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The Analysis of CPUE and Factors Affecting the Catch of Tonda Fishing at Bungus Ocean Fishing Port in West Sumatra

Analisis CPUE dan Faktor yang Mempengaruhi Hasil Tangkapan Pancing Tonda di Pelabuhan Perikanan Samudera Bungus Provinsi Sumatera Barat

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Abstract

Catch per Unit Effort (CPUE) analysis assesses fishing productivity and indicates fish stock abundance in waters. CPUE values represent the ratio between catch and fishing effort. This study aims to determine CPUE values and analyze the production factors influencing catch. The research method used a survey method with purposive sampling techniques. Data were analyzed using CPUE analysis, multiple linear regression, and classical assumption tests. The results showed that tuna fishing production at PPS Bungus during the 2018–2023 period reached 1,053.09 tons, with catches dominated by skipjack tuna and yellowfin tuna. The highest CPUE value occurred in 2019 at 1.49 tons/trip, and the lowest in 2022 at 0.86 tons/trip. The production factors that significantly influenced catch yields were the number of crew members, engine power, and captain experience, while vessel size and trip duration had a negative influence. The coefficient of determination (R^2) value of 0.356 indicates that the research variables only explain part of the variation in catch results. This finding underscores the importance of optimizing production factors and managing fishing efforts to sustain tuna fishing productivity at PPS Bungus.

Keywords: Tonda Fishing, Catch, Production Factors, CPUE

Abstrak

Analisis Catch per Unit Effort (CPUE) digunakan untuk menilai produktivitas penangkapan sekaligus menjadi indikator kelimpahan stok ikan di perairan. Nilai CPUE merepresentasikan perbandingan antara hasil tangkapan dengan upaya penangkapan yang dilakukan.Penelitian ini bertujuan untuk mengetahui nilai CPUE serta menganalisis faktor-faktor produksi yang mempengaruhi hasil tangkapan. Metode penelitian menggunakan metode survei dengan teknik purposive sampling. Data dianalisis dengan analisis CPUE, regresi linier berganda dan uji asumsi klasik. Hasil penelitian menunjukkan bahwa produksi pancing tonda di PPS Bungus selama periode 2018–2023 mencapai 1.053,09 ton, dengan hasil tangkapan didominasi oleh cakalang dan tuna sirip kuning. Nilai CPUE tertinggi terjadi pada tahun 2019 sebesar 1,49 ton/trip dan terendah pada tahun 2022 sebesar 0,86 ton/trip. Faktor-faktor produksi yang berpengaruh nyata terhadap hasil tangkapan adalah jumlah ABK, daya mesin, dan pengalaman nahkoda, sedangkan ukuran kapal dan lama trip berpengaruh negatif. Nilai koefisien determinasi (R^2) sebesar 0,356 menunjukkan bahwa variabel penelitian hanya menjelaskan sebagian variasi hasil tangkapan. Temuan ini menegaskan pentingnya optimalisasi faktor produksi serta

pengelolaan upaya penangkapan untuk menjaga keberlanjutan produktivitas pancing tonda di PPS Bungus.

Kata kunci: Pancing Tonda, Hasil Tangkapan, Faktor Produksi, CPUE

1. Introduction

Bungus Sea Fishing Port (PPS) is located in Bungus Barat village, Bungus Teluk Kabung sub-district, Padang City, West Sumatra Province. Geographically, PPS Bungus is located at coordinates 010 00' 023 - 010 00' 15 ‘south latitude and 1000 00' 233 - 1000 00' 34’ east longitude. The geographical location of PPS Bungus is very strategic because it is situated in the middle of Sumatra Island, near fishing areas. This proximity helps maintain the quality of the fish catch, as the fishing time is shorter. This port is the only Sea Fishing Port on the west coast of Sumatra and is currently the largest tuna export port in Sumatra (PPS Bungus, 2009). The tonda fishing gear has several advantages that make it more preferred by fishermen, including ease of loading due to its simple construction and inexpensive materials, as well as its ability to be operated at various water depths (Rahaningmas et al., 2014).

Tonda fishing has the potential to be developed in Indonesian waters after being analyzed based on aspects of sustainability and utilization of fish resources. Research shows that this fishing gear scored highest in the five assessment criteria of the Code of Conduct for Responsible Fisheries (CCRF), namely environmental friendliness, catch not exceeding capacity, providing economic benefits, and compliance with laws and regulations. By meeting these criteria, Tonda fishing rods rank first among fishing units considered sustainable and reliable in supporting responsible fisheries (Tenriawaruwaty, 2023).

To utilize fish resources sustainably, one step is to conduct stock assessments to determine sustainable potential, optimal effort, and fish utilization rates, ensuring that fish resources remain available in the future without damaging their populations. Optimal effort is the fishing effort that can be made in a single trip to achieve maximum catch results without compromising resource sustainability. Estimating the optimal effort level benefits by minimizing the loss of time, energy, and fishing operation costs, and it is hoped that the fishing efforts will consistently achieve optimal results (Boesono et al., 2011).

In 2020, fishery production at PPS Bungus was recorded at 4,776.14 tonnes, with a production value of IDR 111,028,457,000.00 at an average price per kg of IDR 25,778.00, marking a 14% increase compared to 2019. The volume of fish landed in 2019 was 4,174.51 tonnes with a production value of IDR 107,960,789,500.00. In 2019, the production volume of tonda fish catches was recorded at 232.57 tonnes, which is lower than the 462.69 tonnes in 2018, indicating a significant decline. The increase in the number of tonda fishing vessels at Bungus Seafood Port (PPS Bungus) indicates that fishing with this gear is becoming more profitable. Despite the upward trend in total production, catches using longline fishing gear fluctuated significantly, particularly in 2019, when they declined by nearly 49% compared to 2018 (PPS Bungus Statistical Report, 2019).

This decline indicates that although the number of tonda fishing boats continues to increase, other factors affect fish catches. Significant fluctuations in catches require further attention, especially regarding factors that affect Catch per Unit Effort (CPUE). CPUE is a method used to determine the average annual marine fishery production. Fishery production in an area that has experienced an increase or decrease in production can be determined from the CPUE results. To determine CPUE, the formula used is to divide the catch by the fishing effort (Listiani et al., 2017). This study aims to analyze changes in CPUE and the impact of differences in fishing trips on catch, identify technical and operational factors, such as ship tonnage (GT), engine power (PK), number of crew members (ABK), captain's experience, amount of fuel, and trip duration that affect catch.

2. Material and Method

2.1. Time and Place

This research was conducted in December 2024 at the Bungus Ocean Fishing Port in West Sumatra Province. A map of the research location can be seen in Figure 1.

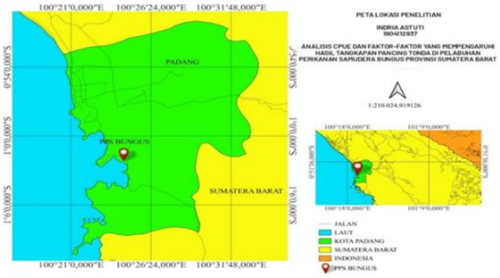

Figure 1. Research location

2.2. Methods

The research method used was a survey method. A survey is an investigation method aimed at obtaining facts about existing phenomena, seeking information based on facts, and collecting primary and supporting data for further analysis or research. The sample was taken based on the number of ships that were in operation during 2018-2023, namely 10 ships. After calculating the accuracy according to Slovin, the error rate was 30%.

2.3. Data Analysis

2.3.1. CPUE (Catch per Unit Effort)

The CPUE value calculation aims to determine abundance and utilization rates based on the ratio between catch and fishing effort, which can be calculated using the Gulland formula in Sibagariang et al. (2011), as follows:

$$CPUE = \frac{Catch\ i}{Effort\ i}$$

Explanation:

$CPUE_i$ = Catch per fishing effort (kg/trip) in year i
$Catch_i$ = Catch (kg) in year i
$effort_i$ = Fishing effort (trip) in year i

CPUE is the annual fishing rate obtained from time series data for at least 5 years. The longer the time series used, the more accurate the prediction obtained.

2.3.2. Normality Test

To determine whether the collected data is normally distributed, a data normality test is used. This test must be performed before data processing. In fact, the Kolmogorov-Smirnov method can be used to assess data normality (Ananda & Fadhli, 2018).

2.3.3. Multicollinearity Test

According to Ghozali (2013), the purpose of normality testing is to determine whether the residual variables in a regression model are normally distributed. A good regression model is indicated by a residual distribution that is close to normal, as this is one of the requirements for fulfilling classical assumptions.

2.3.4. Multiple Analysis

According to Pratomo (2015), multiple regression analysis aims to predict changes in the value of a particular variable when other variables change. It is called multiple regression because there is more than one independent variable, so a multiple linear regression equation is used. The primary purpose of multiple analysis is to measure the relationship between two or more variables and to estimate the value of the dependent variable (Y) based on the value of the independent variable (X). To measure the extent to which independent variables (X) jointly influence the dependent variable (Y) on the catch of tunda fishing boats from 2018 to 2023 at PPS Bungus. Production factors include ship tonnage, engine power, number of crew members, experience, amount of fuel, and trip duration. The multiple regression function equation used in this study is as follows:

$$Y = a + b_1X_1+b_2X_2+b_3X_3+b_4X_4+b_5X_5+b_6X_6$$

Explanation:

Y = Total catch (kg)
A = Intercept (cutting point)
b = Regression coefficient for each production factor
X1 = Ship tonnage
X2 = Engine power (HP)
X3 = Number of crew members (persons)
X4 = Captain's experience (years)
X5 = amount of fuel
X6 = Trip duration

2.3.5. F-Test

The F test is performed to determine whether independent variables jointly or simultaneously affect the dependent variable in a regression model.

2.3.6. T-Test

The t-test is used to evaluate research hypotheses concerning the partial influence of each independent variable on the dependent variable. The t-test, as one of the statistical tests, is used to test the validity of the hypothesis that there is no significant difference between two sample means taken randomly from the same population (Sudijono, 1997).

3. Result and Discussion

3.1. PPS Bungus

At the Bungus ocean fishing port, there are production factors that affect the catch of pole-and-line fishing, including ship tonnage, engine power, number of crew members, amount of fuel, captain's experience, and trip duration. The most dominant catches of pole-and-line fishing vessels at PPS Bungus are skipjack tuna, yellowfin tuna, and bigeye tuna. In 2019, the production volume of pole-and-line fishing catches was recorded at 232.57 tons, a significant decline from 2018's 462.69 tons. The increase in the number of fleets involved in fishing activities at the Bungus Ocean Fishing Port (PPS) has contributed significantly to fishery production (Table 1).

Table 1. Production and production value of PPS Bungus

No	Year	Production (tons)	Production Value
1	2018	462,69	12.011.490,6
2	2019	2382,57	7.125.117
3	2020	7920,516	10.322.383
4	2021	480,415	13.591.134
5	2022	390,238	14.123.794,5
6	2023	143,612	5.147.222

Table 1 shows that PPS Bungus's fishery production amounted to 9,265.952 tons over the last 6 years. Revenue and production value declined from 2022 to 2023, with a total production value of IDR55,321,141.1 over the past 6 years.

3.2. Catch Result of Tonda Fishing Gear

The most commonly used fishing gear at Bungus PPS is the tonda fishing rod. The size of tonda fishing boats varies from 10 GT to 18 GT. This shows the diversity in the capacity and production potential of each boat. The length of tonda fishing boats also shows diversity, ranging from 13.96 to 17.19 meters. The number of crew members on each boat ranges from 4 to 6 people, indicating that each boat is equipped with an adequate team for fishing operations. The catch from tunda fishing vessels at PPS Bungus is dominated by skipjack tuna (*Katsuwonus pelamis*) and yellowfin tuna (*Thunnus albacares*). This reflects the main target species for fishing activities in this region. On average, tunda fishing vessels go on fishing trips at sea for 10 to 15 days.

Fish caught using tonda fishing gear consist of various species, including: yellowfin tuna (*T.albacares*), bigeye tuna (*T.obesus*), skipjack tuna (*K.pelamis*), bigeye tuna (*Auxis thazard*), gray tuna (*T.tonggol*), swordfish (*Xiphias gladius*), flying (*Decapterus* spp), dolphinfish (*Coryphaena hippurus*), sailfish (*Istiophorus platypterus*), snapper (*Lutjanus Cyanopterus*), male mackerel (*Rastrelliger kanagurta*), female mackerel (*Rastrelliger brachysoma*), spiny mackerel (*Scomberomorus commerson*), bentong mackerel (*Selar crumenophthalmus*), kuwe (*Caranx ignobilis*), coral grouper (*Epinephelus lanceolatus*), tetengkek *(Megalaspis cordyla*), and cockatoo (*Scarus croicensis*).

Catch per Unit Effort (CPUE) is the result obtained from comparing the total catch with the number of trips in a year or in a fishing season at sea. Data on the average production value of tunda fishing boats. The following table shows the production value of tunda fishing boats in Table 2.

Table 2. Production value of the tonda fishing boats' catch per unit

No	Vessel Name	CPUE (tons/trips)					
		2018	2019	2020	2021	2022	2023
1.	KM. Bintang laut	2,15	1,07	1,01	1,10	1,05	0,68
2.	KM. Fika	2,08	1,71	1,42	1,14	1,13	1,13
3.	KM. Nike	2,10	2,50	1,46	1,18	1,11	1,35
4.	KM. Fitri	2,20	2,32	1,47	0,68	1,19	1,13
5.	KM. Pristi	0,39	0,89	1,49	1,43	0,40	0,48
6.	KM. Dhini	0,83	0,11	1,66	1,45	0,72	1,06
7.	KM. Empat saudara 02	1,00	1,40	1,82	1,70	0.47	0,53
8.	KM. Empat saudara 03	1,15	3,00	0,71	1,50	0.67	0,72
9.	KM. Mona Jaya	0,79	1,04	1,12	1,15	0,81	0,74
10.	KM. WGAG	1,30	0,88	1,43	0,50	1,03	0,93
	Average	1,40	1,49	1,36	1,25	0,86	0,88

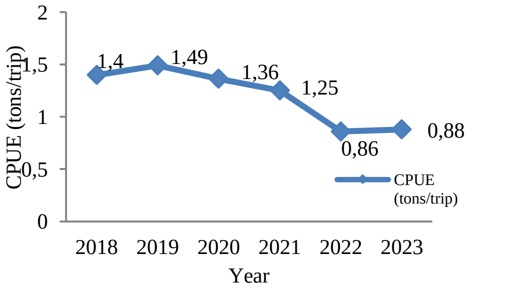

Figure 2. Catch per unit effort of tonda fishing boats

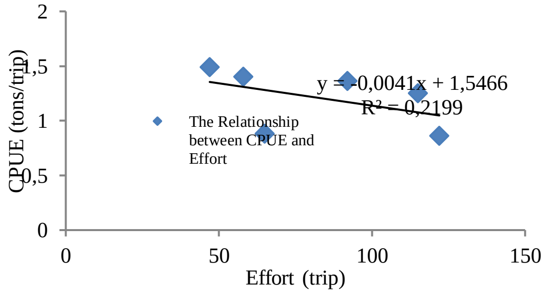

Figure 3. The relationship between CPUE and effort

3.3. Multiple Regression Analysis, Coefficient of Determination (R^2), T-test

After the multicollinearity and normality tests were completed, multiple regression analysis was performed. Based on the results of the multiple linear regression test, a relationship was found between the catch and the following regression equation: Y=-2818.951 X1+104.382 X2 + 4874. 343 X3 + 172. 131 X4 +21.966 X5 -108.480 X6.

The production factor equation obtained can be used to show the effect of production factors on catch. The regression coefficient in the equation shows the impact of each production factor on catch. An increase in production factors will increase catch if the regression coefficient is positive. Conversely, if the regression coefficient is negative, an increase in production factors will result in a decrease in catch. Therefore, increasing each production component does not always lead to increased production if some or all of the regression coefficients of the production factor equation are not positive.

Table 3. Results of the coefficient of determination (R^2) test

Model summary [b]				
Model	R	R squared	Adjusted R^2 has been adjusted	Std. Error estimasi
1	.596[a]	.356	.283	6545.71124

Based on the Model Summary output results, the coefficient of determination (R^2) value is 0.356 or 35.6%. The dependent variable, which is the amount of catch, is influenced by the independent variables used in this model summary, namely ship tonnage, engine power, number of crew members, amount of fuel, captain's experience, and trip duration in 35.6% of cases, according to the coefficient of determination (R^2) value. Meanwhile, the other 64.4% of the variation is influenced by different factors not included in this model. These external influences can include environmental conditions, weather, fishing season, and developments in fishing technology, all of which are considered to impact catch. In addition, there is a significant correlation between production factors and the dependent variable, namely the amount of catch, as indicated by a correlation coefficient R of 0.596 or more than 0.5

The t-test was conducted to test the hypothesis regarding the partial effect of each independent variable on the dependent variable. In this case, it was to determine whether the variables of ship tonnage, engine power, number of crew members, experience, amount of fuel, and trip duration had a partial effect on production volume. The results of the F-test using SPSS 25 can be seen in Table 4.

Table 4. T-test results

No	Variable	Regression Coefficient	Calculated t	Sig	t table	Conclusion
1.	Ship Tonnage	-2818.951	-3.105	.003	2,006	Significant
2.	Engine Power	104.382	1.494	.141	2,006	not Significant
3.	Number of ABK	4874.343	3.067	.003	2,006	Significant
4.	Total Fuel	172.131	.510	.612	2,006	Not Significant
5.	Captain’s Experience	21.966	1.383	.173	2,006	Not Significant
6.	Trip Duration	-108.480	-.245	.808	2,006	Not Significant

From the t-test results, a significance value of 0.05 and t-counts of -3.105 and 3.067 with significance levels of 0.000 were obtained. The t-table was obtained from the statistics table of 2.006, so it can be concluded that ship tonnage has a significant effect on the dependent variable, because the calculated t > table t, namely -3.105 > 2.006 with significance < 0.05, meaning that H0 is accepted. The number of crew members significantly affects the dependent variable because the calculated t-value is greater than the table t-value, specifically 3.067 > 2.006, with a significance level of < 0.05, indicating that H0 is accepted.

The t-test results show that the factors that influence the tonda fishing catch are ship tonnage (X_1) and the number of crew members (X_3). Ship tonnage (X_1) affects the catch because large ships are more stable and able to operate in high waves, thereby increasing the frequency of fishing trips and the chances of a larger catch. Conversely, small-tonnage vessels tend to be unable to go to sea in bad weather conditions, thus limiting fishing activities. Engine power (X_2) does not affect tonda fishing catch results because all vessels have sufficient engine power to reach fishing areas. Fishing success is determined by achieving the optimal speed that matches the swimming speed of the target fish. As long as vessels, whether small or large, can reach this speed, the catch is relatively the same, so variations in engine power do not cause significant differences in catch. The number of crew members (X_3) affects the catch because having more crew members allows the fishing process to be carried out faster and makes the work on board the vessel more effective. The amount of fuel (X_4) does not affect the catch because the vessels carry sufficient and evenly distributed fuel, ensuring that differences in fuel amount do not impact fishing productivity. The captain's experience (X_5) does not affect the catch because the captains who responded likely have sufficient and evenly distributed experience, meaning differences in years of experience do not affect fishing productivity. The length of the trip (X_6) does not affect the catch because all vessels operate with approximately the same number of trips, ensuring optimal fishing conditions.

4. Conclusions

The CPUE values above show that in 2018, it reached 1.4 tons/trip; in 2019, it was 1.49 tons/trip; 1.36 tons/trip in 2020; 1.25 tons/trip in 2021; 0.86 tons/trip in 2022; and 0.88 tons/trip in 2023. The F-test results show that all variables tested —ship tonnage (X1), engine power (X2), number of crew members (X3), amount of fuel (X4), captain's experience (X5), and trip duration (X6) —jointly affect the catch. The results of multiple regression analysis show the relationship between catch and production factors in the form of the equation Y =- 2818.951X1 + 104.382X2 + 4874. 343 X3 + 172. 131 X4 +21.966 X5 - 108.480 X6. The coefficient of determination (R^2) is very low at 0.356 or 35.6%. The t-test results show that the factors that significantly affect production are ship tonnage (X_1) and the number of crew members (X_3).

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