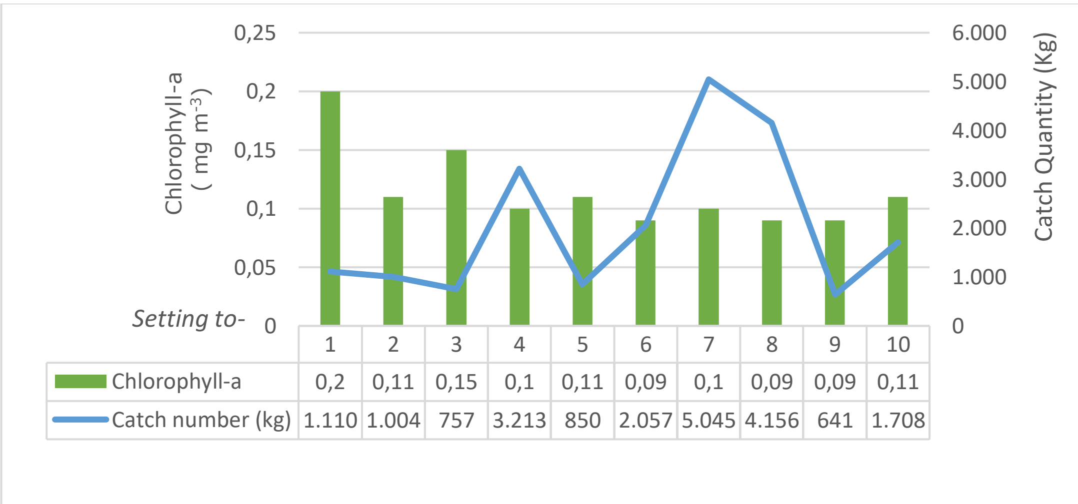


Figure 14. Comparison graph of chlorophyll-a value with the catches quantity on the 1st April 2022 trip.

1. Concentration of chlorophyll-a in Sadeng waters in April 2022 on the second trip: In April 2022, we considered 7 sampling points during the fishing operations; data were obtained from the NASA Ocean Color satellite (NASA 2007). The detailed chlorophyll-a concentration values can be seen in Table 7:

Table 7
The concentration of chlorophyll-a in Sadeng waters in April 2022, for the second trip

Date	*Position*		*Chlorophyll-a*	*Catches*
	Latitude (S)	*Longitude (T)*	*(mg m-^{3})*	*number (kg)*
10/04/2022	08°36'38"	110°38'20"	0.11	1,070
11/04/2022	08°37'44"	110°29'54"	0.12	566
12/04/2022	08°35'20"	110°34'19"	0.11	2,053
13/04/2022	09°05'52"	110°09'27"	0.12	1,046
14/04/2022	08°32'25"	110°35'24"	0.10	781
15/04/2022	08°30'37"	110°38'14"	0.11	2,004
16/04/2022	08°30'25"	110°32'43"	0.09	953
	Average		0.10	1,210

Figure 15 is a graph of the results of the 7 sampling points taken during the 2nd trip:

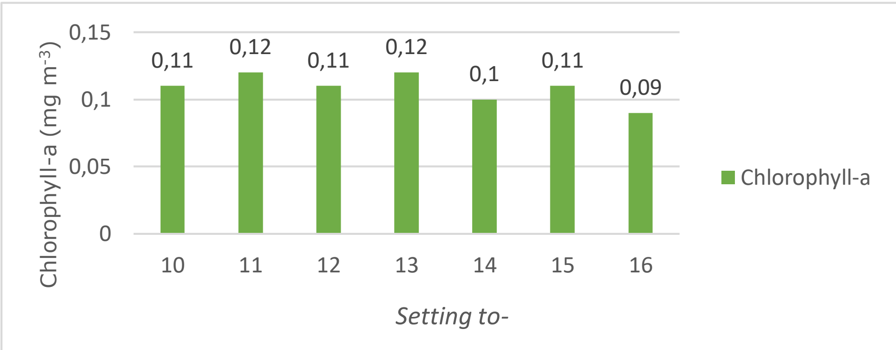


Figure 15. chlorophyll-a value in April 2022, on the 2nd trip.

Based on the data above, it can be seen that from 7 sampling points taken during this trip, the highest increase in the value of chlorophyll-a occurred on April 13th 2022, with a concentration value of 0.12 mg m^{-3}. Meanwhile, the lowest chlorophyll-a value occurred on April 16th 2022, with a chlorophyll-a concentration value of 0.09 mg m^{-3}. The average concentration of chlorophyll-a in April, at the 1st fishing operation trip, was of 0.10 mg m^{-3}.

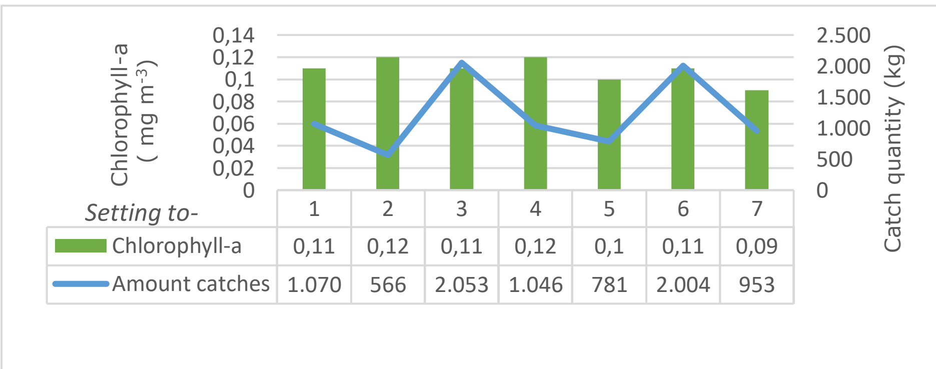


Figure 16. Comparison of the value of chlorophyll-a with the catches quantity, on the 2nd April 2022 trip.

In Figure 16 the comparison of the value of chlorophyll-a and the catch number in April 2022 shows that the highest catch number occurred at the 15th setting, with a total of 2,053 kg, inversely proportional to the chlorophyll-a concentration (0.11 mg m^{-3}, the lowest value). The smallest catch on the 2nd fishing operation trip occurred at the 11th setting, with the amount of 566 kg, when the value of chlorophyll-a concentration was the highest (0.12 mg m^{-3}). From the findings above, it can be concluded that in April the catch quantities are inversely proportional to the values of chlorophyll-a concentrations.

1. Concentration of chlorophyll-a in Sadeng waters in May 2022 on the third trip: The concentration of chlorophyll-a in May 2022 was observed to be stable, ranging from 0.09 to 0.15 mg m^{-3}. In May 2022, 10 sample points were taken using the satellite imagery obtained from NASA Ocean Color. The concentration of chlorophyll-a in Sadeng waters in May 2022 is presented in Table 8.

Table 8

The concentration of chlorophyll-a in Sadeng waters in May 2020, for the 3rd trip

Date	*Position*		*Chlorophyll-a (mg m^{-3})*	*Catch number (kg)*
	Latitude (S)	*Longitude (T)*		
09/05/2022	08°28'50''	110°08'51''	0.20	1,110
10/05/2022	08°44'19''	110°25'58''	0.11	1,004
11/05/2022	08°46'04''	110°54'56''	0.15	757
12/05/2022	09°09'10''	110°16'09''	0.10	3,213
13/05/2022	09°41'15''	109°59'03''	0.11	850
14/05/2022	09°27'33''	109°54'56''	0.09	2,057
15/05/2022	08°57'29''	110°06'22''	0.10	5,045
16/05/2022	08°46'14''	110°37'47''	0.09	4,156
17/05/2022	08°43'39''	110°46'36''	0.09	641
18/05/2022	08°33'23''	110°34'50''	0.11	1,708
	Average		0.11	2,054

The data was synthesized in Figure 17:

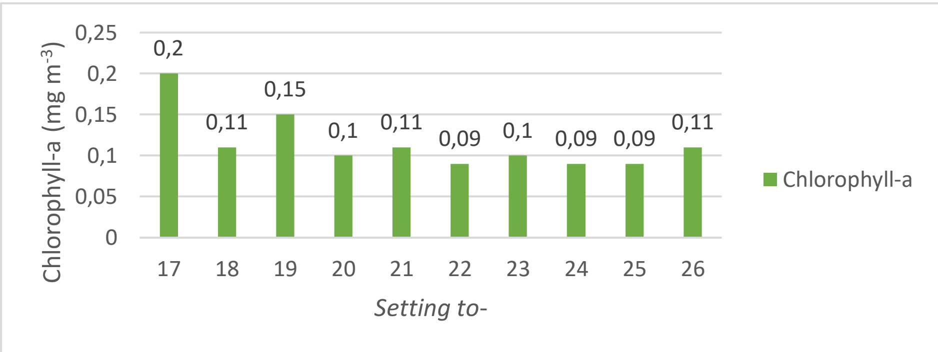


Figure 17. Chlorophyll-a concentration in May 2022, on the 3rd trip.

In Table 8 and Figure 17, it can be observed that the concentration of chlorophyll-a fluctuates in May. The highest chlorophyll-a value occurred on 11th of May 2022, of 0.15 mg m^{-3}, while the lowest chlorophyll-a value occurred on 14th, 16th, and 17th of May 2022, of 0.09 mg m^{-3}. The average concentration of chlorophyll-a in April 2022, on the fourth fishing operation trip, was 0.11 mg m^{-3}.

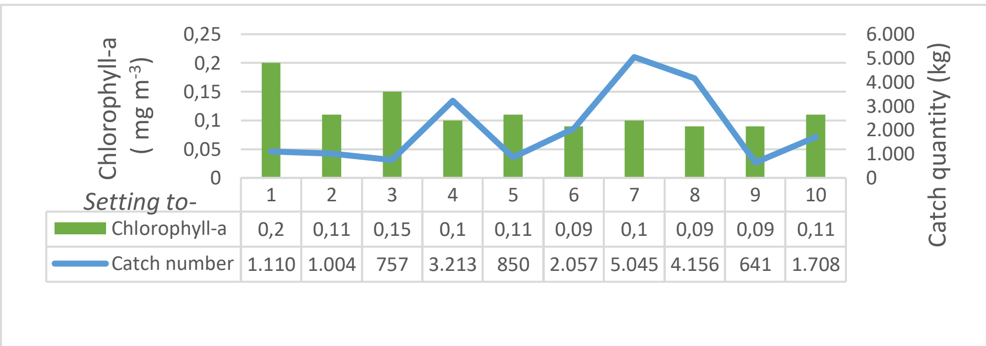


Figure 18. Comparison of chlorophyll-a concentration with the catching quantity in May 2022.

In Figure 18, the comparison of the value of chlorophyll-a and the catching quantity in May 2022 shows that the highest quantity of catches occurred at the setting 23, with a total of 5,045 kg, at a high concentration of chlorophyll-a, with a value of 0.10 mg m^{-3}. Meanwhile, the smallest catch number on the 1st fishing operation trip occurred at the 25th setting, with a total of 641 kg where the chlorophyll-a concentration value reached 0.09. Based on the previous findings, it can be concluded that in May, if the concentration of chlorophyll-a is high then the catch number is high or conversely, if the chlorophyll-a is low then the catch number is also low.

SST data is obtained based on the analysis of MODIS images. The data is then verified against the measurements. The verification results are shown in Table 9:

Table 9

Verification of in-situ SST data with satellite imagery

No. setting	*Data in-situ*	*Data ex-situ*	*Value of error (%)*
1	27.0	28.28	4.92
2	28.1	28.28	0.69
3	28.0	28.29	1.12
4	28.5	26.78	6.69
5	29.0	27.42	6.08
6	27.1	27.39	1.12
7	26.7	28.18	5.69
8	29.2	25.7	13.46
9	30.1	26.98	12.00
10	30.2	28.28	7.38
11	29.7	26.08	13.92
12	27.5	26.21	4.96
13	29.8	27.66	8.23
14	28.5	27.53	3.73
15	30.1	28.04	7.92
16	28.3	27.56	2.85
17	28.2	27.11	4.19
18	29.1	28.4	2.69
19	30.2	28.32	7.23
20	30.3	27.41	11.12
21	28.6	26.13	9.50
22	27.7	28.86	4.46
23	28.3	28.33	0.12
24	27.7	28.56	3.31
25	27.6	27.01	2.27
26	28.3	28.48	0.69
Mean relatives error	28.61	27.59	5.63

According to Fadika et al (2014), data verification is done by calculating the MRE. In-situ SST data verification against the Aqua MODIS satellite image data, at 26 sampling points, shows that the average relative error value is 5.63%. This value is included in the correct category, where the resulting value is no more than 30%. Jaelani et al (2013) stated that values with an average relative error of less than 30% in image data processing can be used for further analysis. Based on the previous statement, it can be concluded that the SST satellite image data can be further analyzed because it has an accuracy of 91.89%. According to Simanjuntak et al (2012), among the factors that cause errors in the satellite image datais a reading error at the time of observation.

***Analysis of the effect of SST and chlorophyll-a on the total catch*.**

1. Normality test

The normality test is part of the data analysis requirements. It is a classical assumption test: before performing a statistical analysis to test the hypothesis, a

regression analysis is used to determine whether the residual values are normally distributed or not. The residual is normally distributed if the significance is more than 0.05 (Gunawan 2020).

In Table 10, the test results, obtained with the SPSS software, can be seen. The asymptotic normality obtained had the significance value (sig.)0.200 (>0.05), so the residual values can be considered as normally distributed.

Table 10

Normality test

One-Sample Kolmogorov-Smirnov Test		
		Unstandardized residual
N		26
Normal parameters[a,b]	Mean	.0000000
	Std. deviation	1016.50300169
Most extreme differences	Absolute	.108
	Positive	.108
	Negative	-.071
Test statistic		.108
Asymp. Sig. (2-fish)		.200[c,d]

[a] Test distribution is Normal; [b] Calculated from data; [c] Lilliefors Significance Correction; [d] This is a lower bound of the true significance.

The basis for decision making in the K - S Normality test is as follows:
- If the significance value (sig.) >0.05 then the data is normally distributed. On the contrary,
- If the significance value (sig.) <0.05, then the data is not normally distributed.

2. Linearity test

In Table 11 of the SST - catches relationship's Deviation from Linearity, the significance value (sig.) obtained is 0.868, greater than 0.05. So it can be concluded that there is a significant linear relationship between the SST variable (X) and the number of catches (Y).

Table 11

Linearity test of the catch number with SST

ANOVA Table							
			Sum of squares	*df*	*Mean square*	*F*	*Sig.*
Catches * SST	Between groups	(Combined)	21329060.787	19	1122582.147	0.539	0.858
		Linearity	1812590.669	1	1812590.669	0.870	0.387
		Deviation from linearity	19516470.118	18	1084248.340	0.521	0.868
	Within groups		12497302.667	6	2082883.778		
	Total		33826363.454	25			

In Table 12 of the chlorophyll-a catches relationship's Deviation from Linearity, the significance value is 0.889, greater than 0.05. So it can be concluded that there is a significant linear relationship between the chlorophyll-a variable (X) and the catch number (Y).

Table 12

Linearity test of total catch with chlorophyll-a

ANOVA table							
			Sum of squares	*df*	*Mean square*	*F*	*Sig.*
Catches * Chlorophyll-a	Between groups	(Combined)	10614882.479	7	1516411.783	1.176	0.364
		Linearity	7753006.461	1	7753006.461	6.012	0.025
		Deviation from linearity	2861876.018	6	476979.336	0.370	0.889
	Within groups		23211480.975	18	1289526.721		
	Total		33826363.454	25			

The basis for decision making in the linearity test by comparing the significance value is as follows:

- If the value of Deviation from Linearity sig.>0.05, then there is a significant linear relationship between the independent variable and the dependent variable.
- If the value of Deviation from linearity sig.<0.05, then there is no significant linear relationship between the independent variable and the dependent variable.

3. Multicollinearity test

The multicollinearity test was used to test whether the regression model found a correlation between the independent variables. If a correlation exists, then there is a multicollinearity (multico) problem (Gunawan 2020). Multicollinearity is detected by examining the Variance Inflation Factor (VIF) value and tolerance, with reference to certain conditions: if the VIF value is less than 10 and the tolerance is more than 0.1, it is considered that there is no multicollinearity (Gunawan 2020).

In Table 13 it is shown that the value of the collinearity tolerance of the two variables is 0.90, more than 0.10, and the VIF statistic value of 1.11 is less than 10.

Table 13

Multicollinearity test

Coefficients[a]								
Model		*Unstandardized coefficients*		*Standardized coefficients*	*t*	*Sig.*	*Collinearity statistics*	
		B	*Std. err.*	*Beta*			*Tolerance*	*VIF*
1	(Constant)	2421.912	998.784		2.425	0.024		
	SST	1.219	2.630	0.089	0.464	0.647	0.900	1.111
	Chlorophyll-a	-117.383	50.033	-0.451	-2.346	0.028	0.900	1.111

[a] Dependent variable: Cathes.

So it can be concluded that the data above does not occur multicollinearity between independent variables. The basis for making decisions on the multicollinearity test with tolerance is as follows:

- If the tolerance value is greater than 0.10, it means that there is no multicollinearity in the regression model.
- If the tolerance value is less than 0.10, it means that there is multicollinearity in the regression model.

4. Heteroscedasticity test

The heteroscedasticity test aims to test whether in the regression model there is an inequality of variance from one observation to another. A good regression model is one without heteroscedasticity or with homoscedasticity (Gunawan 2020). Based on Table 14, it can be observed that the significance value (sig.) for the SST variable (X_1) is 0.811, while the significance value (sig.) for the chlorophyll-a variable (X_2) is 0.089.

Table 14

Heteroscedasticity test

		Coefficients[a]				
Model		*Unstandardized coefficients*		*Standardized coefficients*	*t*	*Sig.*
		B	*Std. Error*	*Beta*		
1	(Constant)	2825.294	3687.361		0.766	0.452
	SST	-30.753	126.844	-0.048	-0.242	0.811
	Chlorophyll-a	-9494.419	5333.793	-0.354	-1.780	0.089

[a] Dependent variable: Cathes.

Because the significance value of the two variables above is greater than 0.05, according to the basis for decision making in the Glejser test, it can be concluded that there is no symptom of heteroscedasticity. The basis for decision making in the heteroscedasticity test, using the Glejser conditions, is as follows:

- If the significance value (Sig.) is greater than 0.05, then the conclusion is that there is no heteroscedasticity symptom in the regression model.
- On the other hand, if the significance value (sig.) is less than 0.05, the conclusion is that heteroscedasticity is occurring.

5. Multiple linear regression

This analysis is used to measure the magnitude of the influence between the independent and dependent variables. There are several eligibility requirements that must be met when regression analysis is used, namely: the number of samples used must be the same, the number of independent variables is 1, the residual value must be normally distributed, there is a linear relationship, there are no symptoms of heteroscedasticity.

Based on Table 15, it is explained that the correlation coefficient (R) of 0.471 between the variables sea surface temperature and chlorophyll-a with the catch means that there is a very strong positive relationship between SST and chlorophyll-a with the fish catch.

Table 15

Model summary

		Model summary		
Model	*R*	*R Square*	*Adjusted R square*	*Std. error of the estimate*
	.471[a]	0.221	0.154	1036.89027

[a] Predictors: (Constant), Chlorophyll-a, SST.

Meanwhile, the R square coefficient obtained is 0.221 or 22%, meaning that the independent variables (SST and chlorophyll-a) affect the Y variable (catch) by 22% while the rest of the catch is influenced by other variables. Based on Table 16, it is observed that the coefficient test of the SST variable produces $t_{count} < t_{table}$ (0.598<2.069) and the significance value obtained is 0.556 (Sig>0.05) so that SST only weakly affects the catch.

Table 16

t_{test}

		Coefficients[a]				
Model		*Unstandardized coefficients*		*Standardized coefficients*	*t*	*Sig.*
		B	*Std. error*	*Beta*		
1	(Constant)	2262.186	977.214		2.315	0.030
	SST	1.539	2.573	0.116	0.598	0.556
	Chlorophyll-a	-106.246	48,953	-0.421	-2.170	0.041

[a] Dependent variable: Cathes.

Meanwhile, by testing the coefficient of chlorophyll-a variable, it was found that $t_{count} > t_{table}$ (2.170>2.069), with a significance value of 0.041 (Sig<0.05) so that it is known thatchlorophyll-a has a strong influence on the catch.

$$Y = 2262.186 + 1.539\ X_1 - 106.246\ X_2$$

The above equation describes the effect of changing the values of the independent variables, in the regression algorithm. The interpretation is as follows:

a. The intercept (2262.186) in this regression model represents the mean value of the catch (the response variable) when SST and Chlorophyll a (predictor variables) are equal to zero.
b. Every increase of 1^0 in SST (X_1) results in an increase of 1.539 in the catch (Y).
c. Every 1 mg m^{-3} increase in chlorophyll-a (X_2) results in a decrease of 106.246 in the catch (Y) since the Chlorophyll has a negative regression coefficient with the catches.

In Table 17, able it can be observed that $F_{count} < F_{table}$ (3.271<3.40), while the significance value obtained is 0.056 (Sig>0.05), so it can be concluded that there is an influence between the combined SST and chlorophyll-a variables on the catch quantities.

Table 17

Significance test (f_{test})

ANOVA[a]						
Model		*Sum of squares*	*df*	*Mean square*	*F*	*Sig.*
1	Regression	7034292.282	2	3517146.141	3.271	.056[b]
	Residual	24728253.103	23	1075141.439		
	Total	31762545.385	25			

[a] Dependent variable: Catch number; [b] Predictors: (Constant), Chlorophyll-a, SST.

Conclusions. The results of the significance test showed that SST had a partial influence on the catch number, while chlorophyll-a had a significant effect on the catch quantity. Meanwhile, if the test was carried out simultaneously, the results would obtaine a significance of 0.056, which means that the combined SST and chlorophyll-a have an influence on the catch quantities.

Conflict of interest. The authors declare no conflict of interest.

References

Abidin A. F., Amron, Marzuki M. I., 2020 Relationship between chlorophyll-a and sea surface temperarure to tuna catch in the Southern Water of Java. Science Research Journal 22(2):55-68.

Alfajri A., Mubarak M., Mulyadi A., 2017 [Spatial and Temporal analysis of sea surface temperature distribution in West Sumatra waters]. Indonesian Environmental Dynamics 4(1):65-74. [In Indonesian].

Anggraeni R., Solichin A., Saputra S. W., 2015 [Several biological aspects of skipjack tuna (*Katsuwonus pelamis*) in relation to fisheries management in PPP Sadeng, Gunungkidul Regency, Yogyakarta]. Management of Aquatic Resources Journal (MAQUARES) 4(3):230-239. [In Indonesian].

Azizah A., Wibisana H., 2020 [Temporal analysis of sea surface temperature distribution from 2018 to 2020 with Terra Modis image data]. Marine Journal: Indonesian Journal of Marine Science and Technology 13(3):196–205. [In Indonesian].

Fadika U., Rifai A., Rochaddi B., 2014 [Seasonal wind direction and speed and its relation to the distribution of sea surface temperature in Southern Pangandaran, West Java]. Journal of Oceanography 3(3):429–437. [In Indonesian].

Gunawan C., 2020 [Proficient in Mastering SPSS practical guide to processing research data (Deeppublish)]. Deepublish, Yogyakarta 210 p. [In Indonesian].

Hastuti, Wirasatriya A., Maslukah L., Subardjo P., Kunarso, 2021 [The effect of chlorophyll-a factors and sea surface temperature on anchovy catches (*Stelesphorus* sp) in Jepara]. Indonesian Journal of Oceanography 3(2):1-9. [In Indonesian].
Hendiarti N., Ohde T., 2004 Investigation of different processes in Indonesian waters using SeaWiFS data. Deep Sea Research Part II Topical Studies in Oceanography 51(1-3):85-97.
Jaelani L. M., Matsushita B., Yang W., Fukushima T., 2013 Evaluation of four MERIS atmospheric correction algorithms in Lake Kasumigaura, Japan. International Journal of Remote Sensing 34(24):8967–8985.
Jayawiguna M. H., Triyono, Wibowo S., 2019 [Overview of the potential, development and challenges of utilizing marine and fishery resources at FMA-RI 573]. AMAFRAD Press p. 3-10. [In Indonesian].
Kusmana C., Hikmat A., 2015 The biodiversity of flora in Indonesia. Journal of Natural Resources and Environmental Management 5(2):187–198.
Ma'mun A., Priatna A., Hidayat T., Nurulludin. 2017 Distribution and potential resources of pelagic fish in Fisheries Management Area of the Republic of Indonesia (FMA-RI 573) Indian Ocean. Indonesian Fisheries Research Journal (JPPI) 23:47–56.
Nufus H., Karina S., Agustina S., 2017 [Analysis of chlorophyll-a distribution and water quality in the Krueng Raba Lhoknga River, Aceh Besar]. Scientific Journal of Marine and Fisheries Students Unsyiah 2(1):58–65. [In Indonesian].
Nugraha E., Gunawan R., Danapraja S., Yusrizal, Kusdinar A., Waluyo A. S., Hutajulu J., Prayitno H., Halim S., Sutisna D. H., 2020 The sea surface temperature effect on the length and size of skipjack tuna (*Katsuwonus pelamis*) catches in the Banda Sea, Indonesia. AACL Bioflux 13(1):1-18.
Nikijuluw V., 2008 [The status of Indian Ocean tuna resources and its implications for Indonesia]. Journal of Indonesian Fisheries Policy 1(1):31-44. [In Indonesian].
Nurman A., 2010 [Utilization of fashionable data to detect fishing areas on the East and West Coasts of North Sumatra]. Journal of Geography 2(2):17-30. [In Indonesian].
Sidik A., Agussalim A., Ridho M. R., 2015 [The accuracy of the value of chlorophyll-a concentration and sea surface temperature using remote sensing data in the waters of Anggantang Island, Sembilang National Park]. Maspari 7(2):25–32. [In Indonesian].
Simanjuntak B. L., Handoyo G., Sugianto D. N., 2012 [Analysis of bathymetry and tidal components for determination of additional depth of jetty ponds in Tanjung Gundul Bengkayang Waters – West Kalimantan]. Journal of Oceanography 1(1):1-8. [In Indonesian].
Sugiyono, 2019 [Quantitative research methods]. Alphabet, 464 p. [In Indonesian].
Wahyuningrum P. I., Nurani T. W., Rahmi T. A., 2012 [Multi purpose capture fishery business in Sadeng, Gunungkidul Regency, Special Region of Yogyakarta]. Maspari Journal 4(1):10-22. [In Indonesian].
Wijopriono. 2012 [The carrying capacity of tuna fisheries resources in the Indian Ocean in relation to fisheries industrialization]. Journal of Indonesian Fisheries Policy 4(2):101-108. [In Indonesian].
Yeka A., Monika D., Rahmani R. M., Sarianto D., Fitri Y., Nurlaela E., Kusmedy B., Nugraha E., Hutajulu J., 2022 The effect of chlorophyll-a on the catches of skipjack tuna (*Katsuwonus pelamis*) in Banda Sea, Maluku, Indonesia. AACL Bioflux 15(3):1226-1237.

Received: 23 August 2021. Accepted:2022. Published online:2023.
Authors:
Priyantini Dewi, Jakarta Technical University of Fisheries, Faculty of Fishing Technology, AUP Street Pasarminggu 12520, South Jakarta, Indonesia, e-mail: prizt.dewi@gmail.com
Sutarjo, Fleet Monitoring and Operation, Directorate General of Marine and Fisheries Resources Surveillance, Medan Merdeka Timur Street No. 16, Central Jakarta, Jakarta, Indonesia, e-mail: sutarjoz79@gmail.com
Maman Hermawan, Jakarta Technical University of Fisheries, Faculty of Fishing Technology, AUP Street Pasarminggu 12520, South Jakarta, Indonesia, e-mail: mhermawan60@gmail.com
Yusrizal, Jakarta Technical University of Fisheries, Faculty of Fishing Technology, AUP Street Pasarminggu 12520, South Jakarta, Indonesia, e-mail: buyung_trc@yahoo.co.id
Mira Maulita, Jakarta Technical University of Fisheries, Faculty of Aquatic Resources Management, AUP Street Pasarminggu 12520, South Jakarta, Indonesia, e-mail: maulita.stp@gmail.com
Eli Nurlaela, Jakarta Technical University of Fisheries, Faculty of Fishing Technology, AUP Street Pasarminggu 12520, South Jakarta, Indonesia, e-mail: elimumtaza@gmail.com
Bongbongan Kusmedy, Jakarta Technical University of Fisheries, Faculty of Fishing Technology, AUP Street Pasarminggu 12520, South Jakarta, Indonesia, e-mail: bkhutapea@gmail.com
Sopiyan Danapraja, Jakarta Technical University of Fisheries, Faculty of Fisheries Extension, AUP Street Pasarminggu 12520, South Jakarta, Indonesia, e-mail: sopiyanraja@gmail.com
Erick Nugraha, Jakarta Technical University of Fisheries, Faculty of Fishing Technology, AUP Street Pasarminggu 12520, South Jakarta, Indonesia, e-mail: nugraha_eriq1@yahoo.co.id

How to cite this article:
Dewi P., Sutarjo, Hermawan M., Kusmedy B., Yusrizal, Maulita M., Nurlaela E., Danapraja S., Nugraha E., 2023 Study of sea surface temperature and chlorophyll-a to the number of fish caught in the waters of Sadeng, Yogyakarta, Indonesia. AACL Bioflux 16(1):

STATEMENT LETTER

Hereby we declare our article with the title:

Study of sea surface temperature and chlorophyll-a influence on the quantity of fish caught in the waters of Sadeng, Yogyakarta, Indonesia

It has gone through several editing processes and we agreed to publish it. Thank you.

Name of the authors:

Priyantini Dewi

Sutarjo

Maman Hermawan

Yusrizal

Mira Maulita

Bongbongan Kusmedy

Eli Nurlaela

Sopiyan Danapraja

Erick Nugraha

Date : January 07, 2023

Eni Kovacs <ek.bioflux@gmail.com>
Kepada: erick nugraha

Sab. 7 Jan jam 17.36

Dear Dr. Nugraha,

We would like to inform you that your manuscript has been published:

http://www.bioflux.com.ro/docs/2023.110-127.pdf

Thank you for publishing with us and best of luck in your future research.

Tampilkan pesan asli

--
Kind regards,
Editor AACL Bioflux
Eniko Kovacs

Balas, **Balas ke Semua** atau **Teruskan**

Kirim