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The influence of temperature and salinity on catches of skipjack tuna (*Katsuwonus pelamis*) in Raja Ampat waters, Papua Indonesia

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Abstract

Salinity is a parameter that plays an important role in the marine ecological system. Salinity can be used to determine oceanographic characteristics, then it can be used to estimate the distribution area of *K. pelamis* populations in a body of water. Measuring salinity is important in determining and recognizing water characteristics that are related to the presence of tuna. Still, salinity itself is not known to have a direct influence on the distribution of tuna. This research was conducted from February to May 2023 in the waters of Raja Ampat Sorong, West Papua to find out whether temperature and salinity influence the number of catches of *K. pelamis*. Data is taken directly by taking measurements using a thermometer and salinometer at the pole and line operating location. Data analysis uses simple linear regression by comparing the significance F value with the alpha value (0.05). After carrying out simple linear regression calculations using temperature and salinity data, significant F values for temperature (0.655011187) and salinity (0.4627131) were obtained, and comparisons were made with the alpha value (0.05). Both significance F values are greater than the alpha value so it can be concluded that temperature and salinity do not have a real influence on the number of catches.

Keywords: Pole and line; Temperature; Salinity; Skipjack tuna; Linear regression; The catch

1. Introduction

In Indonesia, catching skipjack tuna (*Katsuwonus pelamis*) and Yellowfin tuna (*Thunnus albacares*) is mostly carried out in FMA-RI 715, 716 and 717 which covers the Sulawesi Sea, Maluku Sea and the western Pacific Ocean [1]. Utilization of marine biological resources, especially in the field of capture fisheries, has the aim of obtaining maximum results without damaging the sustainability of fish resources with minimal operational costs. [2]. *K. pelamis* is part of the large pelagic fish that has oceanic characteristics or has the characteristic of always moving from one body of water to another that has oceanographic, biological and meteorological conditions that suit its habitat [3].

Oceanographic parameters such as Sea Surface Temperature (SST) and salinity influence various fish activities, such as growth, spawning, metabolism, and other activities [4]. This means that the presence of fish and the determination of potential fishing areas are greatly influenced by the oceanographic parameters of the waters [5]. According to [6], SST for arrest *K. pelamis* is in the range of 29.5 to 31.9°c, catch of *K. pelamis* The highest was in the SST range of 31 to 31.4°C and the lowest catch was found at a temperature of 31.5 to 31.9°C. Research carried out [7] potential fishing area *K. pelamis* has a close relationship with environmental parameters, especially the optimum SST in the range of 29.9 to 31.0°C.

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[8] stated that salinity is one of the parameters that plays an important role in the marine ecological system. Salinity can be used to determine oceanographic characteristics, which can then be used to estimate population distribution areas *K. pelamis* in a body of water [9]. The distribution of fish is closely related to several oceanographic factors such as temperature, salinity and current speed. According to [10] said that the spread *K. pelamis* has a relationship with temperature in nature. Where are the limits and temperature ranges? *K. pelamis* caught varies in several water areas. According to [11] states that the spread *K. pelamis* in a body of water the temperature is 17 to 23^{0}C and the optimum temperature for fishing is 20 to 22^{0}C with a swimming layer between 0 to 40 m. It was explained again that between the cold currents and hot currents, there is an area with lots of food and it is thought that this area is a good fishing ground for fisheries *Thunnus* Sp. and *K. pelamis*.

Salinity is an important factor used to predict the occurrence *K. pelamis* in a body of water [12]. According to [13], Salinity measurements are important in determining and recognizing water characteristics related to the presence of tuna. Still, salinity itself is not known to have a direct influence on the distribution of tuna.

2. Material and methods

This research was carried out for three months from February to May 2023 by following fishing operations on pole and line vessels in Sorong, West Papua. The tools and materials used in this research include stationery, a camera, a thermometer, a salinometer and a bucket.

2.1. Method of collecting data

The method for collecting data is by directly observing activities during fishing. The data collected is in the form of primary data and secondary data, primary data is obtained through direct interviews with related parties, through documentation during practice and through filling in questionnaires. Meanwhile, the primary data obtained is fish catch data, company data, and ship documents.

The data used for this research are SST data and seawater salinity at fishing grounds. Where the data is taken directly *in-situ* using the tools provided.

2.2. Temperature Measurement Methods

SST measurements are carried out before carrying out fishing operations and after carrying out fishing in the following way:

- Take sea water using a bucket, take the water three times
- Then the water is taken a third time as a sample
- Put the digital thermometer into the bucket
- After the temperature on the thermometer is stable then lock the temperature obtained
- Then lift the thermometer and look at the value printed on the thermometer then record the temperature data obtained on the worksheet

2.3. Salinity Measurement Method

Measure the salinity of water in the following way:

- Take sea water using a bucket, take the water three times
- Then the water is taken a third time as a sample
- Take a sample of water in a bucket using a pipette and then drop it into the salinity refractometer
- Then look at the salinity values obtained and record them in the worksheet.

2.4. Data analysis

The data obtained were then tested for temperature and salinity parameters on the catch using simple linear regression analysis to analyze each independent variable X (SST) on Y (catch) and X (salinity) [14].

Simple linear regression analysis is formulated as follows [15]:

$$Y = a + bX$$

Where :
Y = catch (kg)
a = intercept
b = regression coefficient (temperature/salinity)
X = independent variable (temperature/salinity)

Then each independent variable is tested with the dependent variable. This test was carried out by testing the significance F value obtained from the ANOVA table using the Microsoft Excel program with the alpha value used, namely 0.05. with the hypothesis that if the F significance value is less than the alpha value then H_0 is accepted and if the F significance value is greater than the alpha value then H_0 is rejected, where H_0 is a significantly different statement.

- F significance < Alpha value (0.05) → accept H_0
- F significance > Alpha value (0.05) → reject H_0

After testing with simple linear regression, it is then carried out jointly with the two independent variables SST (X_1) and salinity (X_2) with the catch as the dependent variable (Y) using multiple linear regression with the following equation [16]:

$$Y = a + b_1X_1 + b_2X_2$$

Where :
Y = catch/trip (kg/trip)
a = intercept
b_1 = temperature regression coefficient
b_2 = salinity regression coefficient
X_1 = independent variable water temperature (°C)
X_2 = independent variable water salinity (°/∘∘)

The next test is to test the significant value of F with the alpha value. This value is obtained from the ANOVA table output from Microsoft Excel so that to find out the significance decision can be made by comparing the significant F value with the alpha value (0.05). If the F significance value is < the alpha value, then the decision is to accept Ho where H_0 is significantly different.

- F significance < Alpha value (0.05) → accept H_0
- F significance > Alpha value (0.05) → reject H_0

3. Results and discussion

Pole and line is a fishing gear that catches target fish, namely large pelagic fish that live in large groups, making the catching process easier and yield abundant results. The types of target fish caught can be seen in Figure 1.

Figure 1 Fish caught (1) *K. pelamis*, and (2) *T. albacares*

Catches were obtained during two trips. The total catch on trip 1 can be seen in Table 1 below:

Table 1 Composition of the Catch on Trip 1

No	Species	Weight (kg)	Amount (fish)	Total (fish)	Percentage (%)
1	*K. pelamis*	1.00 – 1.49	90	2,756	94.96
		1.50 – 2.49	462		
		2.50 – 4.99	2,173		
		4.50 – 9.99	31		
2	*T. albacares*	2.50 – 4.99	145	146	5.04
		5.00 – 9.99	1		
Total			2,902	2,902	100

Table 1 above can be seen from the catch on the first trip of 2,902 fish, with the dominant fish caught being *K. pelamis* with a total catch of 2,756 fish, while for *T. albacares* The catch was 146 fish. From the number of two types of fish caught, the percentage of catch is obtained for *K. pelamis* as much as 95% while for *T. albacares* as much as 5%. The percentage can be seen in Figure 2.

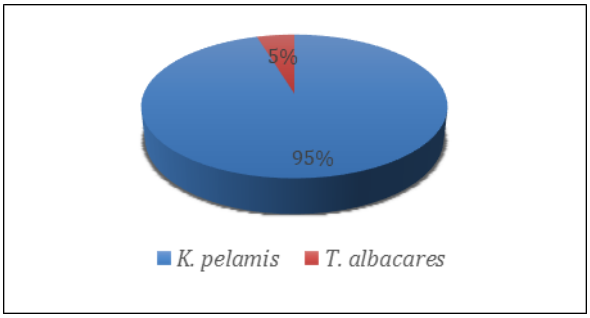

Figure 2 Composition of catch from trip 1

The total catch on trip 1 was then separated by type and weight of fish, along with the catch by type and weight *K. pelamis* and *T. albacares* can be seen in Table 2.

Table 2 Composition of skipjack tuna caught on trip 1

No	Weight (kg)	Number (fish)	Percentage (%)
1	1.00 - 1.49	90	3.27
2	1.50 - 2.49	462	16.76
3	2.50 - 4.99	2,173	78.85
4	5.00 - 9.99	31	1.12
Total		2,756	100

Table 2 above shows the catch results *K. pelamis* on trip 1 there were 2,756 fish, with the largest catch weight being fish measuring 2.50 to 4.99 kg with a total catch of 2173 fish with a percentage of 78.8%. Then the lowest catch was fish weight of 5.00 to 9.99 kg with a total catch of 31 fish with a percentage of 1.1%. The percentage can be seen in Figure 3.

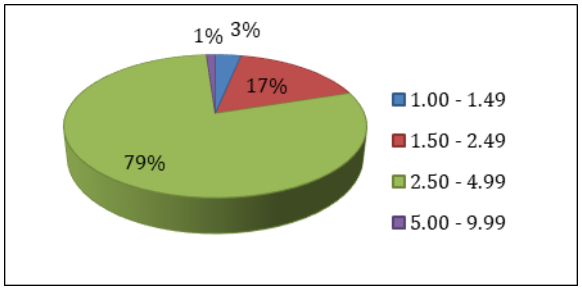

Figure 3 Catch composition *K. pelamis* trip 1

The results of the yellowfin caught on trip 1 can be seen in Table 3

Table 3 Catch composition *T. albacares* on trip 1

No	Weight (kg)	Number (fish)	Percentage (%)
1	2.50 - 4-99	145	99.32
2	5.00 - 9.99	1	0.68
Total		146	100

Table 3 above explains the catches *T. albacares* on trip 1 it can be seen that the total catch is as many as 146 fish with the most fish caught being 2.50 to 4.99 kg with a total catch of 145 fish with a percentage of 99.3%. Meanwhile, the lowest catch was 5.00 to 9.99 kg with a total catch of 1 fish with a percentage of 0.7%. The percentage can be seen in Figure 4.

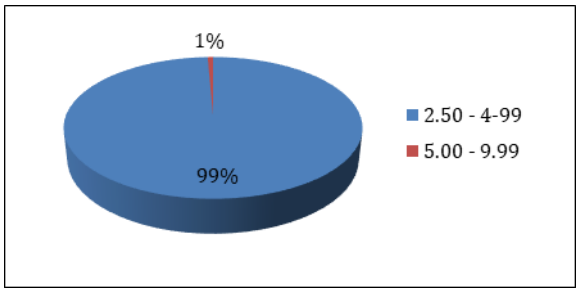

Figure 4 Catch composition *T. albacares* trip 1

The catches obtained on the trip 2 can be seen in Table 4 below:

Table 4 Composition of catches from the trip 2

No	Species	Weight (kg)	Number (fish)	total (fish)	Percentage (%)
1	*K. pelamis*	1.00 – 1.49	2,181	3,638	94.00
		1.50 – 2.49	826		
		2.50 – 4.99	631		
2	*T. albacares*	1.50 – 2.49	138	232	6.00
		2.50 – 4.99	89		
		5.00 – 9.99	5		
Total			3,870	3,870	100

Table 4 above shows that the catch on the second trip was 3,870 fish. It's the same as the catch on the first trip where the catch is dominant *K. pelamis* with a total of 3,638 fish, while for *T. albacares* as many as 232 animals.

The catch data on the second trip was made into percentages with the following percentage results; *K. pelamis* with a 94.00%, meanwhile *T. albacares* is 5.99%, up to a total of 100%. The percentage can be seen in Figure 5.

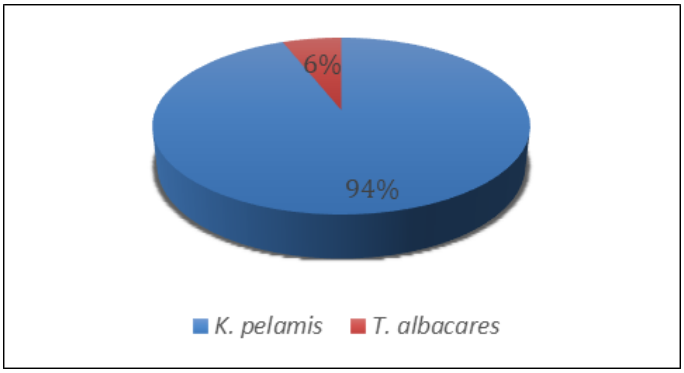

Figure 5 Composition of catch from trip 2

The total catch on the second trip was then separated by type and weight of fish, along with the catch by type and weight *K. pelamis* and *T. albacares* on the second trip:

Table 5 Catch composition *K. pelamis* on trip 2

No	Weight (kg)	Number (fish)	Percentage (%)
1	1.00 - 1.49	2,181	59.95
2	1.50 - 2.49	826	22.71
3	2.50 - 4.99	631	17.34
Total		3,638	100

From Table 5 above you can see the catch results *K. pelamis* on trip 2 there were 3,638 fish, with the largest catch weight being fish measuring 1.00 to 1.49 kg with a total catch of 2,181 fish with a percentage of 59.9%. Then for the lowest catch, the fish weight was 2.50 to 4.99 kg with a total catch of 631 fish with a percentage of 17.3%. The percentage can be seen in Figure 6.

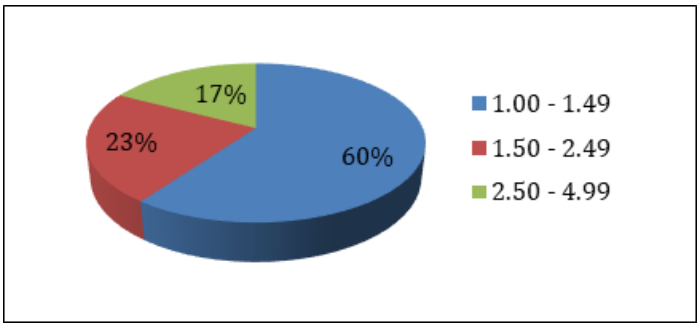

Figure 6 Catch composition *K. pelamis* trip 2

The catch *T. albacares* on the second trip, separated by weight, can be seen in Table 6.

In Table 6, catch results *T. albacares* on trip 2 it can be seen that the total catch *T. albacares* as many as 232 fish with the most fish caught being 1.50 to 2.49 kg with a total catch of 138 fish with a percentage of 59.48%. Meanwhile the catch *T. albacares* The lowest weight was 5.00 to 9.99 kg with a total catch of 5 fish with a percentage of 2.15% which can be seen in Figure 7.

Table 6 Catch composition *T. albacares* trip 2

No	Weight (kg)	Number (fish)	Percentage (%)
1	1.50 - 2.49	138	59.48
2	2.50 - 4-99	89	38.36
3	5.00 - 9.99	5	2.16
total		232	100

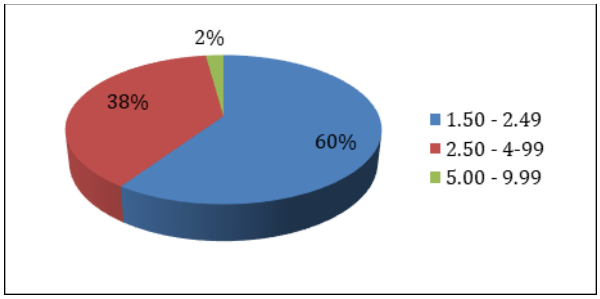

Figure 7 Catch composition *T. albacares* on trip 2

3.1. Catch Results Based on Temperature

Operation *pole and line* were carried out where the water temperature during the author's practice and data collection ranged from 28 to 29.8^{0}C based on SST, the catch results were obtained as shown in Table 7.

Table 7 Catch results based on temperature

No.	Temperature (^{0}C)	Number of setting	Catch (kg)	Average (kg)/setting
1	28.0 - 28.4	5	7200	1440
2	28.5 - 28.9	7	10100	1442.8
3	29.0 - 29.4	1	50	50
4	29.5 - 29.9	2	1525	762.5
total		15	18875	1258.3

Table 7 above shows that the highest catches are found at temperatures ranging from 28.5 to 28.9^{0}C with an average catch of 1,442 kg per setting, while the lowest average catch is at a temperature of 29.0 to 29.4^{0}C with a total catch of 50 kg per setting. This is different from the statement [17] which stated that the arrest *K. pelamis* is in the temperature range of 19 to 23^{0}C. From the table above, a graph like Figure 8 is obtained.

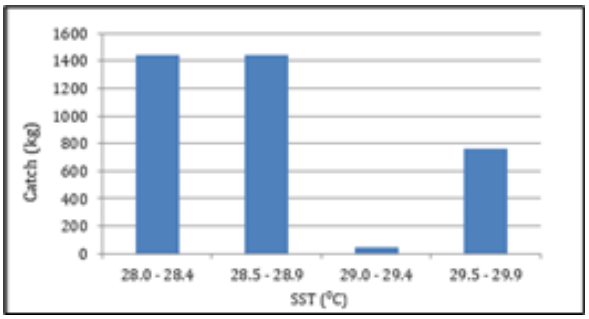

Figure 8 Catch results based on temperature

The data that has been obtained is SST data, then calculated using regression in the Excel program with the SST variable as the independent variable X_1 and the catch as the dependent variable Y. The following results were obtained:

Table 8 Anova table of temperature on catch

Description	Coefisient	F count	Significance F
intercept	11029.80583	0.209113785	0.655011187
SST	-341.2621359		

The value of the significant F temperature is 0.655 with an alpha value of 0.05, getting a significant F value > alpha value so it can be interpreted that the SST variable has no real effect on the catch.

3.1.1. Analysis of catches of K. pelamis based on temperature

The catch of *K. pelamis* based on temperature can be seen in Table 9 below.

Table 9 The catch of *K. pelamis* based on temperature

No	Temperature (^{0}C)	Number of setting	catch of *K. pelamis* (kg)	Average (kg)/setting
1	28.0 - 28.4	5	6370	1274
2	28.5 - 28.9	7	8550	1221.4
3	29.0 - 29.4	1	40	40
4	29.5 - 29.9	2	1275	637.5
total		15	16235	1082.3

Table 9 shows the average catch of K. pelamis Based on temperature, the highest was at temperatures ranging from 28.0 to 28.4^{0}C with an average catch of 1,274 kg a setting, while the lowest catch was at a temperature of 29.0 to 29.4^{0}C with an average catch of 40 kg a setting. Different from statement [18] which states that catching skipjack fish is in the temperature range of 19 to 23^{0}C. Catch graph *K. pelamis* based on temperature can be seen in Figure 9.

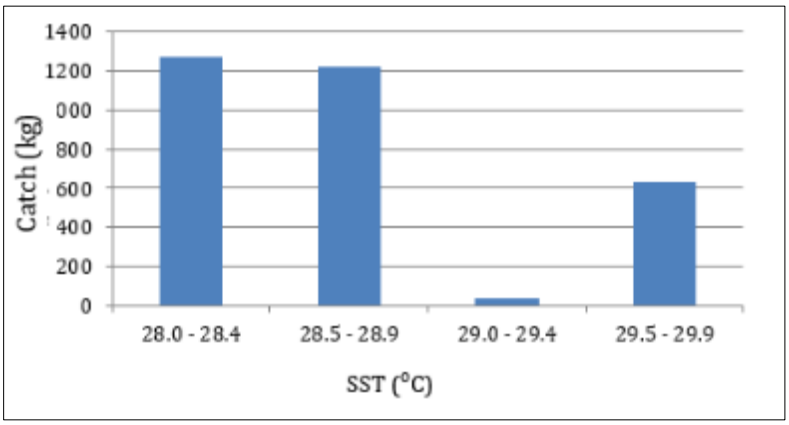

Figure 9 The catch of *K. pelamis* based on temperature

3.1.2. Analysis of T. albacares catches based on temperature

The catch *T. albacares* based on temperature can be seen in Table 10 below.

Table 10 The catch *T. albacares* based on temperature

No	Temperature (^{0}C)	Number of setting	Catch *T. albacares* (kg)	Average (kg)/setting
1	28.0 - 28.4	5	830	166
2	28.5 - 28.9	7	1,550	221.4
3	29.0 - 29.4	1	10	10
4	29.5 - 29.9	2	250	125
total		15	2,640	176

Table 10 above shows the average catch *T. albacares* based on temperature, the highest temperature is in the temperature range of 28.5 to 28.9^{0}C with an average catch of 221.4 kg a setting, while the lowest catch is at a temperature of 29.0 to 29.4 ^{0}C with an average catch of 10 kg a setting, this is different from statement [19] stating the arrest *T. albacares* is in the temperature range between 20 to 28 ^{0}C while in the fishing field, the temperature is above 28^{0}C. Catch graph *T. albacares* based on temperature can be seen in Figure 10.

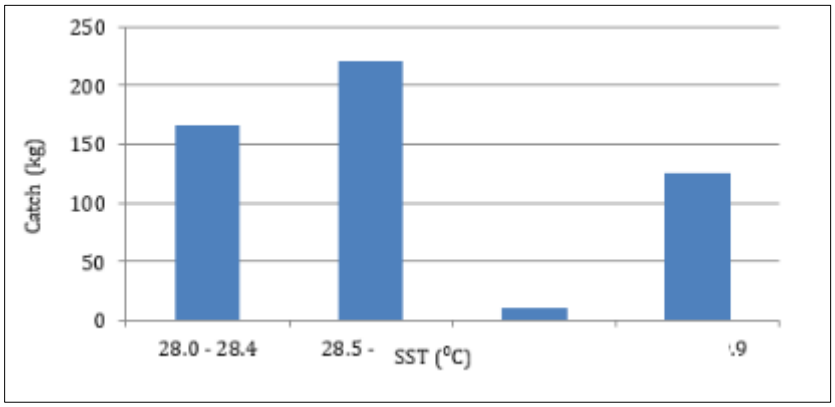

Figure 10 Catch *T. albacares* based on temperature

3.2. Catch Results Based on Salinity

Salinity in the waters during the study ranged from 31.5‰ to 33.5‰. Based on this salinity, the catch results are obtained as shown in Table 11.

Table 11 Catch results are based on salinity

No	Salinity (‰)	Number of setting	Catch (kg)	Average (kg)/setting
1	31.5 - 31.9	1	4,500	4,500
2	32.0 - 32.4	8	6,700	837.5
3	32.5 - 32.9	1	1,800	1,800
4	33.0 - 33.4	4	5,575	1,393.75
5	33.5 - 33.9	1	300	300
total		15	18,875	1,258.33

Table 11 above shows that the most catches are at a salinity of 31.5 to 31.9‰ with an average catch of 4,500 kg per setting. Meanwhile, the lowest catch results were found in water salinity of 33.5 to 33.9‰ with an average catch of 300 kg per setting, this is by the statement [20] stating the arrest *K. pelamis* is in the range of salinity levels between 32 to 35‰. From the data above, the graph can be depicted as follows:

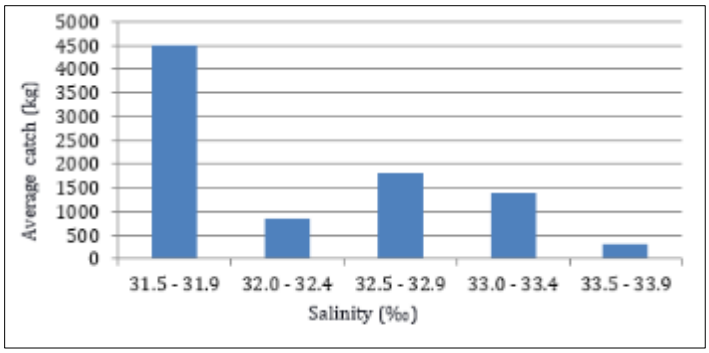

Figure 11 Catch Results Based on Salinity

The seawater salinity data obtained were then calculated using regression in the program with the water salinity variable as the independent variable X_1 and the catch as the dependent variable Y. The following results were obtained:

Table 12 Anova table of salinity on catch results

Description	Coefficient	F count	Significance F
intercept	16615.40493	0.572622667	0.4627131
Water Salinity	-474.471831		

The value of the significance F for salinity is 0.462 with an alpha value of 0.05, getting a significant F value > alpha value means that the seawater salinity variable has no real effect on the catch.

3.2.1. Analysis of K. pelamis catches based on salinity.

The catch of K. pelamis based on salinity can be seen in Table 13 below.

Table 13 The catch of K. pelamis based on salinity

No	Salinity (‰)	Number of setting	Catch of K. pelamis (kg)	Average (kg)/setting
1	31.5 - 31.9	1	4000	4000
2	32.0 - 32.4	8	5570	696.25
3	32.5 - 32.9	1	1550	1550
4	33.0 - 33.4	4	4865	1216.25
5	33.5 - 33.9	1	250	250
Total		15	16235	1082.33

Table 13 shows the average catch of *K. pelamis* based on salinity, the highest is found at a salinity ranging from 31.5 - 31.9 ‰ with an average catch of 4000 kg a setting, while the lowest catch is at a salinity of 33.5 - 33.9 ‰ with an average catch of 250 kg a setting, this is by Blackburn statement 1965 *vide* [20] stating the arrest *K. pelamis* is in the range of salinity levels between 32 to 35 ‰. The catch graph based on salinity can be seen in Figure 12.

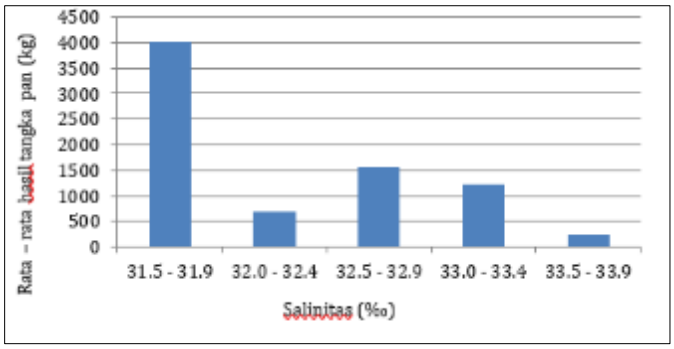

Figure 12 Catch of *K. pelamis* based on salinity

3.2.2. Analyze the catch T. albacares based on salinity.

The catch *T. albacares* based on salinity can be seen in Table 14 below.

Table 14 The catch *T. albacares* based on salinity

No	Salinity (‰)	Number of setting	Catch *T. albacares* (kg)	Average (kg)/setting
1	31.5 - 31.9	1	500	500
2	32.0 - 32.4	8	1,130	141.25
3	32.5 - 32.9	1	250	250
4	33.0 - 33.4	4	710	177.5
5	33.5 - 33.9	1	50	50
total		15	2,640	176

Table 14 shows the average catch *T. albacares* based on salinity, the highest is found at a salinity ranging from 31.5 to31.9 ‰ with an average catch of 500 kg a setting, while the lowest catch is at a salinity of 33.5 to 33.9 ‰ with an average catch of 50 kg a setting, this is by the Blackburn (1965) statement *vide* [20] which states that *T. albacares* fishing is in the range of salinity levels between 32 to 35 ‰. Catch graph *T. albacares* based on salinity can be seen in Figure 13.

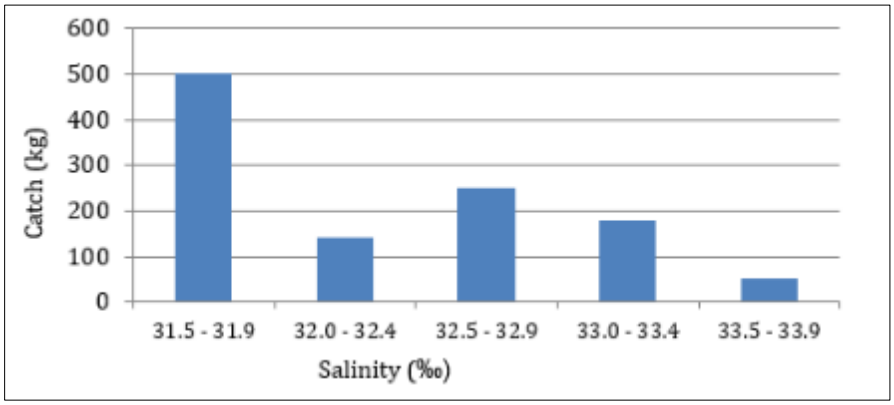

Figure 13 The catch *T. albacares* based on salinity

3.3. Effect of Temperature and Salinity on Catch Results

The data obtained during the two trips obtained 15 data, while the SST data interval ranged from 28 to 29.8^{0}C and seawater salinity ranged from 31.5 to 33.5‰ with a total catch of 18875. Next, the data was processed using the MS program. Excel and obtained the ANOVA table as follows:

Table 15 Anova table of temperature and salinity on catch results

Description	Coefficient	F count	Significance F
Intercep	20298.64873	0.291658927	0.752170808
SST (X_1)	- 184.421939		
Salinity (X_2)	- 425.1194811		

Based on the results of the ANOVA, it is known that the significant value of F is 0.752170808 with an alpha value of (0.05) where the significance value of F > alpha value so the decision H_0 is rejected with the statement H_0 is significantly different so that joint testing of SST and water salinity has no real effect on catch results.

4. Conclusion

The results of the temperature and salinity analysis test on the catch showed that the significance F value of temperature was 0.655011187 and the significance F value of salinity was 0.4627131, which was greater than the alpha value of 0.05, so it could be concluded that temperature and salinity had no real effect on the catch.

Compliance with ethical standards

Acknowledgments

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Disclosure of conflict of interest

No conflict of interest to be disclose.

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